Dynamic road pricing can eliminate congestion

Peter Cramton, R. Richard Geddes and Axel Ockenfels make the case that demand-driven pricing will free up traffic.

Traffic congestion costs us time, money and our health. In 2016, an average driver in the US spent 42 hours in congested traffic during peak hours; Los Angelinos spent 104 hours\(^1\). New Yorkers walk as fast as vehicles crawl along streets in central Manhattan (7.6 km/h)\(^2\). Traffic congestion is a growing problem around the world. The list of top-10 most congested countries includes Thailand, Indonesia, United States, Russia, Brazil, South Africa and United Kingdom\(^3\). Being stuck in traffic is frustrating and stressful. Cars burn 30-80% more fuel\(^4\). This leads to more pollution and CO\(_2\) emissions, an increased risk of heart attacks and strokes, and contributes to asthma and poor infant health\(^5,6\). The global economic damage from increased business costs and wasted time and fuel exceeds $1 trillion each year. And these costs are rising as the world’s population grows and urbanizes.

The habitual response is to call for more roads. But, as ‘the fundamental law of road congestion’ states, increasing road capacity doesn’t diminish traffic\(^7\). More drivers move in. Nor will artificial-intelligence systems, ride-hailing services and autonomous cars ease the gridlock. Navigation systems like Google Maps and Waze facilitate coordination, but this attracts more drivers and can spread congestion to other neighbourhoods and side streets. Uber and Lyft have increased traffic, as more journeys are made. One survey found, for instance, that “49% to 61% of ride-hailing trips would have not been made at all, or by walking, biking, or transit”\(^8\). Self-driving cars reduce accidents and use roads and fuel more efficiently. But those gains may be swamped by an increased desire for cheap and easy transport\(^9\).

The truth is: there is more demand for road use than road space.

We believe the answer lies in dynamic road pricing. Technology has advanced such that cars can be tracked to within a metre. This makes it feasible to measure and price road use in real time according to demand. If the price is set right, enough car drivers would choose to drive at a different time or via a different route or mode to eliminate congestion. Limited road space would be managed, as are airfares, electricity, hotel rooms and train journeys. Paradoxically, overall, this does not push motorists away from the roads. Managing roadways can double the capacity of a congested route in peak times by avoiding traffic jams\(^10\)—just as managing fisheries can avoid overfishing. Pollution and stress would decrease. The funds raised could be used for improving roads and public transit and to reduce fuel and other taxes.

States are looking for innovative pricing schemes. Since 2015, 5,000 volunteers in Oregon have been trialing a tax on miles travelled. Germany, Austria and Switzerland and a dozen other countries follow a similar approach for trucks. Also, over the past decades, some US cities and others like Singapore and Stockholm have begun to experiment with electronic road charging in their inner zones. But such schemes often do little for congestion, as prices are largely fixed and do not meaningfully vary with demand and supply conditions\(^11\). A rather small price does little to mitigate congestion at peak times, and a fixed price that eliminates congestion at peak times would be as inefficient and unacceptable as having Thanksgiving-like airfare levels all year.

Road pricing needs to become fully dynamic to achieve all benefits. We call on policymakers and city managers to move toward systems that track cars’ positions and adjust charges continuously depending on how busy the roads are. There have been three major challenges to dynamic pricing. Until recently, technology was not sufficiently advanced to accurately measure a car’s road use. There are equity and privacy concerns. And there has been no understanding of how the full implementation of network-wide, real-time road pricing would work. Today, research can address these challenges.

Free ride

Congestion is pervasive because motorists take no account of the cost they impose on others. Yes, some people drive to work early, to avoid the worst traffic jam. But as roads become crowded, adding even one car diminishes road space and causes other drivers to slow down.

Road-use prices should reflect the costs of road use that a motorist imposes on others. The system would operate similar to an electricity market\(^12\). Road space—like electricity—is a commodity that can be bought and sold. An independent operator determines prices on each road segment to balance supply and demand, and thereby maximize the network’s value to users whilst keeping traffic flowing.

Prices are levied on all roads in a region. Charges vary with time and place every 10 minutes, say, according to demand estimates and traffic conditions. Prices thus respond to lane closures, weather and sporting events as well as peak commuting times.

More research is needed to estimate efficient prices, but most of the time they will be near zero. On popular routes a 30-minute commute might be as high as $20—but the trip would take 30 minutes rather than an uncertain longer range, say 45-90 minutes. The actual price would depend on how easily drivers can substitute away from the most popular time to other times or modes.

Fees would be tailored to vehicle types. Lorries would pay more. An autonomous vehicle, driven using algorithms to promote free flow, uses less road capacity than a standard car and thus pays less.

