The mean passenger transport speeds across time in France, its determinants, and the interaction with transport demand

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Summary

Transport demand appears as the main determinant of past transport emissions in France, so it is important to better understand its drivers. In relation to relatively constant travel time budgets of around one hour per person per day (known as the Zahavi conjecture), the mean speed of passenger transports largely influence the number of kilometers travelled. The aim of the study is to quantify the evolution of the average travel speed from 1960 to 2017. The analysis shows the importance of modal shift from walking to cars as the dominant cause of acceleration, followed by the increasing speed of cars allowed by the growing share of traffic taking place on highways. At the beginning of the 2000s, a peak in the mean speed is observed, mainly explained by the slowdown on the roads due to road safety policies. It was probably one of the causes of the peak travel observed at that time, with the travellers choosing to reduce their mobility in order to preserve their travel time budgets. It seems that the recent trend of stagnation could be persistent in the next decades, potentially confirming the turn of the millennium on transport speeds and kilometers travelled per person in France.

Introduction

Across time and for various regions of the world, the travel time budgets (TTB) of a population appear as relatively stable, close to one hour per person per day (Zahavi, 1974). This travel time constraint, known as the Zahavi conjecture, has important implications on mobility behaviors, activity programs or the urban form (Marchetti, 1994). These last characteristics have been strongly modified with the acceleration of transport speeds for the last two decades in France, allowed by the access to faster transport modes (Studeny, 1995; Crozet et Joly, 2003). It is therefore interesting to study the evolution of the mean travel speeds across time, and the main determinants of this evolution: the spread of faster transport modes across the population, in terms of share of the TTB; the impact of the increasing share of transport modes on rapid infrastructures such as highways for road transport or high speed rails for trains; and the impact of speed changes for each infrastructure, influenced by changes in the characteristics of the vehicles, speed limitations or driving behaviors. The hypothesis of constant travel time budgets is also interesting to explore for the recent changing trends in the transport demand, which could eventually be partly due to changes in the mean transport speeds if we follow the idea of stable TTB. The individual transport demand has peaked at the beginning of the 2000s in France as in other OECD countries, sometimes interpreted or studied as a possible peak car or peak travel, even if the recent trend is about a new increase of demand in the years 2010s (Goodwin, 2012; Grimal, 2015). This question is particularly important also to explain the trends in transport CO_2 emissions, as a previous analysis showed the major influence of transport demand in the evolution of past transport CO_2 emissions in France (Bigo, 2019). Finally, in light of the recent trends on transport speeds, its determinants and its interaction with the individual transport demand, the question of the possible evolution of this mean transport speed for the future will also be discussed.

Methodology

The study consists in gathering the necessary data in order to estimate the evolution of the mean passenger transport speed in France from 1960 to 2017.

Firstly, the historical data on travel demand (expressed in passenger.kilometers) for each transport modes has been collected, with the analysis taking into account seven transport modes: walking, cycling, the motorized two-wheelers, cars (comprising part of the light commercial vehicles that also benefit to passengers, with an estimation of 60% of the vehicle.kilometers, supposed to be constant across time), road public transit, trains, and airplanes. The data used for the calculations is mostly public, with rather precise data for rail transport, public yearly estimations for road transports and air transport, but more uncertainties for the estimations about walking and cycling. These last estimations come from national mobility enquiries with time intervals varying between five and fourteen years, which explains more precaution on the interpretation of the trend at the beginning of the period when these modes still represent a large share of the total travel time (data from CGDD, CITEPA, SNCF, Omnil, DGAC, Papon).

Secondly, for road transport modes, the data is divided into three different kinds of infrastructures or areas: urban traffic, rural traffic, and highways, with a further decomposition for car traffic according to the speed limitation of the roads (data from CITEPA). It allows taking into account the effect of an increasing share of their traffic on rapid roads. Similarly for trains, different kinds of train services are split, between tramways (streetcars), metros, suburban trains for the Great Paris region, regional trains, intercity trains, and high-speed trains (data from CGDD, Omnil).

