Transportation Economics: Helping us to understand the Problem of Disequilibrium in Transportation in the Modern Cities

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Abstract

Transportation economics studies the movement of people and goods over space and time. Historically it has been thought of as located at the intersection of microeconomics and civil engineering. However, if we think about it, traditional microeconomics is just a special case of transport economics, fixing space and time, and where the good being moved is money. Modern economics provide us with the ways we can use to solve the modern day transportation problems emerging due to high density of population as well as less area for the transport to move on. The disequilibrium of demand for and supply of transport need to be analysed so that means have to found out for correcting that disequilibrium.

Keywords: Demand, Supply, Equilibrium, Disequilibrium, Budget, Feedback system, Virtuous circle, Simulation, Modal choice.

1. Introduction

What are the differences between a Boeing 747, an oil tanker, a car and a bicycle? Extensive indeed, but they each share the common goal of fulfilling a derived transport demand, and they thus all fill the purpose of supporting mobility. Transportation is a service that must be utilized immediately since it cannot be stored. Mobility must occur over transport infrastructures, providing a transport supply. In several instances, transport demand is answered in the simplest means possible, notably by walking. However, in some cases elaborate and expensive infrastructures and modes are required to provide mobility, such as for international air transportation.
An economic system including numerous activities located in different areas generates movements that must be supported by the transport system. Without movements infrastructures would be useless and without infrastructures movements could not occur, or would not occur in a cost efficient manner. This interdependency can be considered according to two concepts, which are transport supply and demand:

**Transport supply**: The capacity of transportation infrastructures and modes, generally over a geographically defined transport system and for a specific period of time. Therefore, supply is expressed in terms of infrastructures (capacity), services (frequency) and networks. The number of passengers, volume (for liquids or containerized traffic), or mass (for freight) that can be transported per unit of time and space is commonly used to quantify transport supply.

**Transport demand**: Transport needs, even if those needs are satisfied, fully, partially or not at all. Similar to transport supply, it is expressed in terms of number of people, volume, or tons per unit of time and space.

Transport supply and demand have a reciprocal but asymmetric relation. While a realized transport demand cannot take place without a corresponding level of transport supply, a transport supply can exist without a corresponding transport demand. This is common in infrastructure projects that are designed with a capacity fulfilling an expected demand level, which may or may not materialize, or may take several years to do so. Scheduled transport services, such as a public transit or airlines, are offering a transport supply that runs even if the demand is insufficient. Infrastructures also tend to be designed at a capacity level higher than the expected base scenario in case that demand turns out to be is higher than anticipated. In other cases, the demand does not materialize, often due to improper planning or unexpected socioeconomic changes.

There is a simple statistical way to measure transport supply and demand for passengers or freight:

The passenger-km (or passenger-mile) is a common measure expressing the realized passenger transport demand as it compares a transported quantity of passengers with a distance over which it gets carried. The ton-km (or ton-mile) is a common measure expressing the realized freight transport demand. Although both the passenger-km and ton-km are most commonly used to measure realized demand, the measure can equally apply for transport supply.

For instance, the transport supply of a Boeing 747-400 flight between New York and London would be 426 passengers over 5,500 kilometers (with a transit time of about 6 hours). This implies a transport supply of 2,343,000 passenger-kms. In reality, there could be a demand of 450 passengers for that flight, or of 2,465,000 passenger-km, even if the actual capacity would be of only 426 passengers (if a Boeing 747-400 with optimal seating configuration is used). In this case the realized demand would be 426 passengers over 5,500 kilometers out of a potential demand of 450 passengers, implying a system where demand is at 105% of capacity.

Transport demand is generated by the economy, which is composed persons, institutions and industries and which generates movements of people and freight. When these movements are expressed in space they create a pattern, which reflects
mobility and accessibility. The location of resources, factories, distribution centers and markets is obviously related to freight movements. Transport demand can vary under two circumstances that are often concomitant; the quantity of passengers or freight increases or the distance over which these passengers or freight are carried increases. Geographical considerations and transport costs account for significant variations in the composition of freight transport demand between countries. For the movements of passengers, the location of residential, commercial and industrial areas tells a lot about the generation and attraction of movements.

