The influence of the history of establishing Czech railways on their present-day economic efficiency.[1]

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Introduction

At the present time, railway transport in the European Union (EU) is going through a renaissance – at the level of plans and goals of transport policy at least (for more detail see e.g. *European Conference of Ministers of Transport 1993*, *European Commission 2001*, *Seidenglanz 2005, Barrot 2005*). This interpretation is the basis for proposals, conceptions and strategies of a reform of railway transport's institutional structure in EU member countries, i.e. in the Czech Republic as well, including identification of related problems (see *Ministerstvo dopravy 2005* or e.g. *Kloutvor – Šíp – Vorlíček 2001*, *Nash – Rivera-Trujillo 2004*, and *Šíp 2005*). An indispensable part of these reforms are liberalisation and privatisation of railway transport services, as well as separation of operation as such from administration and ownership of infrastructure, i.e. from the railway network with its necessary technological facilities. An absolutely fundamental complication is posed by an actually automatic assumption that the railway transport network, formed in the second half of the 19th century, covers the economically relevant destinations and directions, as well as its network covers the economically relevant territory from the regional point of view. Thus, it is assumed that the railway network was formed on the basis of economic needs, ensuring profit for the owners of railways and for transport operators, and providing transport services in regions, in such directions and volumes that were effectively demanded. The railway network is thus automatically regarded as a parallel to the public road network; according to this interpretation, railway network density (as calculated per square kilometre of territory or per capita – see Table 2.1) represents a positive factor.

The present text aims at demonstrating that the railway transport network in the Czech Republic does not fulfil the above-mentioned assumptions, i.e. that it was constituted in circumstances which were only in some cases in conformity with the assumption of economically efficient operation. Therefore, it is illusory to think that privatisation of railway transport services will result in their preservation in the future or in their reconstruction in an extent and quality presumed by conceptions of revitalisation of railways. The principal method here is application of the principle of "path dependence" on railway transport, following the approach that "history matters", just like this principle is used in the works by e.g. *Puffert (2002)*, *David (1993)*, or *Arthur (1994)*. The application of methodology of path dependence within the framework of the present text and the resultant conclusions also correspond to the approach adopted by *Liebowitz* and *Margolis (1995a)*, who are otherwise critical to the general use of the historical method. Another idea is also an empirical finding that railway lines built with the use of the biggest subsidies are the least efficient in terms of operation (*Gathon – Pastieau 1995* and *Campos – Cantos 2000, p. 233*).

The procedure will be as follows: first, I will describe the chosen methodology of solution and I will explain the economic aspect of the problem; next, I will define eight basic archetypes of establishing the individual railway lines on the Czech Republic's territory in the context of present-day economic and political conditions; these findings will then serve as the basis for my graphic analysis of the Czech railway transport network and for the formulation of a

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conclusion. The sense of this analysis is not to doubt the process of revitalisation of railways (and particularly not the concept of liberalisation and privatisation of railway services!), but to provide a real basis for the mentioned assumptions. This is where the impulse should arise for making the targets of revitalisation of railways in the Czech Republic and its supposed results more realistic, as well as for reconsidering the expected (or rather just anticipated) costs of the process. This text‘s ambition is to enrich the present-day economic debate on the current state and the future of railway transport in the Czech Republic by its historical context, as well as to refute some traditional misconceptions and clichés which contort economic analyses and political decision-making.

1. Methodical approach to solving the problems of railways

Railway transport is a mode of transport services, characterised by numerous specifics (evidenced by a number of studies, see e.g. *Nash 1992*, *Campos – Cantos 2000, p. 171*). The standard methodology of analysis and comparison of railway transport is based on a few theoretical concepts which explain the specifics of this transport service mode and set out the preconditions of economically efficient operation. These concepts include: (i) existence of sunk costs, (ii) economies of scale, (iii) economies of traffic density, and (iv) the network effect. The state's transport policy is (and has always been – see *Kvizda 2005*) essential for railway transport. At the same time, the state decides about the targets, preferences and, to a large extent, also costs of individual transport modes, not only on the basis of economic, but also social criteria. When analysing railway transport, it is necessary to take into consideration several other theoretical concepts which, along with economic concepts, determine the conditions of a socially efficient operation. These concepts particularly include: (v) safety of operation, (vi) emission burden of operation, (vii) occupation of land, and (viii) energy requirements of operation. I will now discuss the individual concepts in detail and consequences will be drawn from them in order to determine necessary preconditions of efficient (both economically and socially) operation on the railway network. In conclusion of this part I will analyse in detail the problems of competition – (i) as a process which formed the railway network, (ii) as a state of the transport services market, and (iii) as an instrument of the state transport policy.

1.1. Sunk costs

One of the specific signs of railway transport are high fixed costs in the form of track and signalling. Since as early as the 19th century this phenomenon has been frequently subject to examination (*Acworth 1905*) and has become, among others, a classical example of natural monopoly. Although it has turned out that the original analytic methods based on cost accounting overestimated the volume and importance of fixed costs (*Griliches 1972*), these costs are specific for railway transport, determining its position against other modes of transport. This means in practical terms that railway companies tried naturally and are still trying to reduce the costs either absolutely, or relatively to operating costs. Absolute reduction of costs of infrastructure may lead to underinvestment in railway facilities at the expense of safety of operation – a historical example may be the neglect of maintenance of the track and signalling in the 1870s on the North Line of Emperor Ferdinand in Austria (*Hons 1990, p. 111*), in modern times serves quite as warning the neglect of maintenance and underinvestment in infrastructure owned by Railtrack after an extensive privatisation of railways in Great Britain, resulting in tragic train accidents in Clapham and Hatfield in 2000 (*Bamford 2001, p. 79*).

In view of the specific nature of fixed costs of railways, it was impossible to capitalise such investment, not even partly, and transfer to a different business activity. That would mean the gravest fear and the biggest obstacle to building a new line. One of the conditions that ensues from this and that had to be fulfilled by a railway established as a private enterprise, to be able to redeem the registered capital and to finance fixed costs of infrastructure: it had to be founded in the region and in the direction which generated a long-term stable and economically relevant demand for transport services. Because railway enterprise was so sensitive to investment in infrastructure, an idea evolved as early as in mid-19th century that the state should take over a part or the whole of the risk connected with sunk costs, i.e. systems of state subsidies were formed, as well as guarantees of returns on capital investments or state ownership of infrastructure. A railway founded by the state had to meet economic, as well as social goals – as far as the applied sunk costs are concerned, this means identical conditions as for a private railway; from the social point of view, it had to connect places and regions whose servicing by transport had been desirable in the long run. A relative reduction in costs of infrastructure is further connected with the following three concepts.

1.2. Economies of scale

Economies of scale reflect the relation between the inputs and the total volume of outputs, including operation and size of network. Studies based on an analysis using the Cobb-Douglas production and cost function (*Keeler 1974*, *Caves – Christensen – Swanson 1980*) have demonstrated that infrastructure is the source of a large majority of fixed costs, i.e. the track and land; similar studies comparing the individual modes of transport (e.g. *Winston 1985, Wetzel – Growitsch 2006*) have shown that it is just railway transport where significant economies of scale occur in this connection. In view of high fixed costs in the form of infrastructure the construction of parallel duplicate lines providing transport services to an approximately identical segment of customers cannot be effective – not even at the cost of increased competition, and therefore pressures on operational efficiency. Contrary to this, what appears to be efficient is that infrastructure burdened with sunk costs is used by several mutually competing carriers, which is exactly the core of the strategy of current railway reforms. However, in the era of private railways owning infrastructure and providing transport services, many examples denying the logic may be found. Similarly inefficient may be the state's attempts to ensure transport services to a region by supporting railway transport by the public service order. In some parts of the network, despite the potential effect of economies of scale on railway, the access to services may be secured at a lower cost by bus transport. The same holds true for freight transport in connection with the environmental burden of the operation.

1.3. Density of traffic

Another important finding ensues from Keeler's study (*1974*) that there are two sources of economies of scale: (i) returns from the size of a business and (ii) returns from the density of traffic. Returns (savings) from density of traffic reflect the relationship between inputs and outputs, while the size of network remains unchanged. Subsequent studies (namely *Caves – Christensen – Tretheway – Windle 1985*) demonstrated that it is just traffic density what is absolutely crucial for railway transport, whereas the size of a business is marginal (i.e. economies of scale are constant, whereas returns from traffic density is growing). Density of traffic is also a factor which, in relation to economies of scale, determines effectiveness of railway companies established within the framework of the present-day liberalisation and privatisation of railways in Europe (*Stelling – Jensen 2005*). It is neither easy, nor is it quite unambiguous to distinguish the effect of returns from density of traffic and from economies of scale; however, studies examining this relationship have come to the conclusion that density of traffic is the dominant factor of efficiency of operation (see *Jara-Díaz – Cortés – Ponce 2001*). At the same time, density of traffic is the factor which provides railway with a competitive advantage over other transport modes: i.e. a possibility to dispatch long heavy trains for long distances or to transport a large number of passengers on shuttle trains within short intervals. From this point of view, the decisive factor for efficiency of railway transport network is its ability to generate adequate supply of transport capacity in backbone directions (*Fischer – Bitzan – Tolliver 2001*). A factor which decreases density of traffic is duplicity of lines, a factor which does not increase density of traffic is inappropriate routing of lines; density of actual network is then an irrelevant factor.