Thirdly, the evolution of the commercial or mean transport speed for each of these transport modes is estimated. This speed is considered constant for the whole period for transport modes as walking, cycling, tramways, metros and suburban trains. For the other transport modes, the evolution of their speed is much more significant and important for the final results. The evolution of trains transport speed is estimated through the evolution of the best travel times for various origin-destination pairs across time (open data from SNCF). The data of the national road safety institute give the average free flow speeds for different speed limitations from 1987 to 2017 (ONISR), which are combined with the share of the different traffic conditions (free-flow, heavy traffic, saturated, stop and go) from André et al (2014) and the evolution of congestion from the ministry (data within URF, 2019).

This data collected on transport demands and mean speeds for each transport mode, allow calculating their relative daily transport time per person. Their aggregation gives an estimation of the total daily travel time budget (TTB) from 1960 to 2017, and dividing the daily individual transport demand by this TTB gives the evolution of the mean passenger transport speed.

Finally, a decomposition analysis into three determinants is conducted by using the log-mean divisia index (LMDI; Ang, 2004), in order to evaluate the dominant drivers of the mean speed evolution across time among: the evolving shares of the seven transport modes within the time budget, interpreted as a factor of modal shift (MS) towards faster or slower transport modes; the two other factors relate to the evolution of speed for each transport mode; the second factor concerns the share of each infrastructure (urban, rural or highways for road; different kinds of trains for rail) within the mode, it accounts for the effect of the building of highways and high-speed train lines, and is interpreted as an effect of infrastructure shift (IS); finally, the last driver represent the speed evolution (SE) for each type of transport mode or infrastructure, factor which is especially important during the last years for road transports.

Results and discussion

1) The close relationship between individual demand and the mean speed

The estimations of the mean travel time budget (TTB) from 1960 to 2017, the average daily individual transport demand and the mean speed, indicate a close relationship between the two last variables (see Figure 1) and a mean TTB close to one hour per person and per day for the whole period. This time budget increases slightly across the whole period from around 53 minutes until the end of the 80s, and is very close to one hour from 1995, with a slight increase from 58 to 60.5 minutes until 2017. As the data for walking is subject to important uncertainties both for the number of kilometers travelled and its mean speed (set constant at 3 km/h), and due to its important share for the first years of the analysis (falling from 70% of the TTB in 1960 to 25% in 1980, and then decreasing more slightly to 20% in 1990 and 16% in 2017), the actual TTB and its trend for the first years is difficult to interpret.

Nevertheless, the share of walking is quite low by 1990, and the travel time budgets are relatively stable for this period, which allows a better analysis of the trends of this last period, which is the most important to study due to the recent variations in transport demand. Indeed, probably the most interesting point of the analysis is the decrease of the mean travel speed at the beginning of the 2000s, together with the individual transport demand, confirming the hypothesis of a possible role of transport speed among the causes of the peak travel. It is then possible that the travellers have reduced the number of kilometers travelled in order to preserve their TTB in a context of decreasing travel speeds, for which the main contributors will be studied into the next section. This hypothesis is reinforced by the fact that the two curves of transport speeds and demand are close for the whole period and especially for 1990-2017, with a coincident increase at the end of the 20th century, a decrease for the years 2000s, and a recent new increase for the years 2010s.