2. Supply and Demand Functions
Transport supply can be simplified by a set of functions representing what are the main variables influencing the capacity of transport systems. These variables are different for each mode. For road, rail and telecommunications, transport supply is often dependent on the capacity of the routes and vehicles (modal supply) while for air and maritime transportation transport supply is strongly influenced by the capacity of the terminals (intermodal supply).

- **Modal supply.** The supply of one mode influences the supply of others, such for roads where different modes compete for the same infrastructure, especially in congested areas. For instance, transport supply for cars and trucks is inversely proportional since they share the same road infrastructure.

- **Intermodal supply.** Transport supply is also dependent of the transshipment capacity of intermodal infrastructures. For instance, the maximum number of flights per day between New Delhi and London cannot be superior to the daily capacity of the airports of New Delhi and London, even though the New Delhi - London air corridor has potentially a very high capacity.

- Transport demand tends to be expressed at specific times that are related to economic and social activity patterns. In many cases, transport demand is stable and recurrent, which allows a good approximation in planning services. In other cases, transport demand is unstable and uncertain, which makes it difficult to offer an adequate level of service. For instance, commuting is a recurring and predictable pattern of movements, while emergency response vehicles such as ambulances are dealing with an unpredictable demand.

- Transport demand functions vary according to the nature of what is to be transported:
  - **Passengers.** For the road and air transport of passengers, demand is a function of demographic attributes of the population such as income, age, standard of living, race and sex, as well as modal preferences.
  - **Freight.** For freight transportation, the demand is function of the nature and the importance of economic activities (GDP, commercial surface, number of tons of ore extracted, etc.) and of modal preferences. Freight transportation demand is more complex to evaluate than passengers.
• **Information.** For telecommunications, the demand can be a function of several criteria including the population (telephone calls) and the volume of financial activities (stock exchange). The standard of living and education levels are also factors to be considered.

3. **Supply / Demand Relationships**
Relationships between transport supply and demand continually change, but they are mutually interrelated. From a conventional economic perspective, transport supply and demand interact until an equilibrium is reached between the quantity of transportation the market is willing to use at a given price and the quantity being supplied for that price level. However, several considerations are specific to the transport sector which make supply / demand relationships more complex:

• **Entry costs.** These are the costs incurred to operate at least one vehicle in a transport system. In some sectors, notably maritime, rail and air transportation, entry costs are very high, while in others such as trucking, they are very low. High entry costs imply that transport companies will consider seriously the additional demand before adding new capacity or new infrastructures (or venturing in a new service). In a situation of low entry costs, the market sees companies coming in or dropping, fluctuating with the demand. When entry costs are high, the emergence of a new player is uncommon while dropping out is often a dramatic event linked to a large bankruptcy. Consequently, transport activities with high entry costs tend to be oligopolistic while transport activities with low entry costs tend to have many competitors.

• **Public sector.** Few other sectors of the economy have seen such a high level of public involvement than transportation, which creates many disruptions in conventional price mechanisms. The provision of transport infrastructures, especially roads, was massively funded by governments, namely for the sake of national accessibility and regional equity. Transit systems are also heavily subsidized, namely to provide accessibility to urban populations and more specifically to the poorest segment judged to be deprived in mobility. As a consequence, transport costs are often considered as partially subsidized. Government control (and direct ownership) was also significant for several modes, such as rail and air transportation in a number of countries. The recent years have however been characterized by less governmental involvement and deregulation.

• **Elasticity.** Refers to the variation of demand in response to a variation of cost. For example, an elasticity of -0.5 for vehicle use with respect to vehicle operating costs means that an increase of 1% in operating costs would imply a 0.5% reduction in vehicle mileage or trips. Variations of transport costs have different consequences for different modes, but transport demand has a tendency to be inelastic. While commuting tends to be inelastic in terms of costs, it is elastic in terms of time. For economic sectors where freight costs are
a small component of the total production costs, variations in transport costs have limited consequences on the demand. For air transportation, especially the tourism sector, price variations have significant impacts on the demand.