1.4. Network effect

Network effect is defined most often as a change in income from a supplied good depending on the change in the number of subjects demanding the identical good (e.g. *Katz – Shapiro 1985*, *Liebowitz – Margolis 1995b*). A positive network effect, i.e. a situation of rising revenues in connection with a growth in the market, has a similar impact on a company's functioning as economies of scale. A firm which produces a good incompatible with other potential substitutes (i.e. owning a network) has a competitive advantage over producers of incompatible substitutes if its network is bigger than network of other competitors. Network effect is traditionally associated with railway operations, its manifestation in the past (better to say, belief in its manifestation) was reflected in several typical processes: branching of integral networks owned and operated by a single carrier, construction of branch and connecting lines, unification of track gauges, nationalisation of infrastructure and construction of unitary national networks. Surprisingly, empirical studies focused on analysing network effect on the railway have not proven its demonstrable relevant existence. When analysing the network in a given region, *Walker (1992)* reached the conclusion that the effect of economies of scale is stronger and prevalent, whereas *Callan* and *Thomas (1992)* proved as dominant density of traffic, network effect being only connected with it. Comparison of two studies of North American and European railways is interesting: an analysis of 27 North American railways (*Friedlander 1993*) identified a strong network effect and just weak economies of scale, whereas a study by *Preston (1994)*, analysing 14 European railways (see also *McGeehan 1993*, *Cantos 2000*) proved as a strong network effect, however, depending (along with economies of scale) on the characteristic of network. This allows us to deduce a big importance of returns from density of traffic (*Quinet – Vickerman 2004, p. 151*). It may also be assumed that the conditions of founding North American railways were more favourable for the establishment of an optimal network than European conditions. When analysing railway transport, it makes sense to take into consideration the conditions of establishing the network, too. It follows from the above-said that returns from density of traffic is decisive for efficiency of railway transport.

1.5. Safety of operation

Traffic accidents are one of the main external costs of transport, together accounting for more than 50% of total external costs (*Kutáček 2005*). Railway transport seems to be extraordinarily safe in this connection; an EU estimate puts costs of railway traffic accidents at 0.2% to 4.6% of GDP (*ECMT 1998*). However, this interpretation may contain considerable distortions, e.g. *Kutáček (2005, p. 48)* quotes for the Czech Republic (year 2004) approx. 1,400 fatal injuries in car accidents and just 8 fatal injuries in railway accidents. When these statistics are converted into transport output (i.e. calculated by the numbers of persons transported on the roads and on the railway), we get an equivalent figure of approx. 800 potentially fatal injuries on the railway. Further, taking into account that fatal injuries on level crossings are charged to the account of road transport, not railway transport (which basically generates them, however), it is obvious that railway accidents cannot be completely marginalised[2]. It is important for an analysis within the framework of this text that just accidents at level crossings are closely connected with the extent of network (i.e. the number of crossings of railways with the road transport network) and with density of traffic (i.e. the probability of collision of vehicles on a level crossing). The higher is the density of traffic at the crossing of the given communications, the lower relatively are the costs of building a secured crossing or overpasses of roads and railway tracks. Reduction in external costs of transport in the segment of accidents may thus be achieved not only by transferring part of transport services from roads to railways (as supposed by revitalisation strategies), but mainly by utilising the effect of traffic density on the railway network.

1.6. Emission burden of traffic

Another significant external cost is pollution of air by emissions. Such costs e.g. for the Czech Republic are estimated at 1.1% GDP (*Kutáček 2005, p. 47*). The current strategy of revitalisation of railways in Europe is based on the assumption that railway is capable of transporting a comparable volume of goods and number of passengers with a considerably lower environmental burden (*European Commission 2001*). The pitfall of various comparative studies on emission burden is that they are frequently based on a status quo ratio of individual transport modes in transport of goods and people, without reflecting the ratio. E.g. the study by the Centre for Transport Research (*Centrum dopravního výzkumu 2004*) quantified the volume of external costs of railway transport in the Czech Republic as 3.4% of total external costs of transport (see *Kutáček 2005, p. 47*). This, however, does not answer the question of how ecologically efficient an increase in the share of railway transport would be. The study also did not consider the ecological burden of electric traction, and there are just electrified lines that account for the largest transport volumes. Nevertheless, generation of electricity burdens the environment with a large volume of emissions and it is still mostly based on consumption of non-renewable resources or on nuclear power, still debatable from the ecological point of view. Moreover, the technical solution of railway transport is based on transportation of a relatively high dead weight: railway cars are substantially heavier than road vehicles. It is evident from the above-stated that railway transport may be ecologically more efficient only if it is loaded sufficiently; as e.g. *Peltrám* writes *(2005, p. 71)*, optimal transport performance from the point of view of emission burden must be derived from marginal transport volumes. This concept is closely connected with the above-described effect of returns from traffic density – i.e. the higher will be density of traffic in the given transport relation, the higher the effect of reduction in specific emission burden may be expected. On the contrary, it may be implied in connection with the network effect that branching of the network leads to reduction in density of traffic in the branches, and consequently to reduction in ecological competitive advantage of railways over road transport. This means that road transport will always be ecologically more favourable for transport of a few dozen tons of goods or twenty passengers.

1.7. Occupation of land

Technical solution of railways enables to transport by a double-track line approximately as many people within an hour as a 16-lane highway. One of the world's busiest airports – O'Hare Airport in Chicago – checked in around 60 million passengers a year in the 1990s, whereas one of the Parisian railway stations – Gare du Saint Lazare – managed 150 million; a standard big airport takes up an area equivalent to about 500 km of a high-speed railway line

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[2] The number of accidents at railway level crossings in the Czech Republic has been rising over the past few years: e.g. 235 accidents in 2002 claimed 24 human lives, three years later 274 accidents occurred, claiming lives of 53 people (according to http://www.mdcr.cz/NR/rdonlyres/5530E0E6-4F63-4554-B561-979BEFF4CFAA /0/Nehodynaprejezdech.rtf).

(*Lowe 1994, p. 7*). These classical textbook examples, however, are difficult and questionable to apply generally. The correct methodological approach would be an analysis of opportunity cost; nevertheless, this is extraordinarily problematic since a comparable data base of the costs of using individual transport modes is not available (*Hibbs 2003, p. 134*). Despite this the logic of the matter leads to deduction that the decisive criterion will be the price of occupied land in relation to the ability to repay this primary cost from operating revenues. This criterion also includes the principle of economies of scale and density of traffic, as described above, and it should be taken into consideration in this respect also for the purposes of public support. It may be concluded, again, that the opportunity cost of occupation of land will increase in connection with the network effect and decrease with the effect of traffic density.

1.8. Energy requirements of operation

This concept is utterly out of the scope of economy as, in economic terms, it is included in operational costs and thus enters the standard assessment of efficiency of operation. A special focus on energy requirements is brought about particularly by strategic and political factors connected with dependence on crude oil, imported from politically unstable territories; e.g. there are estimates for the USA which say that converting 5% of passenger car transport from motorways into electrified railways would reduce imports of oil from the Gulf by 17% (*Lowe 1994, p. 11*). Contrary to car or air transport, railways may use, beside diesel traction, also the electric traction, based on traditional coal, still available in Europe, or on nuclear power, or on a very environmentally-friendly water power. The decisive criterion for a strategic choice between a public support to railway or road transport is again the principle of economies of scale and returns from density of traffic.

1.9. The concept of competition in railway transport

The aim of liberalisation and privatisation of railway operations is a higher level of economic efficiency of transport services by means of a higher level of economic competition. The competition is often viewed as an instrument *per se* – i.e. the ability of competition to promote efficiency of production of services is generally presupposed (e.g. *Campos – Cantos 2000*, *Estache – Rus 2000*). Speaking about railway transport services, two basic forms of competition can be distinguished there: competition in the market, and competition for the market (*Estache – Rus 2000*, *Quinet – Vickerman 2004*). Present strategies of railway reforms (as many studies show – e.g. *Nash-Rivera-Trujillo 2004*) are based on competition for the market for train-operated-companies (TOC) as the general principle[3]. But what is the framework the TOCs are competing within? The framework of the railway service market is formed (or should be formed – as the EU railway reform's strategy requires) by the railway network separated from the operations and regulated and (usually) owned by the state. That means, nowadays, that TOCs are about to compete for the market which is created by the railway network established 170 years ago. The core question is whether the network is something to be competed about. Naturally, there is no question of technical condition of the infrastructure (even if the infrastructure is generally heavily underinvested, as far as Eastern Europe is concerned). The problem is the network itself – its compactness, its shape, connected points (places), its capacity, duplicity of lines, congestion etc. The right question is whether the network is suitable for the TOCs' business plans, as well as for potential passengers' willingness. The bigger the gap is between the network's possibilities (limits) and TOCs' / passengers' demand, the higher is the level of the network's imperfection (i.e.

[3] Actually, there are two levels of competition on the railway service market: the one between TOCs, and the other between railways and other transport modes (especially coach services and air transport). The first of them only is discussed in this paper.

inefficiency). Speaking about the government's transport policy, the level of this inefficiency correlates to the amount of public subsidy the government pays to private TOCs to operate non-profit lines.

2. Railway network on the territory of the Czech Republic

A number of analyses based on simple as well as very advanced econometric methods have been carried out and published in order to confirm the above-mentioned assumptions. However, generalisation of resulting models and their application in economic policy faces serious complications (*Nash – Wardman – Button – Nijkamp 2002, p. 16*), stemming from the specifics and peculiarities of individual national (regional) railway networks. Further in the text, I will attempt to describe and analyse one of the specifics in the Czech conditions: the way how individual components of the railway network came to existence. The first public railway on the present-day Czech territory was the horse-drawn line from Linz to České Budějovice (Budweis), opened for operation in 1828, the last big public railway was the line from Havlíčkův Brod to Brno, put to use in 1953. Within these nearly 130 years, over 9,500 kilometres of lines have been built on the Czech territory. Their motivation of founding, as well as economic and political conditions at the time of their founding, have differed considerably. The history of formation of the Czech railway network may be divided into several crucial stages on the time axis: (i) the first developer stage from the 1820s, marked by the first private railway companies (particularly the North Line of Emperor Ferdinand – KFNB); (ii) the second stage from 1841, when the initiative was taken over by the state which started to build the core railway network at its own expense (The North State Line – NStB); (iii) a further period of private railways, which began in 1855 by the state's resignation from building and operating railways on its own (because of shortage of funds) and privatisation of state-owned railways (The Company of State Line – StEG): this period was also characterised especially by coalmine lines; (iv) and the last stage from the 1870s when the state took over the initiative again and supported financially a mass construction of local lines. This has led to a heterogeneous railway network with a relatively high density (see Cartogram 2.1). This network has changed only a little since 1914.