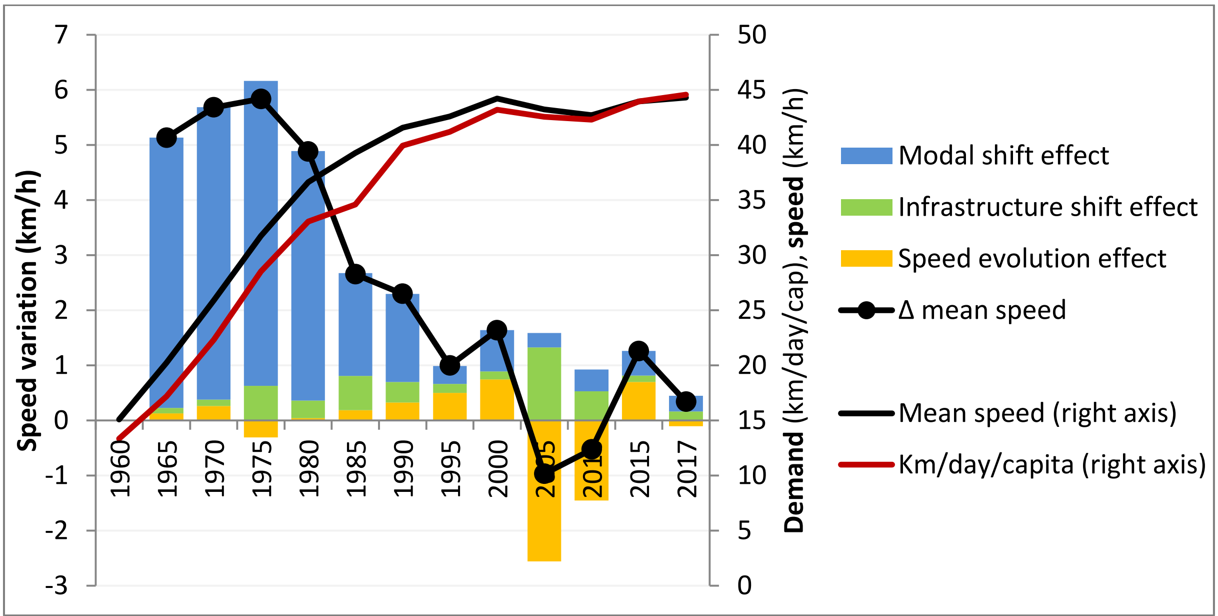

Figure 1: Evolution of the estimated transport demand, mean speed, and the drivers of its evolution with the modal shift, infrastructure shift and speed evolution by infrastructure effects, 1960-2017 (5 years interval, except 2015-2017)

2) The contribution of the three main drivers

The main historical driver of the increase of the mean passenger speed is the modal shift towards faster transport modes, measured in terms of evolving shares of each of the seven considered transport modes within the total travel time budget. The impact of this factor is particularly important at the beginning of the period, with an increase of 1 km/h of the mean speed each year (or around 5 km/h every 5 years, see Figure 1) due to the increase in the share of cars (that include part of the LDVs traffic) in the TTB from 20% in 1960 to 50% in 1975, 60% in 1981 and around two thirds of the TTB since 1990, this increase being mainly at the expense of walking. The contribution of this modal shift factor has decreased across time, with an impact of +0.3 km/h per year during the 80s, and a +0.1 km/h each year since 1990, due to the slight growths in terms of TTB of rail and air transports.

The second driver, called the infrastructure shift effect, has also contributed regularly to the increase of the mean transport speed, but to a lesser extent than the modal shift effect. The effect is due especially to the deployment of the highways. The share of the road traffic that takes place at high speed on these roads increased from around 3% of the car BTT in 1960 to 24% in 2017, after a slighter increase in recent years. The effect of the high-speed train development on the mean speed of trains and the whole mobility speed is significantly lower, due to the lower share of trains within the TTB (from 5% to 7% on the period), and to the overall decrease in proportion of the TTB represented by medium and long-distance trains compared to suburban, metros and tramways on the global period (the share of these short distance trains passed from 50% to 65% between 1960 and 2017).

