Dynamic road pricing would stop 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 health. In 2016, the average US driver spent 42 hours in congested traffic during peak hours; Los Angeles drivers spent 104 hours. New Yorkers can walk as fast as vehicles crawl along streets in central Manhattan today (7.6 km/h); cars move even slower than in 2013 (10.5 km/h), despite fewer cars entering the city. Being stuck in traffic is frustrating. It increases fuel consumption and air pollution. The economic damage globally exceeds $1 trillion each year. And those costs are rising as the world’s population grows and urbanizes.

The habitual response is to call for more roads. But, as Duranton and Turner state, increasing road capacity often doesn’t diminish traffic. More drivers simply move in. Nor will artificial-intelligent systems, ride-hailing services and autonomous cars solve the gridlock. Navigation systems like Google Maps and Waze have facilitated coordination and reduced uncertainty regarding travel times. But this induces more demand and may even create new congestion in neighborhoods and side streets. Uber and Lyft have increased traffic, as more journeys are made. Self-driving cars may reduce accidents and use fuel more efficiently. Increased desire for cheap and easy transport, however, may swamp those gains.

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

Still, technology can be used to overcome congestion. Cars’ locations can be tracked to within a metre, making it feasible to measure and price road use 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 alleviate congestion. Road use would be managed, as are airfares, electricity, hotel rooms and train journeys. The funds raised could be used for improving roads and public transit, and to reduce fuel and other taxes.

The reason congestion is so pervasive is 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. Dynamic road pricing reduces demand for road use to eliminate congestion. Prices are set at each time and each location to reflect the cost motorists impose on others. Paradoxically, a free-flowing roadway has up to twice the capacity of a congested route. This capacity expansion at peak times in response to reduced demand means that even a small fraction of price-responsive drivers can improve throughput dramatically.

Cities in the United States and Singapore and Stockholm have experimented with road charging, reducing traffic congestion to some extent. Those schemes have so far only been carried out in small areas and with largely fixed prices. Cars are only tracked at points where they pass gantries.

The next step is to manage congestion on all roads in a regional network. To take this step, the region must install low-cost measurement devices in each vehicle, either A-GPS or more advanced kinematic devices. Once road use is measured, it can be priced. Singapore, a longtime innovator in dynamic road pricing, has plans to install A-GPS devices in every vehicle and will begin more extensive road pricing in the early 2020s.

We propose that prices be made comprehensive, covering all congested road segments. They should gradually be brought closer to social costs. Most often, social costs will be close to zero, but at peak times may be $20 on the most popular routes. Twenty dollars may seem high to some, but contrast this with the cost to park the car for a few hours in a parking garage. Keep also in mind that throughput at peak times will be substantially increased, that many motorists can avoid driving at peak times, and that the revenue is used to replace inefficient means of road funding. Providers of transport apps, such as Google and Apple, can easily integrate price information to help users make transport decisions. Data about pricing and the aggregate behavioral response should be publicly available to allow researchers and innovators to glean insights from the data to guide next steps, both with respect to management of today’s network and targeting investments for the future.

Dynamic road pricing in practice

A fully efficient congestion pricing system may seem like a radical idea. However, it has been successfully applied in electricity markets for over a decade. Indeed, the market design for road use can build on the extensive experience from the electricity sector, where today effective and robust mechanisms dynamically price network capacity. The market operator in U.S. wholesale electricity markets establishes prices at each node in the network that induce participants to maximize social welfare subject to network constraints. The same would be true for road pricing. The market operator would set prices to maximize the value of the network subject to free-flow capacity constraints.

As in other markets, the behavioral response to pricing is greater when consumers have more time to respond. For this reason, real-time prices tend to be more volatile than forward prices, such as day-ahead, week-ahead, and month-ahead. Forward markets let consumers improve plans and better manage price risk. Forward

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markets play this role in electricity markets, and they should play a similar role in markets for road use.