With regard to the above-mentioned conditions for success of the present-day revitalisation of railways, the circumstances of founding individual lines are very important: (i) if the incentive which led to their founding and which determined economic efficiency of their operation has ceased to exist to the present date, a possibility of economically rational and efficient transport operation may hardly be expected on such lines at the present; (ii) if the motivation of the founding of such lines was doubtful economically, determined by non-transparent policies of subsidies and lobbying, their successful revitalisation may hardly be expected either. I have defined eight basic archetypes for an analysis of the characteristics of the Czech railway network (the archetypes are divided into three groups) of individual railway lines according to the type of their founding within the current situational context:

Group A: Lines founded as cost-effective

1. Lines founded as private enterprises motivated by profit (other than in groups B and C).
2. Lines founded by the state as the backbone network (other than in group C).

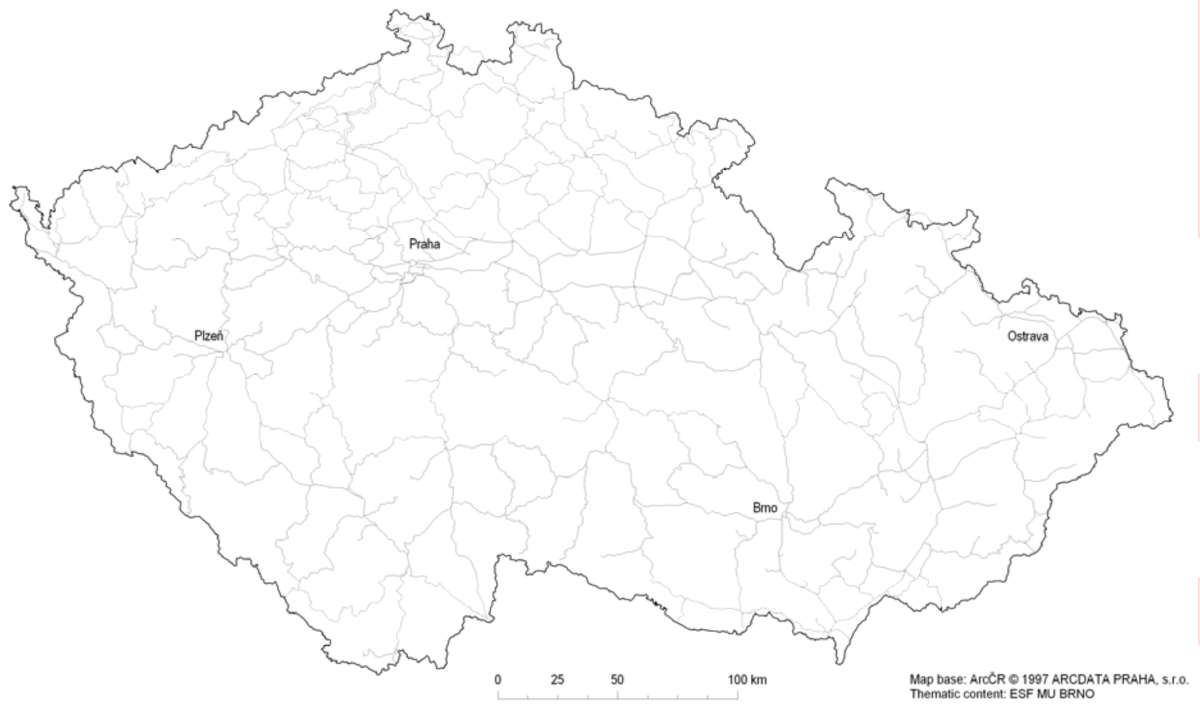
Group B: Lines founded as economically inefficient

3. Lines built by private companies as connecting or duplicate.
4. Lines built by private companies on an order from the state.
5. Local lines built with the state's financial support.

Group C: Lines which have become economically inefficient due to changed conditions

6. Coalmine lines (other than in group A).
7. Branch lines built by large private railway companies and private local lines (other than in group B).
8. Lines built in different geopolitical conditions (other than in groups A and B).

Cartogram 2.1. Railway network in the Czech Republic.

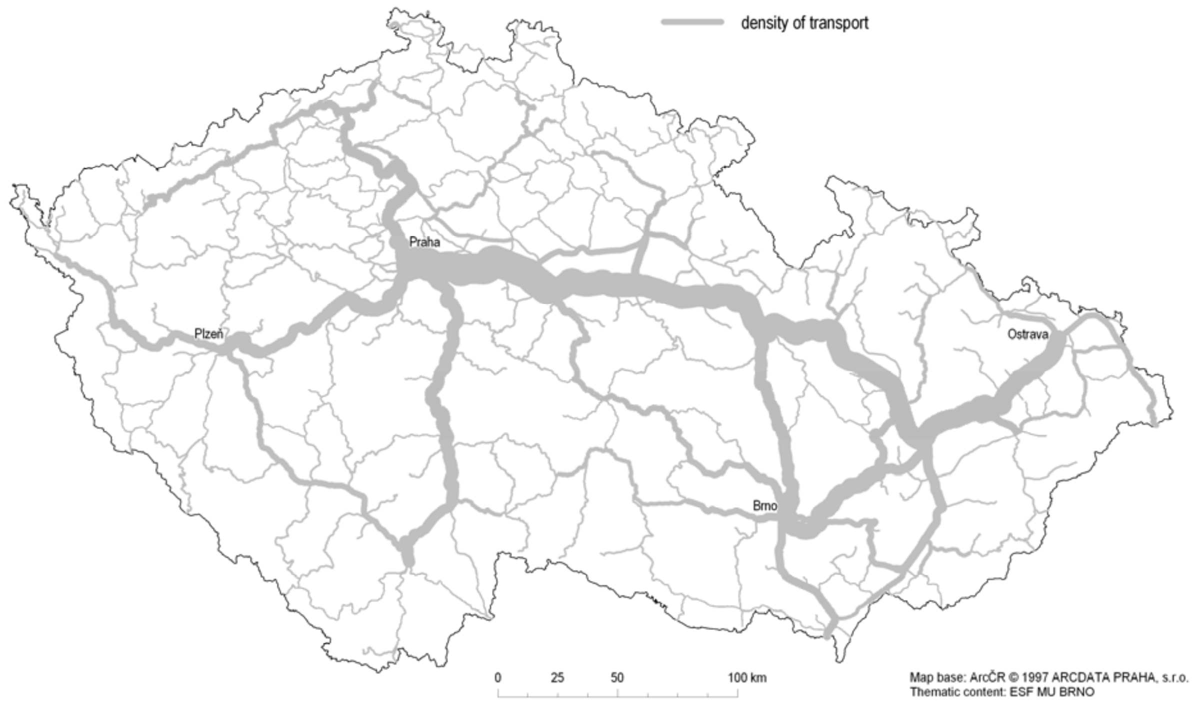


Source: ČD (Czech Railways)

I include railway lines into the individual groups according to the dominant motive for their founding, always considering whether the motivation has endured till the present time or not. There obviously occur cases when the changing economic and political situation at the present time influences positively the economic efficiency of operating some lines. Because these are few isolated cases and because such changes could not have been anticipated at the time of building the lines, I do not take them into consideration for the classification of lines. This cannot even be subject to any generalising analysis, but rather to an individual assessment of a particular line.

Empirical studies carried out on the basis of theoretical concepts mentioned in the first section show that the most important factor determining the economic and social efficiency of operating individual lines is density of traffic. Therefore, I will first formulate theoretical prerequisites of their (in)effective operation for individual groups of lines, based on a previous analysis, particularly taking into account the concept of returns from density of traffic. Also, this part of the Czech railway network will be compared with the present-day density of traffic (Cartogram 2.2).

Cartogram 2.2. Density of traffic in the Czech railway network.



Source: ČD (Czech Railways).

3. How individual parts of the railway network were formed

3.1. Lines built by private companies to make a profit

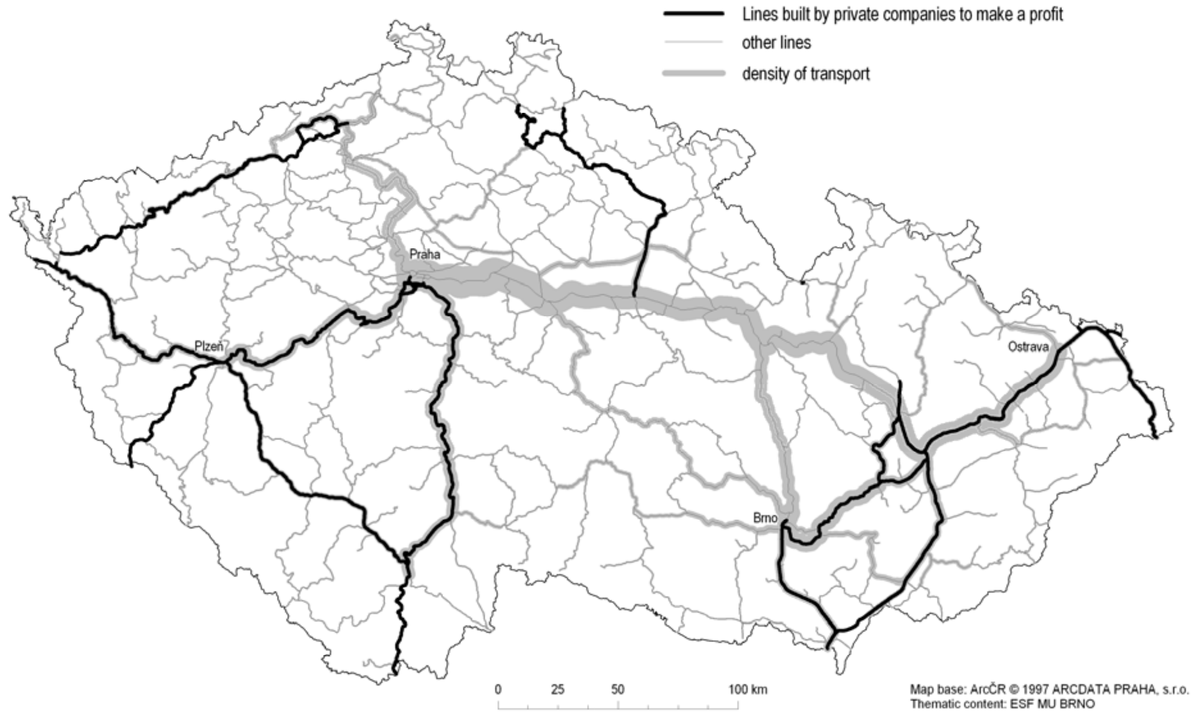
Private railways were built in Austria[4] at the very beginning of ”the railway age” – i.e. between 1828 and 1841– without any state subsidy. The state licensed the railways without any restrictions or requests as for route planning. This means that the first lines were built clearly with regard to economic criteria and connected the most important cities of the economy. What is important, there were little to compete about as a railway service market was emerging gradually. The first railway was built from České Budějovice (Budweis) to Linz in 1828, crossing the Danube-Elbe watershed. The other railway – Kaiser Ferdinand Nord Bahn – connected Vienna with Brno in 1839. This railway became one of the biggest private enterprises on the Continent; finished in 1855, the line connected Vienna with Ostrava and Krakow. The next stage of building private railways began in 1855 and lasted till 1875. During this stage the state influenced routing of private lines according to political and strategic (nowadays we could say ”public”) concerns – e.g. passing a royal military stronghold, the line had to call there, etc. In return, the state began to support private railway companies using three ways: (i) guarantee of a minimal gain from invested capital (usually 5%), (ii) direct subsidy, and (iii) purchase of railway shares by the state. The first private railways were followed after 1855 by several private lines connecting Vienna, České Budějovice (Budweis), Plzeň (Pilsen), Liberec (Reichenberg) and other major cities.