Finally, the third driver of the mean speed evolution is about the speed for each mode or infrastructure. The maximum speed in terms of technical capabilities of the vehicles has not evolved for the majority of the transport modes or vehicles, as the speed of walking, cycling, tramways, metros, cars, buses or airplanes is rather stable for some decades. However, the change has been significant for long-distance trains at the beginning of the period, and for high-speed trains which are interpreted rather as a change in infrastructure in the decomposition. Above all, the main impacts over the period are due to the evolution in speed limitations and controls, and the corresponding behaviors of the drivers. The most significant regulatory change over the 1960-2017 period is the introduction of speed limitations for rural, national roads and highways, of respectively 90, 110 and 130 km/h in 1973-1974. There is no precise data on the impact on driving speeds, but this change participated largely to the drop by 32% from 1972 to 1974 in the road death rate per unit of traffic, that demonstrates that the speed limitation has actually changed the driving speeds (Orselli, 2009). The other major change is the impact of the introduction of speed control radars in 2003: this led to a peak in the driving speeds for roads limited to 110 and 130 km/h which were increasing before; while the mean speed dropped for urban roads (50 km/h since 1990, 60 km/h before) and the roads limited to 90 km/h, after a steady evolution for the decade before. The fall in the free-flow driving speeds for 90, 110 and 130 km/h roads is in the order of -7 km/h between 2002 and 2005 (ONISR, 2020). It is the main and sufficient cause of the mean travel speed peak that is observed during this period, with an estimated decrease by more than 2 km/h or almost -5% in three years. If travellers would not increase their TTB by this same order of magnitude in order to keep on travelling the same distances, they logically partly adapted to this kind of 'peak speed' by decreasing the demand in terms of kilometers travelled.

3) *Future perspectives for the mean speed and travel demand*

At the end of the studied period, a slight increase has been observed both for the transport demand and mean speed, which can be explained by a persistence of the slight positive contribution of the modal shift and infrastructure shift effects, while the speed evolution per infrastructure increased again between 2010 and 2015.

This slight recent increase should not hide the trend to a stabilization of the mean speed, considering that the three main studied drivers should not contribute highly to an increase of the mean speed for the next years and decades.

Firstly, the modal shift effect is weak for the three last decades, as the car mobility has ever reached the saturation in terms of TTB since 1990; the possible higher shift towards rail transport could not change significantly the mean speed as its speed is not much higher than the average speed; the airplanes could still develop (especially for international traffic, not taken into account here) as its TTB is still low, with a high risk in terms of associated emissions that could encourage a higher regulation of its growth; also, the revival of policies supporting active modes and especially bike trips should reduce the average speed.

Secondly, the policy in France is rather oriented towards a stop in new infrastructures building; even if some projects of highways, airports extensions or high-speed lines could be achieved, the pace of extension and then the impact on the mean transport speed should slow down compared to the past trend and is probably close to saturation.

Thirdly, the trend for the speed per infrastructure, which is especially crucial for cars, should rather evolve to a slowdown. In July 2018, the speed limit for the rural roads passed from 90 to 80 km/h, and an increasing number of cities are calming traffic through the extension of 30 km/h zones. It is possible that this slowdown of speed limits will also concern faster roads as the highways in a near future, like recently decided the Netherlands in order to lower the carbon emissions of transport in the country.

Conclusion

The analysis of mobility demand and speed per mode from 1960 to 2017 in France has allowed estimating the evolution of the mean travel speed of the whole mobility on this period. It appears that this speed evolved closely to the number of kilometers travelled, from around 15 to 45 km/h and km/day travelled per person. While the growth in the average speed has been explained mainly by the shift towards faster transport modes and more weakly to the shift towards highways, the peak observed at the beginning of the 2000s was mainly due to the slowdown of car drivers on roads due to the speed control radars introduction in 2003. It is then possible that the peak travel observed at the same period was partly due to the peak in the average travel speed, if the travellers were willing to preserve their travel time budgets.

As the main drivers of the mean speed increase seem to be close to saturation, the turn of the millennium could coincide lastingly with the stabilization of the mean mobility speed and the number of kilometers per person travelled in France. Furthermore, a coherent climate policy on transport could even leads to a slowdown of the mean speed and the distances travelled in the next decades, due to a possible combination of active mode promotion, regulation of aviation transport and the reduction of the speed limits on roads.

Keywords: speed, travel time budgets, transport demand, peak travel, France

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