- As transport demand is a derived demand from individuals, groups and industries it can be desegregated into series of partial demands fulfilled by the adaptation and evolution of transport techniques, vehicles and infrastructures to changing needs. Moreover, the growing complexity of economies and societies linked with technological changes force the transport industry to constant changes. This leads to growing congestion, a reduction in transport safety, a degradation of transport infrastructures and growing concerns on environmental impacts.

4. Supply and Demand Equilibrium

As with earning grades and cheating, transportation is not free, it costs both time and money. These costs are represented by a supply curve, which rises with the amount of travel demanded. As described above, demand (e.g. the number of vehicles which want to use the facility) depends on the price, the lower the price, the higher the demand. These two curves intersect at an equilibrium point. In the example figure, they intersect at a toll of Rs.0.50 per km, and flow of 3000 vehicles per hour. Time is usually converted to money (using a Value of Time), to simplify the analysis. Costs may be variable and include users' time, out-of-pocket costs (paid on a per trip or per distance basis) like tolls, gasolines, and fares, or fixed like insurance or buying an automobile, which are only borne once in a while and are largely independent of the cost of an individual trip.

5. Disequilibrium

However, many elements of the transportation system do not necessarily generate an equilibrium. Take the case where an increase in A begets an increase in B. An increase
in B begets an increase in A. An example where A an increase in Traffic Demand generates more fuel Tax Revenue (B) more fuel Tax Revenue generates more Road Building, which in turn increases traffic demand. (This example assumes the gas tax generates more demand from the resultant road building than costs in sensitivity of demand to the price, i.e. the investment is worthwhile). This is dubbed a positive feedback system, and in some contexts a "Virtuous Circle", where the "virtue" is a value judgment that depends on your perspective.

Similarly, one might have a "Vicious Circle" where a decrease in A begets a decrease in B and a decrease in B begets a increase in A. A classic example of this is where (A) is Transit Service and (B) is Transit Demand. Again "vicious" is a value judgment. Less service results in fewer transit riders, fewer transit riders cannot make as a great a claim on transportation resources, leading to more service cutbacks.

These systems of course interact: more road building may attract transit riders to cars, while those additional drivers pay gas taxes and generate more roads. One might ask whether positive feedback systems converge or diverge. The answer is "it depends on the system", and in particular where or when in the system you observe. There might be some point where no matter how many additional roads you built, there would be no more traffic demand, as everyone already consumes as much travel as they want to. We have yet to reach that point for roads, but on the other hand, we have for lots of goods. If you live in most parts of the India, the price of water at your house probably does not affect how much you drink, and a lower price for tap water would not increase your rate of ingestion. You might use substitutes if their prices were lower (or tap water were costlier), e.g. bottled water. Price might affect other behaviors such as lawn watering and car washing though.

6. Conclusion
The life of metropolis depends upon its transportation system, and a healthy urban economy requires that transport be smooth and efficient. The automobile-centered unplanned travel networks of today are proving increasingly as urban activity and
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congestion grow. Further, the costs of continuing to support automobile-based transport systems are forbidding in terms of space absorbed for highways, energy requirements and ecological consequences.

Aware of these factors most metropolitan areas are moving to coordinate and streamline their transport systems, and to provide mass transit alternatives to the automobile. These shifts have required urban transportation planners to forecast accurately the response of transportation demand to changes in the attributes of the transport system. Traditional urban transportation planning models developed primarily to forecast the effect of long-run changes in population demography on travel demand in static transportation system have proved suited and unreliable in providing answers to the policy questions facing planners. So, planners are building new models to forecast the demand in the long-run so that appropriate supply part can be provided to deal with the problem of disequilibrium that the modern cities are facing.

Transportation economics help the planners in analyzing these problems so that appropriate policies can be prepared and timely implementation of these policies can be done before the transportation system came to a standstill position.

References

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