The private railways built during the first or the second stage connected the most important regions of the country – speaking about economic, as well as political importance. During the last century a few was changed in this importance. Figure 3.1 shows the network of railways of the 1st group – these railways correspond to the lines of the highest traffic density. 1,538

[4] The territory of the Czech Republic belonged to the Austrian Empire till 1918.

km of these lines were built between 1828 and 1874 with the average length of 102.5 km. As for competition, these railways competed in the market freely (during the second stage, they competed with some slight restrictions as for routing). Anyway, it could hardly be described as a throat-cut competition – the railway companies did not compete with each other as the potential market was open and wide. Quite a strong competition appeared at that time between railways on the one side and road service and navigation on the other side – this development was naturally based on the technological advantage of railway transport. The network was shaped according to the demand for transport services – what is the most important, there was not (and still is not) any reason for any change of the demand other than a switch from one transport mode to another.

Figure 3.1. Lines built by private companies to make a profit.

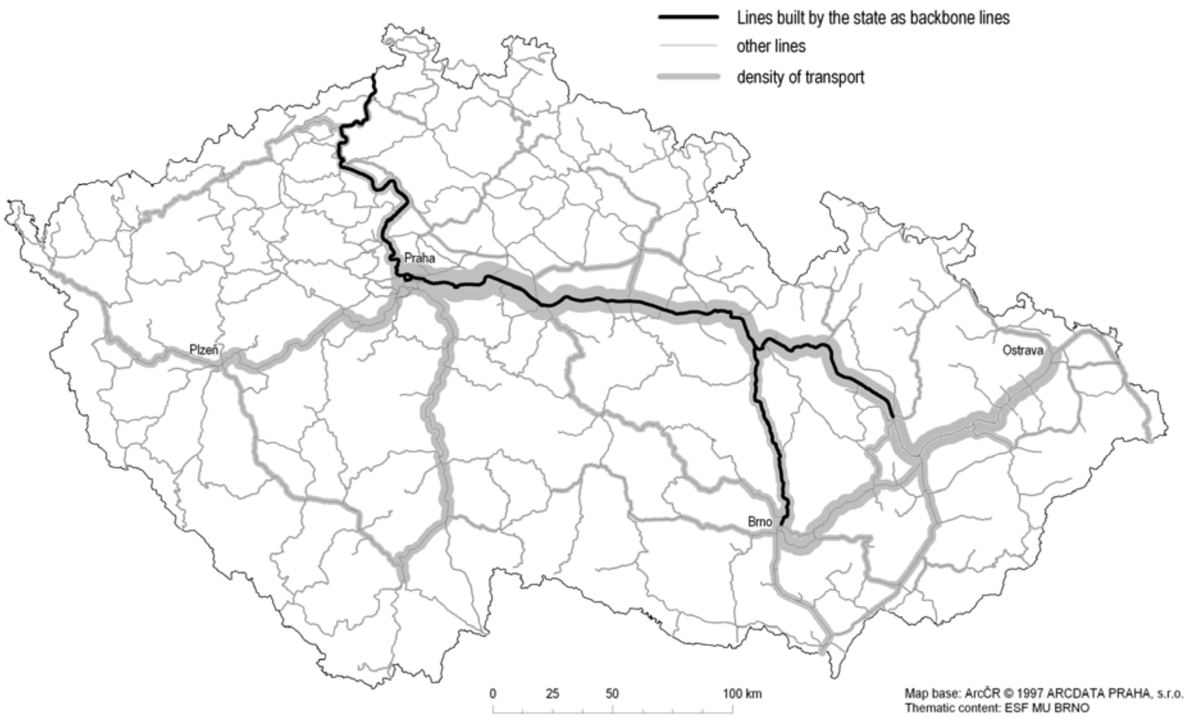


3.2. Lines built by the state as backbone lines

The state changed its policy towards the railways completely at the beginning of the 1840s: the empire's authorities decided to build the railway network on their own account. The first state trunk line was opened in 1841 and connected Prague with Vienna via Olomouc. The next line, opened in 1849, made this connection shorter via Brno. The last state line was opened in 1850, connecting Prague with Dresden via Podmokly. The capital of Austria – Vienna – was connected with the Saxon capital – Dresden, and the capital of Prussia – Berlin. As for the Czech network, the lines made a real transport backbone of the economy from the west to the east, connecting the major north-south line from Vienna to Krakow.

No other state railways were built after 1850. The Austrian state budget became short of money quite quickly (due to huge military expenses) – that is why the state changed its railway policy again (and again completely): further development of the railway network was based on private enterprise, slightly regulated and supported by the state (as I described in the section above). 472 km of the state trunk lines were built between 1845 and 1850 in the average length of 157.3 km. Figure 3.2 shows the network of railways of the 2nd group – again, these railways correspond to the lines of the highest traffic density. As for competition, there was no competition in the market because the lines were planned and built by the state. These lines created the basic (backbone) network connecting the major economic and political centres – the demand for transport services was ensured, there is no reason for any change of demand today (other than the switch to another transport mode as I mentioned above).

Figure 3.2. Lines built by the state as backbone network.



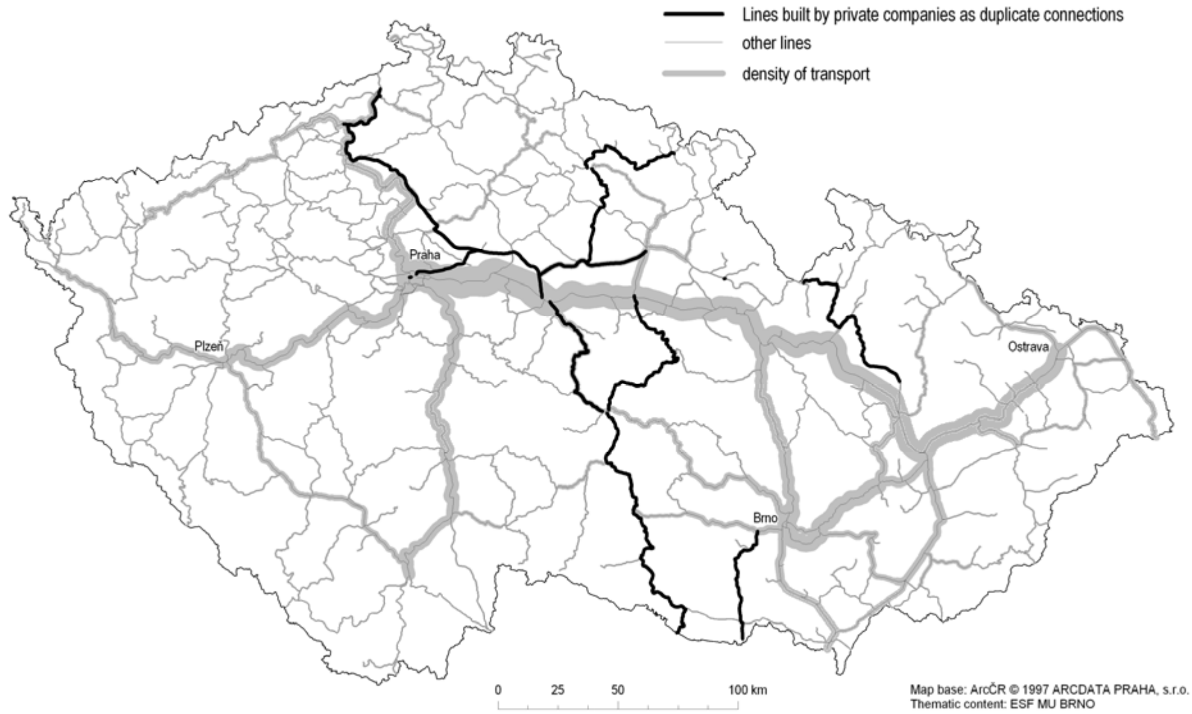
3.3. Lines built by private companies as duplicate lines

Railmania seized Austria in the 1870s; railway companies expanded their lines, trying to exploit the network effect and/or economies of scale. Because the most profitable (i.e. the most efficient) lines had already been engaged, the companies tried to find alternative connections between connected places, i.e. duplicates of existing profitable lines. The problem was the fact that there was no competition for the market there – just competition in the market. Each railway company owned its own infrastructure (tracks and signalling) – sharing a particular track together with another company was not an option. Let us take into account that at the same time the state subsidised private companies to build and run its own lines. That all together led to establishing many duplicate lines. Their existence resulted from competition in the market – but in unequal conditions (due to non-transparent interventions and support of the state).

The major problem of duplicate lines is their operational inefficiency, as the lines were built on less convenient grounds. The very typical duplicate lines were built by the Österreichishe Nordwestbahn company at the beginning of the 1870s. The lines connected Vienna with Dresden, crossing the Moravian Highlands and by-passing Prague – that is why the lines recorded lower operational efficiency and lower density of traffic.

