TIME MULTIPLIER IN TRANSPORTATION

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ABSTRACT

The article reveals the essence of multiplier effect and time multiplier. An example of calculation of time multiplier is provided with the example of travel by car along 10 km route in the metropolitan city. A comparative analysis of characteristics of time multiplier and traditional, macroeconomic multiplier is given. It is emphasized that considerable values and high volatility of time multiplier can be seen as an evidence of unfavorable situation in the transportation system, and attempts of «smoothing» serve as criteria of improvement of this situation.

Keywords: transport, economy, expenses, multiplier effect, time multiplier, speed efficiency, travel time, transport infrastructure.

Background. *In economics, multiplier effect refers to excess of changes in aggregate output over the change of exogenous costs, such as investments. The essence of this effect is that incurred exogenous costs cause a chain (gradually decaying) reaction of secondary consumer expenses, generating additional production volumes. As a result, the total increase in production will exceed initial additional costs [1, p. 884-898].*

The ratio of total increase in aggregate production of goods and services to the original exogenous costs is called a multiplier factor or just a multiplier.

One of the tools of forming multiplier effect, as shown in [2, 3], is investment in transport infrastructure.

Objective. *The objective of the author is to investigate functioning of time multiplier regarding transportation field.*

Methods. *The author uses general scientific methods, analysis, comparison, evaluation approach.*

Results. *Noting the importance of multiplier effect for improvement of economic dynamics, we should remember that multiplier effect acts in the presence of unused production resources when the actual level of production is below potential. The increase in aggregate demand, involving unused resources into the economic turnover, could lead to an increase in aggregate production. Otherwise, the result will be a rise in prices rather than volume of production [1, p. 896].*

However, aggregate demand, aggregate production, production resources, regarded as aggregates in macroeconomics, have a complex structure. Some kinds of resources may be under-utilized and complementary factors of production at the same time are fully incorporated into the manufacturing process. Accordingly, exogenous costs involving free resources in economic turnover at the same time cause a rise in prices of complementary factors of production, relative lack of which will lead to economic disparities – the basis of crisis phenomena. More details on this issue are considered by L. von Mises [4, p. 536-541].

In addition, additional costs exogenous to the economic system, such as public investment, are a downside of taxes, i.e. reduction in private spending [5]. Therefore, when evaluating multiplier effect of public investment it is necessary to take into account short-received effects of failed private spending.

Thus, multiplier effect, the concept of which has already been firmly established not only in economics but also in economic practice, public policy, emerges not in all cases, and requires a very balanced assessment.

Along with this, already familiar category, another different kind of multiplier can be observed on transport, which is that the change in the start of travel time (or shipment of goods) leads to a significant change in the time of its completion. This time multiplier is vividly manifested in metropolitan areas.

Table 1 shows time multiplier on example of travel by car along a 10 km route in the metropolitan city in the morning. The data show that the shift of travel start to an earlier time gives a considerable gain in the length of a trip, resulting in arrival time varies considerably longer than departure time. Ration of change in arrival time to the change in departure time and will be a quantitative expression of time multiplier.

The essence of time multiplier differs from traditional, macroeconomic one. First of all, the fact that there is no kind of «chain reaction» that forms a multiaxial multiplier effect.

But there are some similarities.

For appearance of time multiplier effect free resources are also needed, in this case – reserves of transport infrastructure capacity. Actually, this effect is based on the shift of travel time for the period of less traffic intensity when there are greater reserves of carrying capacity. Indeed, when they are less than 25-30% (i.e. level of carrying capacity occupancy exceeds 70-75%) speed reduces [6]. And this decline is more noticeable if the level of reserves is less. When approaching reserves to zero, the speed decreases dramatically – the movement turns into «standing», there is known to all «traffic jam».

Therefore, the shift of the trip time from period when reserve of carrying capacity is, for example, 5% for a period of 10%reserve, although it does not allow to move with «normal» speed, nevertheless significantly reduces the trip. The shift to the period of 20%reserves implies an even greater acceleration, etc.

And the most important essential similarity of time multiplier with macroeconomic one is that in both cases, the initial costs are rewarded with great results, multiplication occurs, replication through the use of free (or relatively free) resources takes place.

Of course, in the case of travel time it is not about money, but about time resource. But as they say, «time is money» – and it is not just an aphorism expressing conventional wisdom, but absolutely accurate economic thesis. Any time expenditure, not even related to production of any goods, is value for human and, therefore, is subject to valuation. And time is probably the only one in the full sense of the word irreparable, non-renewable resource of human activity which value relative to other resources increases as more and more people are making plenty of various material benefits.

Table 1

Time multiplier on the example of a trip along a 10 km route in the metropolitan city

Trip variant	Departure time, h-min	Arrival time, h-min	Trip duration, h – min	Mean speed, km/h	Changes in				Multiplier
					departure time, min	arrival time, min	trip duration, min/%	speed, km/h/%	
1	7-30	8-45	1-15	8	X	X	X	X	X
2	7-15	8-15	1-00	10	15	30	15/20	2/25	2
3	7-05	7-40	0-35	17	10	35	25/41,7	7/70	3,5
					X	X	X	X	X

Therefore, improving speed effectiveness under modern conditions becomes crucial for all modes of transport including railways [7, 8], and solution of related tasks is mainly carried out on the basis of innovation [9].

It should be also explained why a shift to an earlier trip in the morning should be considered as additional costs. By doing so, people are forced to reduce the time of sleep, which is clearly useful. In other cases the change of travel time may have other motives. But it is obvious that the greatest occupancy of roads occurs in those periods that best suit the real needs of the population. Accordingly, any deviation from established time frames is currently subject to certain inconveniences, so – to the costs in the broadest sense of the word.

Having dealt with the costs associated with the change in time of the trip start, it is necessary to consider results in more details. It should be noted that the dependence of arrival time and duration of the trip from departure time, and hence the performance of temporary multiplier, are not sustainable. They are very volatile, and their fluctuations are difficult to predict. The subject, choosing a trip, has to follow a very approximate idea of the extent of such fluctuations and focus on the approximate level of average values, i.e. to maintain a high probability of being late or the worst-case scenario, based on the minimum value of time multiplier, and therefore with a high probability to be in the situation of early arrival. This means again the actual loss of time, time, which is taken out of productive work or leisure activities [6].

In fact, always the effect, associated with time multiplier, is realized in practice only in part, the higher is the volatility of the multiplier, the less optimal ratio of unknown quantities can be achieved.

The time multiplier is most typical for trips on private vehicles, but can also occur on public transport. Indeed, in peak hours public land transport movement slows down, and in metro there are «bottlenecks» at stations of interchange, near ticket offices and ticket machines. In addition, the comfort of travel reduces sharply, and this may serve as an incentive to change the time of the trip.

Conclusions. *Availability of time multiplier on transport, on the one hand, talks about some of the possibilities of accelerating trip, often very substantial. On the other hand, those possibilities have an unhealthy basis as they emerge resulting from transport infrastructure deficit, to overcome which it is necessary not only to develop it, but also to ensure rational payment for its use, adjusting the price, depending on the level of demand [6]. Therefore, significant values and high volatility of time multiplier can be regarded as an evidence of the unfavorable situation in the transport system, and its «smoothing» can be considered as a measure to improve the situation.*

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