An advantage of dynamic pricing is that it includes the means with which to charge the full social cost of a vehicle’s use—both congestion and pollution. Prices may be varied to keep air-quality measures, such as particulate matter, within limits. Although this would not affect the number of cars at peak times, it would increase the price of dirty cars relative to clean cars. Electric cars, for instance, would pay less. This would be a far less costly and less intruding measure to fight pollution than banning diesel cars from town centres, which Germany is discussing.

Prices would be tracked with navigation apps, like Google Maps and Waze. Such tools would present both real-time information as well as forecasts of future prices, much like they do today for trip duration. Prices would be integrated into taxi and ride-hailing fares.
As in other markets, changes in pricing should be smooth to avoid ‘shocks’. And many consumers need time to react. Forward purchase, such as buying your daily commute once a month in advance, would let consumers plan and avoid the greater risk of real-time prices. This can be done automatically by the market operator as part of a default road-use plan. Consumers would benefit from a sensible default but could adopt an alternative plan from a competitive retail market.

Not everyone needs to respond to prices. The system works fine even if most drivers do not respond to price. What is needed is a significant minority who take price into account. An increasing share of motorists will adapt behaviour as they become familiar with the system. Some will change the time of their commute; others will cycle or take the train or bus. Consumers make similar trade-offs today, where the price of road use is delay.

There are still lessons to be learned about how best to manage the network and target investments to improve the network. Data about pricing and the aggregate behavioral responses on transport choices should be publicly available. This allows researchers and innovators to glean insights about the effectiveness of a fully comprehensive transport market, develop apps that facilitate transport decisions to motorists and users of ride-hailing services and autonomous cars, and improve acceptability and satisfaction among users.

Concerns

Road-pricing schemes are often criticized as perpetuating inequality—poorer people may be less able to afford to drive at popular times of day than richer ones. Although more research on distributional consequences is needed, simple examples suggest that the problem is smaller than one might think at first glance. In fact, pricing can make everybody better off—even before the revenue from congestion pricing is redistributed. For instance, suppose the left lanes of a multi-lane highway are priced efficiently at peak times. Because this increases throughput on the left lanes, there are fewer motorists on the right lanes, so that everybody on the right lanes must be better off. Because motorists on the left lanes can choose to switch to the not-priced right lanes, but decided not to do so, they must be better off, too.

Even a poor worker, who absolutely must be at work at 8 am and who has no access to public transit or to other substitution possibilities, and even if all lanes on all roads are priced, can be better off. Suppose the free-flow travel time is 30 minutes, the expectation is 60 minutes and the maximum is 90 minutes. Today the worker must depart at 6:30 am. With efficient pricing, however, she can choose to pay the price and depart at 7:30 am. But she can also continue to depart at 6:30 am. In the latter case, because of increased throughput, she may well end up paying a zero price, plus her travel time will be halved and fuel costs and pollution will be reduced. Moreover, the revenue from congestion pricing may be given back to motorists, for example to lower road tax and fuel duty. It could also be invested to improve public transit.

The current situation, by contrast, is unfair. Using roads for free is equivalent to governments subsidizing people who impose the biggest congestion and pollution costs on society. Road use is an essential service. The norm for other essential services like electricity, gas, water and communications is for consumers to pay for the services they use. The fact that road use has not been charged for is a fluke of history—congestion wasn’t a problem when cars were invented. And until recently technology did not allow low-cost measurement of use and easy communication of pricing.

The benefits of pricing are currently underappreciated by voters and politicians. Yet public support builds after the benefits of such schemes become evident. Before Stockholm introduced a 2€ charge during peak hours for vehicles entering the inner city, two thirds of residents were against the plan. After the measure reduced traffic, two thirds were in favour. After a similar scheme was started in Milan, eighty percent voted for extending charges to more roads and vehicle types.

Road pricing raises privacy concerns. Monitoring and enforcement require that the system operator know the location of each vehicle during use. Technically this is easy and cheap. Each vehicle would have a device for this purpose. To mitigate privacy concerns, the transport market’s system operator would have strict rules that no individual data would be shared with others, as it is standard in telecommunications and related industries. Modern cryptography even makes it possible for the system operator to run the market without any human having access to the individual data and still prove that the market rules are faithfully followed. Research on whether such advanced systems improve acceptability to motorists is lacking, although the advent of navigation apps and ride-hailing suggests that users are happy to accept some loss of privacy for improved services.

Next steps

The first step is to get measurement devices in vehicles to measure road use. Singapore plans to install tracking and payment devices in all cars beginning in 2020. Oregon charges volunteers having the requisite on-board equipment a per-mile fee. Others experiment with similar approaches. These are excellent starting points to take the next steps toward a comprehensive system of road pricing. Policymakers and city managers can make incremental progress. Pricing should become more dynamic and gradually move closer to real-time social costs.

Researchers should study the incremental efficiency and distributional effects, and public responses.

Service providers, such as Google, Apple, Uber and Lyft, should integrate the relevant price information into their apps in innovative ways.

Dynamic pricing is the inevitable future of roads.

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