Figure 3.3 shows the network of railways of the 3rd group – these railways correspond to the lines with low density of traffic. 801 km of these lines were built between 1869 and 1874 in the average length of 101.1 km. This part of the network resulted from a very strong competition in the market – however, the competition had evolved under special circumstances which I mentioned above (non-transparent subsidy from the state).

Figure 3.3. Lines built by private companies as duplicate connections.



3.4. Lines built by private companies on order from the state

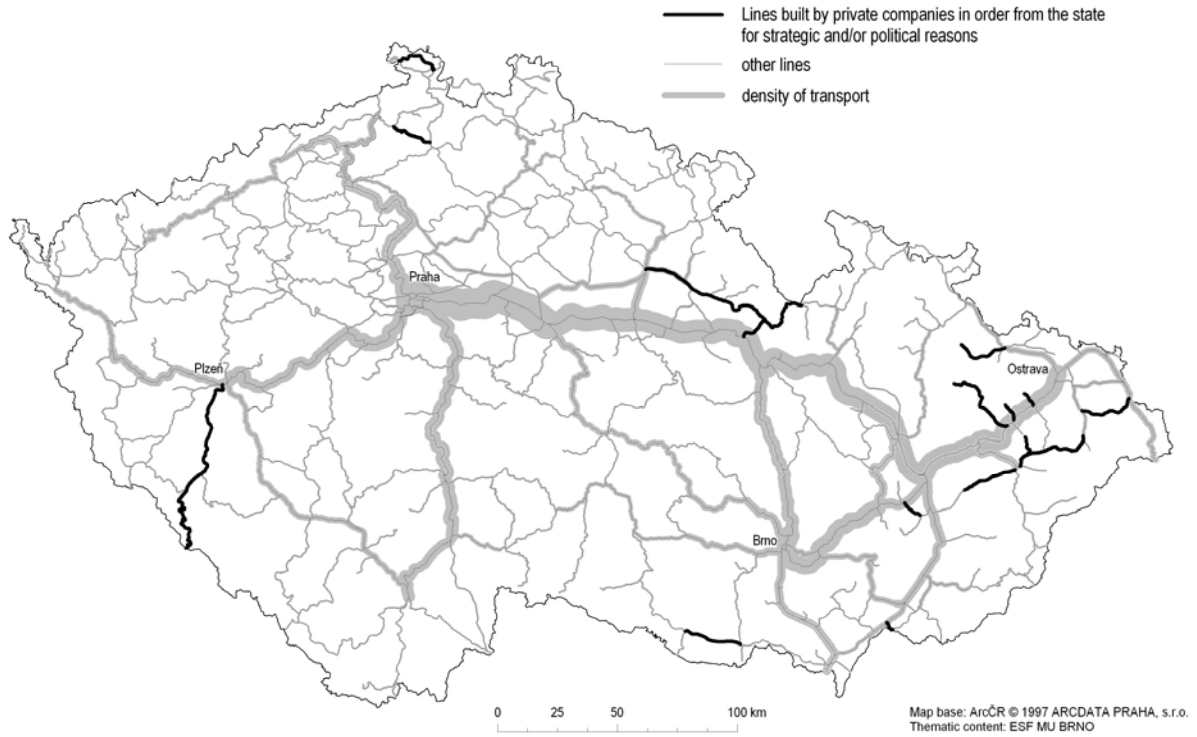
The state – especially the military authority – recognised the importance of railways for transport of troops during a war time (namely after the lost war against Prussia in 1866). That is why the state charged railway companies to build on their own account several lines which had little economic but great strategic sense. Inefficient lines and/or duplicate lines appeared within the Czech network. One of the longest duplicate strategic lines built according to the political order doubled the old line from Vienna to Krakow along the section which went too close to the Prussian frontier. Several other lines had to be built to reinforce connection with strategic friend-countries – Bavaria and Saxony. All of them went across hilly areas – these lines have little economic importance but high operating costs.

461 km of these lines were built between 1870 and 1892 with the average length of 30.7 km. Figure 3.4 shows the network of railways of the 4th group – these railways correspond to the lines with a low density of traffic.

3.5. Local lines built by private companies and supported by the state.

The building of main lines was nearly completed at the end of the 1870s, but a lot of towns still lay out of the railway network. There was a problem there because connecting of these towns with the main lines of the network was not seen as a good business – that is why it was hardly possible to involve private capital in such business without any state support. To solve the problem the state issued a special law in 1880 which supported building of the 2nd class railways – i.e. local, branch, regional lines etc. The support had two forms: (i) financial subsidies, and (ii) technical allowances. As for the financial subsidies, the state guaranteed a minimal gain from invested capital, supplied railway companies with capital (a company had to invest 25% of the total amount of capital only, the rest was provided by the state without

Figure 3.4. Lines built by private companies on order from the state.



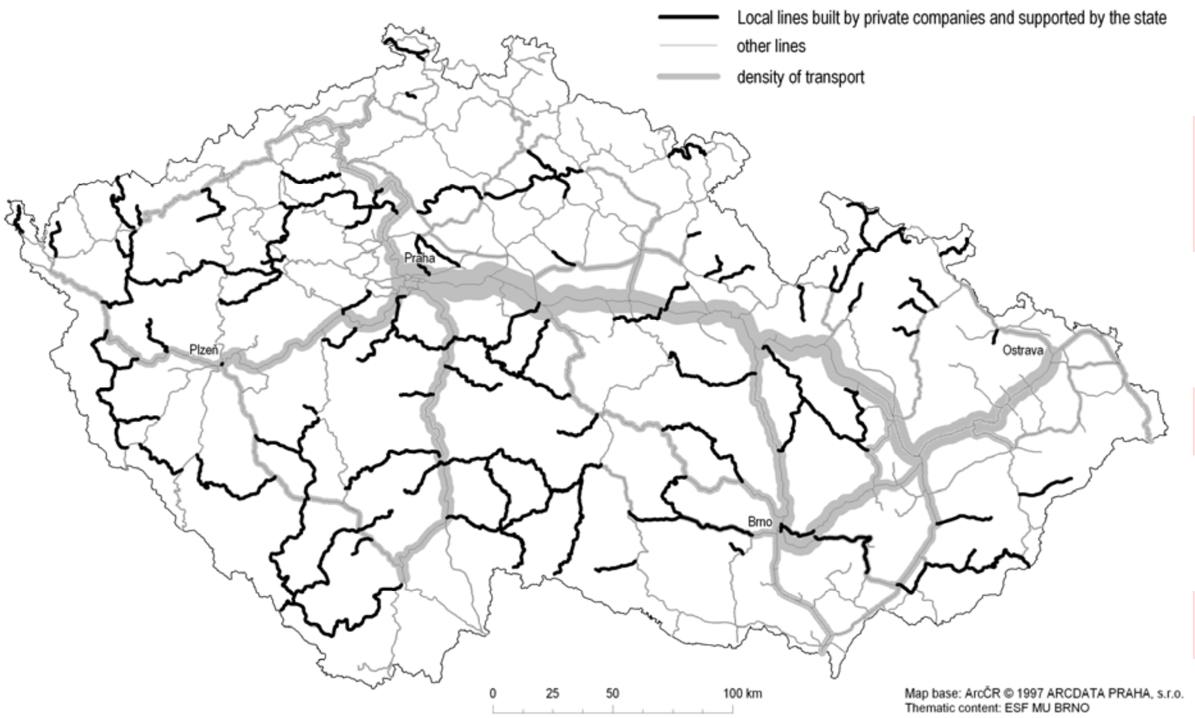
interest), the loan had to be paid back in 90 years, and so on. As for the technical allowances, local railways could be built according to lower standards compared with main lines: light track, turns of small diameter, slope up to 50‰, maximum speed up to 15 mph, no signalling due to a presupposed low density of traffic (of about 1 or 2 pairs of trains a day). As for planning and building the local railways, the key role was played by local lobbies: there had to be someone there interested in building a local line to make an extra profit from the new line – an owner of a local (usually small) factory, sugar mill, sawmill, quarry, etc. as well as a big farm. An important role was played by local politicians as well – they tried to attract potential voters by giving them a gift: a new railway to their sleepy town. The principle of state guarantee of the minimal gain from invested capital appeared to be an essential motive for building local railways. Comparing the local lines built in Bohemia[5] – where the gain was guaranteed – with local lines built in Moravia[6] – where the gain was not guaranteed – we can see a significant difference: the total / average length of local lines in Bohemia was about 1,900 km / 33 km in contrast with 261 km / 14 km in Moravia.

Altogether, local railways were built according to particular interests of local lobbies and politicians, but on the account of the state; at the same time the state had little chance to influence routing of local lines. This development resulted in building local lines which were deficient even at the time of opening, which were able to pay back neither interest nor the credit from the state, and served not public demand, but private interest of local lobbies. Not surprisingly the local railways are quite inefficient nowadays, as well as they were in the history (many empirical studies concluded this fact generally – e.g. *Gathon – Pastieau 1995* or *Campos – Cantos 2000, p. 233*).

[5] Bohemia was an autonomous part of the Czech lands surrounding its capital Prague.
[6] Moravia was an autonomous part of the Czech lands surrounding its capital Brno.

3,039 km of these lines were built between 1871 and 1914 with the average length of 30.4 km. As for competition, there was a very strong competition for state support there as well as competition in the market – but no competition for the market. According to the initial assumption, density of traffic is low on the Czech local lines (see Figure 3.5).

Figure 3.5. Local railways built by private companies and supported by the state.



