Using Technology to Eliminate Traffic Congestion

Traffic congestion is one of modern societies’ major social challenges. Global congestion costs were estimated at about $1 trillion in 2013. In 2016, the average U.S. driver spent 42 hours in congestion during peak hours, and an average driver in Los Angeles spent 104 hours. Today, the average traffic speed in central Manhattan is that of a brisk walk, 7.6 km/h, down from 10.5 km/h five years ago. Cities and regions around the world are experiencing comparable congestion levels, and congestion’s social costs are growing rapidly almost everywhere\(^1\). Under existing traffic policies, traffic will inevitably end in a crisis.

The habitual response is to call for more roads. However, numerous studies show that an increase in road capacity does not relieve congestion. “The Fundamental Law of Road Congestion” states that, if new unpriced capacity is added, traffic congestion will become as severe as before the capacity addition\(^2\). Even multibillion investments in new roads in cities like Los Angeles and Houston did little to reduce commuting times. Ride-hailing services like Uber and Lyft also appear to increase traffic, which is probably why both services strongly support the introduction of new pricing mechanisms\(^3\). It is unclear that self-driving cars will reduce traffic congestion. The associated decrease in costs and increase in the desire for mobility may instead swamp any efficiency gains\(^4\).

Yet technology remains the solution to gridlock. Through advances in communications, a vehicle’s location can be identified and communicated to within a cubic meter, allowing precise measurement of road use. Real-time congestion pricing is viable for the first time. By internalizing a driver’s social costs at each time and location, congestion pricing surgically reduces demand to eliminate congestion. Paradoxically, demand management not only balances supply, but expands supply and thus maximizes throughput. A free-flowing roadway has up to twice the capacity of a congested roadway at peak times\(^5\).

A road-use price that eliminates congestion always exists. The reason is that, although some motorists are unable or unwilling to change behavior in response to a price, at least in the short run, studies indicate that consumers' responses to price changes are sufficiently flexible to eliminate congestion. Responses include curtailing road demand, shifting times of travel, and changing travel routes or modes. The highly nonlinear relationship between travel time and traffic (vehicles per hour) implies that only a small fraction of drivers need shift during peak times to improve throughput significantly. More vehicles do not affect other motorists’ travel times when traffic is below a road’s physical limit. But when the road gets close to its physical limit, a small increase in the number of vehicles leads to a decline in throughput of as much as 50%. Put differently, if dynamic pricing can reduce demand by as little as 5%, congestion can be eliminated. Without pricing, however, motorists will not take the social costs that they are imposing on others into account when choosing to use a road.

Congestion pricing often raises equity and fairness concerns. However, it is not congestion pricing but the lack thereof that poses equity and fairness problems. Motorists pay a price with or without congestion pricing, but one’s “price” is paid in delay cost and travel time uncertainty. Users do respond to this price, but the price is waste and is set incorrectly—the delay cost does not reflect the negative externality one user imposes on others. Dynamic congestion pricing, which correctly reflects the social cost of road use, eliminates this wasteful cost, and maximizes the value derived from existing road capacity.
The resulting congestion prices are fair. Today, those who drive at peak times, contributing most to congestion and pollution, pay the same price as those who do not impose such costs on others. Indeed, rejecting congestion pricing for fairness reasons is economically equivalent to demanding subsidies for those who impose the highest cost on others. This is hardly fair. Moreover, most studies show that the rich pay more congestion charges than the poor because they use roads more heavily at the most popular times. Finally, if revenues created by congestion pricing are used to enhance affordability and to improve public transport, the poor can substantially benefit from congestion pricing, and more so than the rich.

The effectiveness and social implications of congestion pricing are often underappreciated. For instance, because of heterogeneity in the motorists’ flexibility, combined with the nonlinear impact of traffic on congestion, the price that sufficiently reduces demand to eliminate congestion is often lower than one might expect. Underestimation of benefits and overestimation of problems partly explain why congestion pricing must frequently deal with strong opposition before introduction. Yet, after people gain experience, support is often strong. In Stockholm, for instance, before a major road-use pricing trial started, two-thirds were against the charges. After the trial, more than two-thirds were in favor of the charges. In Milan, after gaining experience, eighty percent voted for extending the system to cover more roads and more vehicle types. And in San Diego, seventy percent of the lowest-income users strongly support its dynamically-priced HOT lanes.

Dynamic congestion pricing is not a novel concept. It has been successfully used with airfares, electricity rates, hotel rates, and train fares. Empirical studies in the United States, Singapore, Milan, Stockholm and elsewhere confirm the effectiveness and efficiency of pricing mechanisms to address traffic congestion, although those applications are often limited to a cordon around the city, or to a small set of roads within, and prices typically are not responsive to real-time changes in demand. Cities and governments around the world are looking for more effective and comprehensive pricing approaches. Today is the right time. The non-pricing of roads stems from the fact that roads were originally uncongested, and that pricing, collecting, and enforcing payments was too costly. This is history. Modern communications allow road use to be monitored and charged based on real-time scarcity. A comprehensive system of direct, variable road-use charges is now possible, allowing a leap forward to the most efficient end-state for road pricing. The market design for road use can build on the extensive experience in sectors, such as electricity, where effective mechanisms dynamically price network capacity. Doing so eliminates the inefficiency, frustration and unfairness that comes with current road use. It is the inevitable future of roads.
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