Prices should adjust in real time, say every 10 minutes, to balance supply and demand. Thus, prices respond to lane closures, weather, sporting events, or other shocks to supply and demand. Many motorists would not respond to sudden price changes. That is acceptable since the market operator requires only a small fraction to respond for effective network management. The response is sure to grow as consumers and businesses adapt to pricing. Some consumers have flexibility with respect to the time of commute. Some have flexibility with respect to mode—carpool, vanpool, bike, bus, train, etc.

Dynamic road pricing is easy, because it is easy to measure the social cost of road use. It is simply the price required to balance supply and demand. This efficient congestion price is scaled by vehicle type, since different vehicles use a different quantity of the road’s capacity; an autonomous vehicle, driven with algorithms to promote free flow, uses less capacity than a standard car.

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. For instance, in Europe, a vehicle-dependent pollution charge can be computed at each location and time to ensure that the critical values of particulate-matter are not exceeded. This would be a precise and cost-efficient way to address the social costs of local pollution—unlike banning diesel cars in cities, which is currently discussed in Germany and elsewhere. Incorporating emission costs reduces congestion costs but does not complicate the task of balancing supply and demand to eliminate congestion. It improves consumers’ decisions both in the short and long term.

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 to inform consumer decision making, much like they do today for trip duration. Prices would be integrated into taxi/ride-hailing fares.

**Equity and fairness**

Road-pricing schemes are often criticized because of equity concerns—poorer people may be less able to afford to drive at popular times of day than richer ones. Such concerns can be addressed. Unlike delay costs, the revenue from congestion pricing is not lost. It can be given back to motorists, to enhance affordability where needed, and to improve public transit and reduce fuel and other taxes. This alleviates undesired distributional effects.

On the other hand, the absence of efficient dynamic pricing creates unfairness that cannot easily be addressed. Not paying for road use is equivalent to paying subsidies to people who impose high congestion and pollution cost on society. Those who create the largest burden for others benefit the most from free road use.

Road use is certainly an essential service. But the norm in other sectors is for consumers to pay the cost of services consumed.

Electricity, gas, water, sewage, and communications are all essential services provided in regulated industries. In all cases, use is measured and paid for based on the cost of service provision. Road use now stands out as the exception, rather than the norm. This is an artifact of history. In the early decades of automobiles, congestion and pollution were non-issues. Times have changed.

One reason change has been slow is that the effectiveness and benefits of efficient pricing to address congestion and pollution are often underappreciated by voters and politicians. Yet, after people gain experience, support for congestion pricing can be strong. In Stockholm, for instance, before a major road-use pricing trial started, two-thirds were against the charges. Vehicles were charged 2€ during peak hours when crossing a cordon around the inner city. The charges significantly decreased traffic across the cordon and improved the predictability of travel times. So, after the trial, more than two-thirds were in favor. In Milan, after gaining experience with a similar scheme, eighty percent voted for extending the system to cover more roads and vehicle types.

**Next steps**

Recent advances in technology allow policymakers and city managers to take the next step toward a comprehensive system of road pricing. This suggests an incremental path toward eliminating congestion. For instance, Singapore will soon install devices in every vehicle that can measure each vehicle’s use of the road network. However, the current pricing of road use is coarse—only at gantries on major arteries—and unresponsive—updated quarterly. We propose to make prices more granular and gradually move prices closer to real-time social costs.

Similar opportunities are arising all over the world. For instance, because many U.S. states have seen the revenue from motor fuel taxes diminish as the fuel efficiency of vehicles has improved, and because fuel taxes typically are not indexed to inflation, states like Oregon are experimenting with a tax on vehicle miles traveled. Its 2015 “OReGO” program charges volunteers having the requisite on-board equipment a fee of 1.7 cents per mile within pre-identified zones. However, since the experiments are only meant to explore options to replace fuel taxes for road funding, pricing is fixed and not related to social cost. Here, too, a natural next step is to gradually make prices fully efficient.

Moving gradually minimizes policy risks, allows researchers to study the incremental efficiency and distributional effects, and helps gain public support. It also allows app providers, such as Google, Apple and Uber, to integrate the relevant price information and other innovations into their apps, which helps users make better transport decisions. This appears to be the inevitable future of roads.

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