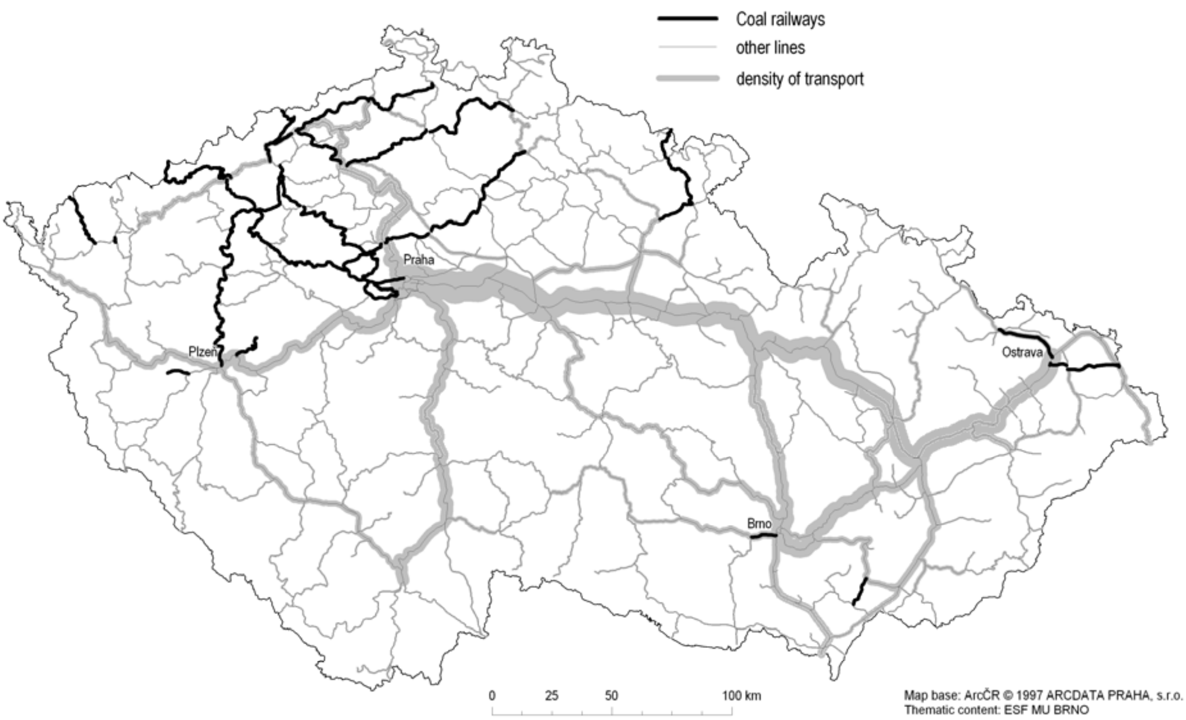
3.6. Coalmine railways.

At the very beginning of the railway age many lines were built to connect coal mines with major cities and steel mills. Coal used to be the most important commodity transported on railways: coal was burnt in engines to move trains, coal became the only fuel in steel mills – and steel became the most important material for construction of rail tracks, as well as rolling stock (*Hlavačka 1990*) – most of industrial production was directly based on coal. It is clear then that building and running of lines to transport coal was a good business – coalmine railways were the most profitable ones in the 1800s (*Hlavačka 1990*). That is why there was a very hard competition in the market: many railway companies tried to build a line connecting collieries with towns. The first lines were quite short (Brno – Rosice 20 km, Prague – Kladno 30 km, Pilsen – Stupno 20 km, etc.), later coalmine lines were built to farther destinations (Pilsen – Most 141 km, Řetenice – Liberec 145 km, etc.) and abroad, namely to Saxony. The competition between railway companies was neither even nor fair: the companies formed local monopolies buying collieries, excluded competitors (i.e. other mines) from the market by setting up high tariffs, or by lobbying for additional by-state-guaranteed privileges, etc.

Because coalmine lines were so profitable, competition in the market resulted in building several duplicate lines, connecting e.g. North-Bohemian mines with Prague four times and with Liberec twice. At the time when the whole economy depended on coal, all coalmine lines were profitable, i.e. efficient – but there is little to transport nowadays: former coalmine lines cross the country by-passing towns and connecting collieries and steel mills which were shut down years ago. Of course, there are several important and profitable coal mines as well as steel mills and chemical works at the present – these huge plants are well served by several main lines I gathered into the 1st and/or the 2nd groups: Prague – Olomouc, Břeclav – Ostrava, Ústí n/L – Chomutov, etc.

Figure 3.6 shows the lines of coalmine railways which were built just to transport coal (i) from collieries which were shut down, or (ii) to places where there is no demand for coal presently (i.e. big cities without heavy industry based on coal – chemical works, steel mills, etc.). 1,083 km of these lines were built between 1855 and 1911 with the average length of 47.1 km. Operating these lines is inefficient today, there is no relevant demand for transport services – the coalmine railways belong to the lines with the lowest density of traffic.

Figure 3.6. Coalmine railways.

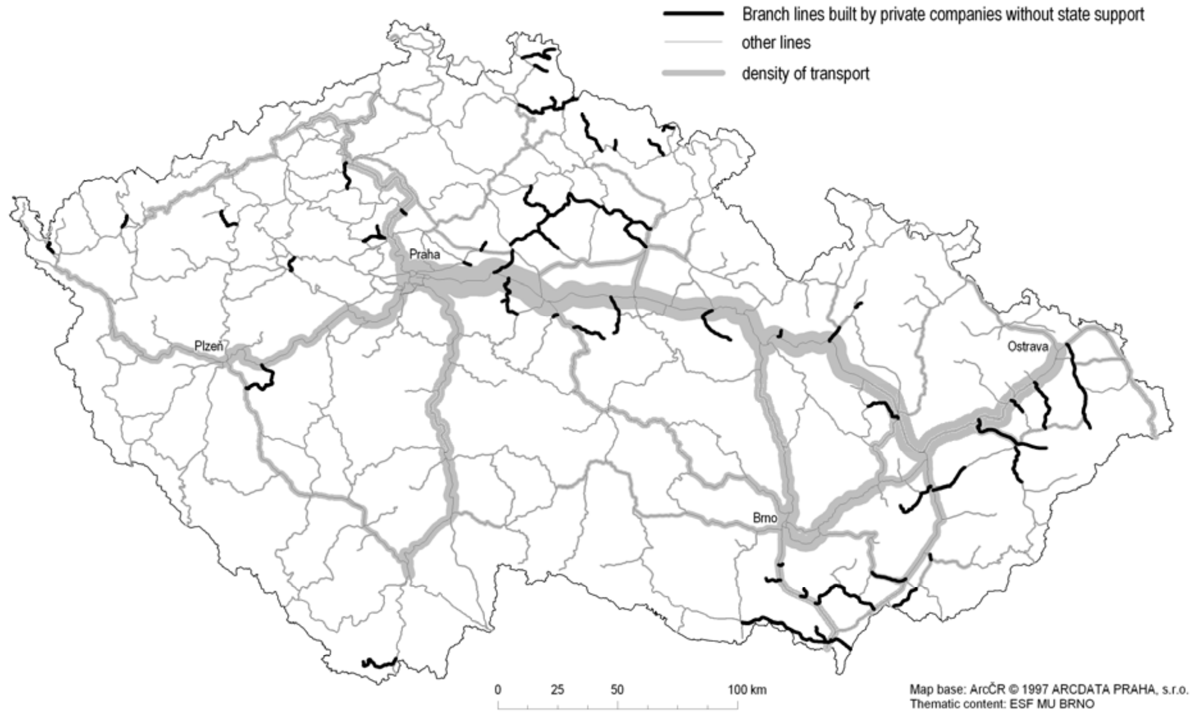


3.7. Branch lines built by private companies without state support.

Railway companies built branch lines from 1870s, believing it would increase their income from network effect and give them a competitive advantage. It was believed that branch lines would attract further passengers and increase haulage on main (trunk) lines. Even if these lines were built by private companies without a direct state subsidy, the state supported them indirectly – by technical allowances in the same way I described in section 2.5, which in fact resulted in higher operational costs and lower effectiveness. As for the routing of these lines, the major motive was the same as I described for the local lines: serving local factories, sugar mills, farms, etc. Putting together, the branch lines were built according to particular interests of a local-industry lobby, more or less affecting the density of traffic on trunk lines. As for competition, there was a very strong competition in the market as railway companies tried to increase their network to the prejudice of the other competitors.

903 km of these lines were built between 1871 and 1911 with the average length of 15.3 km. Nowadays, the branch railways are quite inefficient, the density of traffic is low there (see Figure 3.7).

Figure 3.7. Branch lines built by private companies without state support.



3.8. Lines built at the time of different geopolitical circumstances.

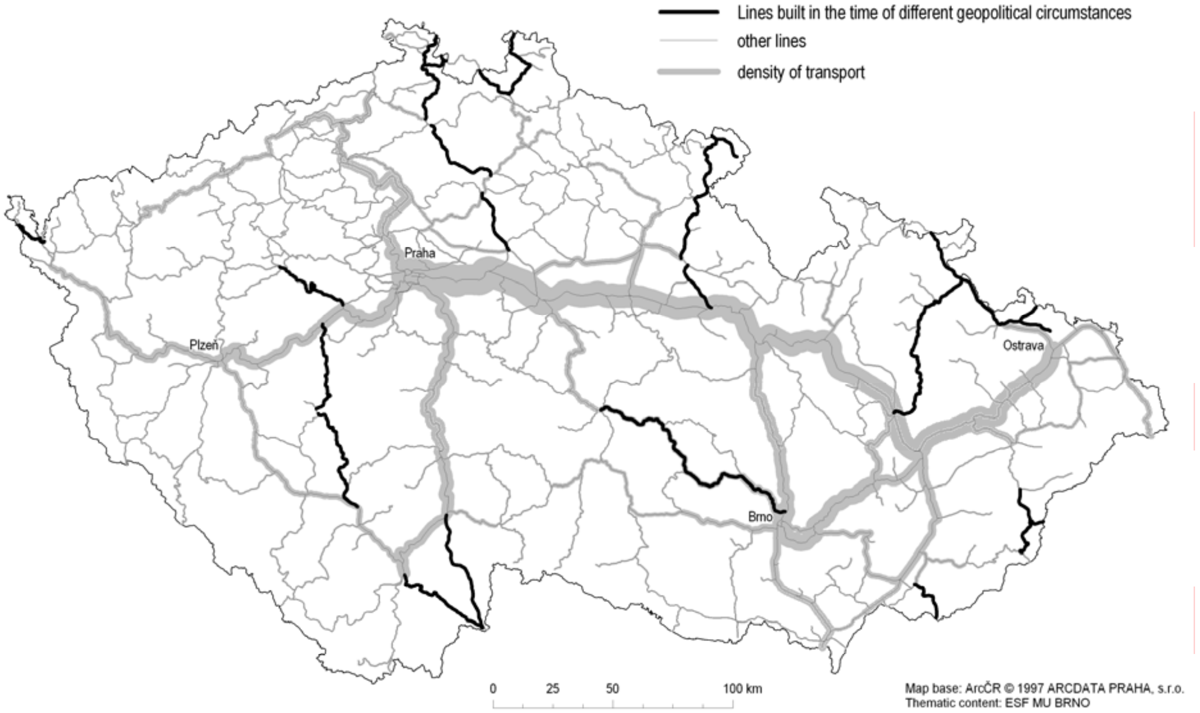
The Czech territory went through difficult political development during the 1800s and 1900s – it used to belong to five entities: the Austro-Hungarian Empire, Czechoslovakia, the protectorate, Czechoslovak Socialist Republic, Czech Republic. This development was followed by (i) changes of frontiers, as well as (ii) changes of natural economic and social relations, and resulted in re-orientation of the routes of the main North-South connection (i.e. Vienna – Prussia / Galicia) to the East-West (Moscow – Slovakia – Prague); finally, the routes covered widespread destinations after the collapse of the Iron Curtain in 1989.

These changes resulted in construction of several lines which lost their importance in the following periods. Quite a long line (of the length of 150 km) was built to connect West-Bohemian towns (Rakovník and Beroun) with Vienna directly, i.e. by passing Pilsen, in 1876. The line is interesting because it was the only one built by the state on its own account after 1855 and before nationalisation in the 20th century. Other lines were built in Northern Bohemia (Sudetenland) to connect towns inhabited by German-speaking people with their neighbouring towns in Prussia and Saxony. Quite an important line (of course temporarily only) was built by the state during the period of the protectorate in the 1940s. Nazi Germany annexed 35% of the Czech territory and many lines were disconnected, including the most important one from Prague to Brno and Ostrava. That is why the state decided to build a new line from Prague to Brno. Even though the total length (256 km) of the new connection is absolutely the same as the old one (built by the state in 1845), operating costs nearly tripled due to the crossing of the Moravian Highlands in the length of 120 km. Nowadays, the line is deficient, duplicating the backbone line, having a low density of traffic. Similar lines were built to connect Slovakia after WW1 – and resulted in similar troubles.

914 km of these lines were built between 1859 and 1953 with the average length of 45.7 km. Times are changing. Some of these lines used to be subject to strong competition in the market and used to be quite profitable, some of them were built by order from the state and

never made a gain. But all of them will be hardly efficient in the future – competition for the market would have to be heavily supported by the state. Figure 3.8 shows the network of railways of the 8th group – these railways correspond to the lines with a low density of traffic.

Figure 3.8. Lines built at the time of different geopolitical circumstances.



Conclusion

The aim of this study has been to analyse the Czech railway network with regard to the history of its origin, as well as to prove that "history matters" as far as its present-day efficiency and competitiveness are concerned. The principal tool for the analysis was comparison of density of traffic on the individual components of the Czech railway network, made according to the way how they came to existence. Many railway lines were built as unprofitable, with direct financial losses anticipated at the time of construction. We can hardly expect the contrary at the present, with conditions for cost-effective operation even having deteriorated. Reasons for construction of many lines were other than economic – e.g. strategic, social, speculative, and political. Similarly, operation of such lines should be considered using social and environmental criteria – in any case, it should be considered with respect to the economic and social efficiency of alternative transport modes. From the economic point of view, railways were built on the basis of some myths and misconceptions (such as overestimating the network effect, economies of scale, impact on regional development) – this must be reconsidered nowadays and the effect of density of traffic must be applied. It is worth considering in areas where density of traffic is economically insufficient whether the loss would be compensated by other social effects. The state itself has petrified defects in railway transport by its own activities. Thus, the current railway network in the Czech Republic is not a result of efficient, competitive and profitable entrepreneurship in the 19th century, but rather a mixture of fragments of previously profitable or highly loss-making lines built on the basis of different motives, as well as operated by the state on the basis of different motives till the present.

Figure 4.1. Lines of group A.

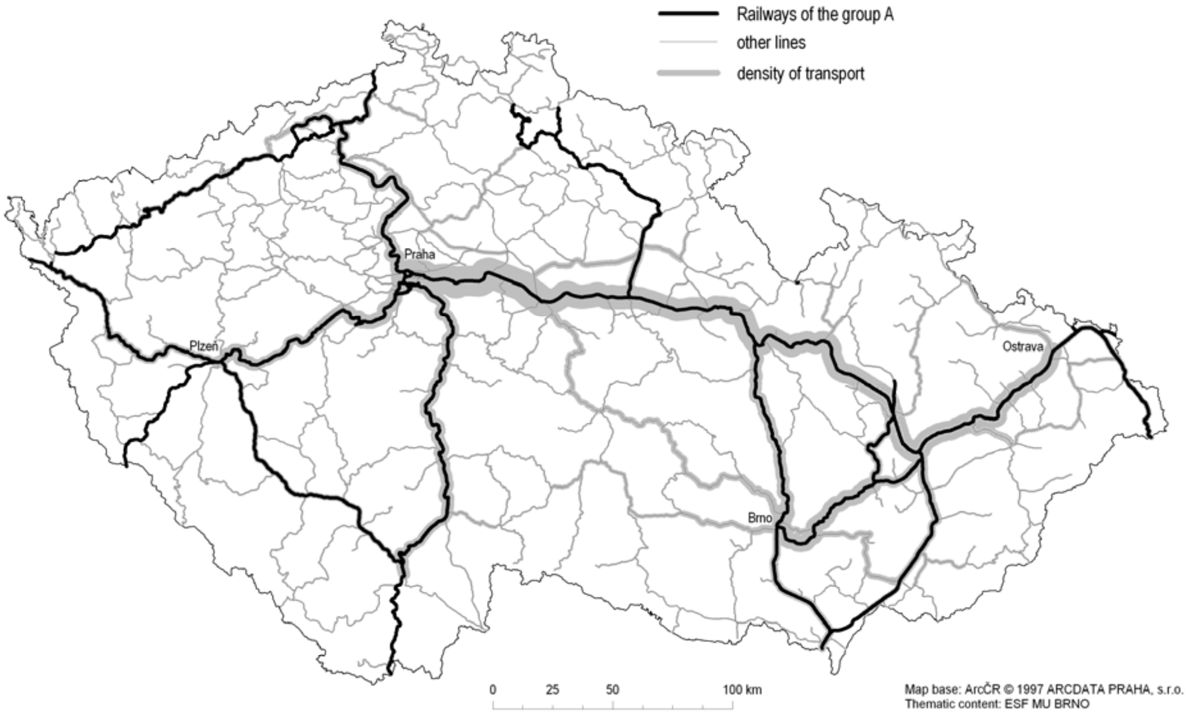
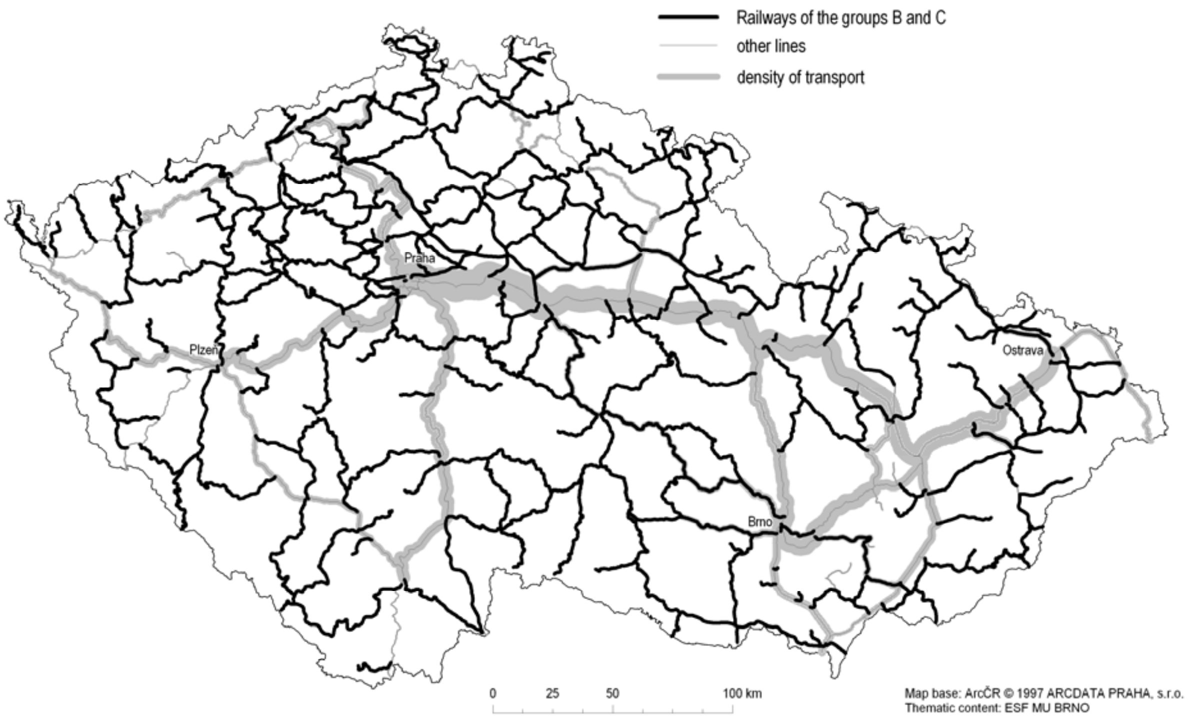


Figure 4.2. Lines of groups B and C.



Cartograms 4.1 and 4.2 show the summary of all lines built on the Czech territory which possess theoretical prerequisites for being efficient (group A) and lines which lack such prerequisites (groups B and C). The comparison demonstrates that lines of group A cover directions of those parts of the network which even today manifest a markedly higher density of traffic; on the contrary, lines of groups B and C are lines with a very low traffic density.

With regard to the fact that the initial assumptions have been confirmed, we may suppose that not even privatisation and liberalisation of railway operation can raise the efficiency of operation on the whole network. Railways can only become a more competitive mode of transport in a limited segment of the network.

References

[1] ACWORTH, W. M. (1905) *The Elements of Railway Economics*. Oxford: The Clarendon Press.

[2] ARTHUR, W. B. (1994) *Increasing Returns and Path Dependence in the Economy*. Ann Arbor: University of Michigan Press.

[3] BAMFORD, C. G. (2001) *Transport Economies*. Studies in Economics and Business. Oxford: Heinemann.

[4] BARROT, J. (2005) Rozvíjení železničního trhu. Doprava – ekonomicko technická revue. 2005/6, pp. 3-4.

[5] CALLAN, S. – THOMAS, J. (1992) Cost Differentials Among Household Goods Carriers. *Journal of Transport Economics and Policy* N° 26/1992, pp. 19-34.

[6] CAMPOS, J. – CANTOS, P. (2000) Railways. In: ESTACHE, A. – RUS, G. DE (eds) *Privatization and Regulation of Transport Infrastructure. Guidelines for Policymakers and Regulators*. WBI Development Studies. Washington D.C.: The World Bank, pp. 171 – 234.

[7] CANTOS, P. (2000) A Subadditivity Test for the Cost Function of the Principal European Railways. *Transport Reviews* N° 20/2000, pp. 275-290.

[8] CAVES, D. W. – CHRISTENSEN, L. R. – SWANSON, J. A. (1980) Productivity in U.S. Railroads, 1951-1974. *Bell Journal of Economics*, N° 11/1, pp. 166-181.

[9] CAVES, D. W. – CHRISTENSEN, L. R. – TRETHEWAY, M. W. – WINDLE, R. J. (1985) Network Effects and the Measurement of Returns to Scale and Density for U.S. Railroads. In: DAUGHETY, A. F. (ed) *Analytical Studies in Transport Economics*. Cambridge: Cambridge University Press.

[10] CENTRUM DOPRAVNÍHO VÝZKUMU (2004) *Výzkum zátěže životního prostředí z dopravy*. zpráva projektu VaV CE 801 210 109, Brno: CDV

[11] DAVID, P. A. (1993) Path Dependence and Predictability in Dynamic Systems with Local Network Externalities: A Paradigm for Historical Economics. In FORAY, D. – FREEMAN, C. (eds.) *Technology and the Wealth of Nations: The Dynamics of Constructed Advantage*. London: Pinter.

[12] ESTACHE, A. – RUS, G. DE (2000) The Regulation of Transport Infrastructure and Services: A Conceptual Overview. In: ESTACHE, A. – RUS, G. DE (eds) *Privatization and Regulation of Transport Infrastructure. Guidelines for Policymakers and Regulators*. WBI Development Studies. Washington D.C.: The World Bank, pp. 5-50.

[13] EUROPEAN COMMISSION (2001) *White Paper – European Transport Policy for 2010: Time to Decide*. Brussels: EC.

[14] EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT (1993) *Privatisation of Railways*. RoundTable90. Paris: Economic Research Centre.

[15] EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT (1998) *Efficient Transport for Europe. Policies for Internalisation of External Costs.* Paris: Economic Research Centre.

[16] FISCHER, P. A. – BITZAN, J. – TOLLIVER, D. (2001) *Analysis of Economies of Size and Density for Short Line Railroads*. Fargo: North Dakota State University http://www.ndsu.nodak.edu/ndsu/ugpti/MPC_Pubs/html/MPC01-128/index.html

[17] FOGEL, R. M. (1964) *Railroads and American Economic Growth: Essays in Economic History*. Baltimore: John Hopkins Press.

[18] FRIEDLANDER, A. *et al.* (1993) Rail Costs and Capital Adjustments in a Quasi-regulated Environment. *Journal of Transport Economics and Policy* N° 27, pp. 131-152

[19] GATHON, H. J. – PESTIEAU, P. (1995) Decomposing Efficiency into its Managerial and its Regulatory Components: the Case of European Railways. *European Journal of Operational Research* N° 3/80, pp. 500-507.

[20] GRILICHES, Z. (1972) Cost Allocation in Railroad Regulation. *Bell Journal of Economics and Management Science*, N° 3/1, pp. 26-41.

[21] HLAVAČKA, M. (1990) *Dějiny dopravy v českých zemích v období průmyslové revoluce*. Praha: Academia.

[22] HUDEC, Z. a kol. (2004) *Atlas drah České republiky 2004-2005*. Praha: Dopravní vydavatelství Malkus.

[23] HONS. J. (1990) *Čtení o Severní dráze Ferdinandově*. Praha: Nakladatelství dopravy a spojů.

[24] JAKUBEC, I. – JINDRA, Z. (2006) *Dějiny hospodářství českých zemí od počátku industrializace do konce habsburské monarchie*. Praha: Univerzita Karlova – Karolinum.

[25] JARA-DÍAZ, S. R. – CORTÉS, C. – PONCE, F. (2001) Number of Points Served and Economies of Spatial Scope in Transport Cost Functions. *Journal of Transport Economics and Policy*, Vol. 35, N° 2, pp. 327-342.
[26] KATZ, M. L. – SHAPIRO, C. (1985) Network Externalities, Competition, and Compatibility. *The American Economic Review*, Vol. 75/1985, N° 3, pp. 424-440.
[27] KEELER, T. E. (1974) Railroads Costs, Returns to Scale, and Excess Capacity. *Review of Economics and Statistics*, N° LVI, pp. 201-208.
[28] KLOUTVOR, J. – ŠÍP, E – VORLÍČEK, J. (2001) *Železnice jako součást dopravního trhu*. Praha: Liberální institut.
[29] KREJČIŘÍK, M. (1991) *Po stopách našich železnic*. Praha: Nakladatelství dopravy a spojů.
[30] KUNC, J. – KRYLOVÁ, V. (2005) Železniční doprava a regionální rozvoj v ČR – minulost či skutečnost? *Národohospodářský obzor* 4/2005, pp. 33-44.
[31] KUTÁČEK, S. (2005) Externí náklady železniční dopravy. *Národohospodářský obzor* 4/2005, pp. 45-51.
[32] KVIZDA, M. (2005) Problémy železniční dopravy v historické perspektivě. *Národohospodářský obzor* 4/2005, pp. 52-67.
[33] LIEBOWITZ, S. J. – MARGOLIS, S. E. (1995a) Path Dependence, Lock-in and History. *Journal of Law, Economics, and Organization*. N° 11/1995, pp. 205-226.
[34] LIEBOWITZ, S. J. – MARGOLIS, S. E. (1995b) Are Network Externalities a New Source of Market Failure? *Research in Law and Economics* N° 17/1995, pp. 1-22.
[35] LOWE, M. D. (1994) *Back on Track: The Global Rail Reviva.*. Worldwatch Paper N° 118, Washington D.C.: Worldwatch Institute.
[36] McGEEHAN, H. (1993) Railway Costs and Productivity Growth. *Journal of Transport Economics and Policy* N° 27, pp. 19-32.
[37] MINISTERSTVO DOPRAVY (2005) *Dopravní politika České republiky na léta 2005 – 2013*. Praha: MD ČR.
[38] NASH, C. (1992) Appraisal of Rail Projects. *Project Appraisal*, Vol. 7, N° 4, pp. 211-218.
[39] NASH, C. – WARDMAN, M. – BUTTON, K. J. – NIJKAMP, P. (2002) *Railways*. Chaltenham: Edward Elgar Publishing.
[40] NASH, C. – RIVERA-TRUJILLO, C. (2004) *Rail Regulatory Reform in Europe – Principles and Practice*. paper presented at the STELLA Focus Group 5, Athens, June 2004.
[41] PAVLÍČEK, S. (2002) *Naše lokálky. Místní dráhy v Čechách na Moravě a ve Slezsku*. Praha: Dokořán.
[42] PELTRÁM, A. (2005) Jak je to s železnicemi. *Národohospodářský obzor* 4/2005, pp. 68-80.
[43] POSPÍŠIL, T. – TOMEŠ, Z. (2005) Kvantifikace objemu státních dotací do železniční dopravy v ČR. *Národohospodářský obzor* 4/2005, pp. 81-91.
[44] PRESTON, J. (1994) *The Economics of Rail Privatization*. paper, Paris: l'Ecole Polytechnique
[45] PUFFERT, D. J. (2002) Path Dependence in Spatial Networks: The Standardization of Railway Track Gauge. *Explorations in Economic History* 39/2002, pp. 282-314.
[46] QUINET, E. – VICKERMAN, R. (2004) *Principles of Transport Economics*. Cheltenham: Edward Elgar Publishing.
[47] SEIDENGLANZ, D. (2005) Vývoj železniční dopravy v Evropě a její pozice v evropské dopravní politice. *Národohospodářský obzor* 4/2005, pp. 92-104.
[48] SCHREIER, P. (2004) *Zrození železnic v Čechách, na Moravě a ve Slezsku*. Praha: Baset.
[49] STELLING, P. – JENSEN, A. (2005) *Train Operator's Economies of Scale and Business Strategies*. Third Conference on Railroad Industry Structure, Competition and Investment: Stockholm School of Economics, http://www.hhs.se/NR/rdonlyres/C090FEAC-BB96-40A2-9306-3C8F9A9DC662/0/Stelling_and_Jensen_Train_Operators_Economies_of_Scale.pdf
[50] ŠÍP, E. (2005) Promarněné příležitosti Českých drah. *Národohospodářský obzor* 4/2005, pp. 105-109.
[51] WALKER, T. (1992) Network Economies of Scale in Short and Truckload Operations. *Journal of Transport Economics and Policy* N° 26/1992, s. 3-17.
[52] WETZEL, H. – GROWITSCH, C. (2006) *Economies of Scope in European Railways: An Efficiency Analysis*. IWH-Discussion Paper 5, Halle: Intitut für Wirtschaftsforschung Halle.
[53] WINSTON, C. (1985) Conceptual Developments in the Economics of Transportation: an Interpretative Survey. *Journal of Economic Literature* N° 23/1985, pp. 57-94.