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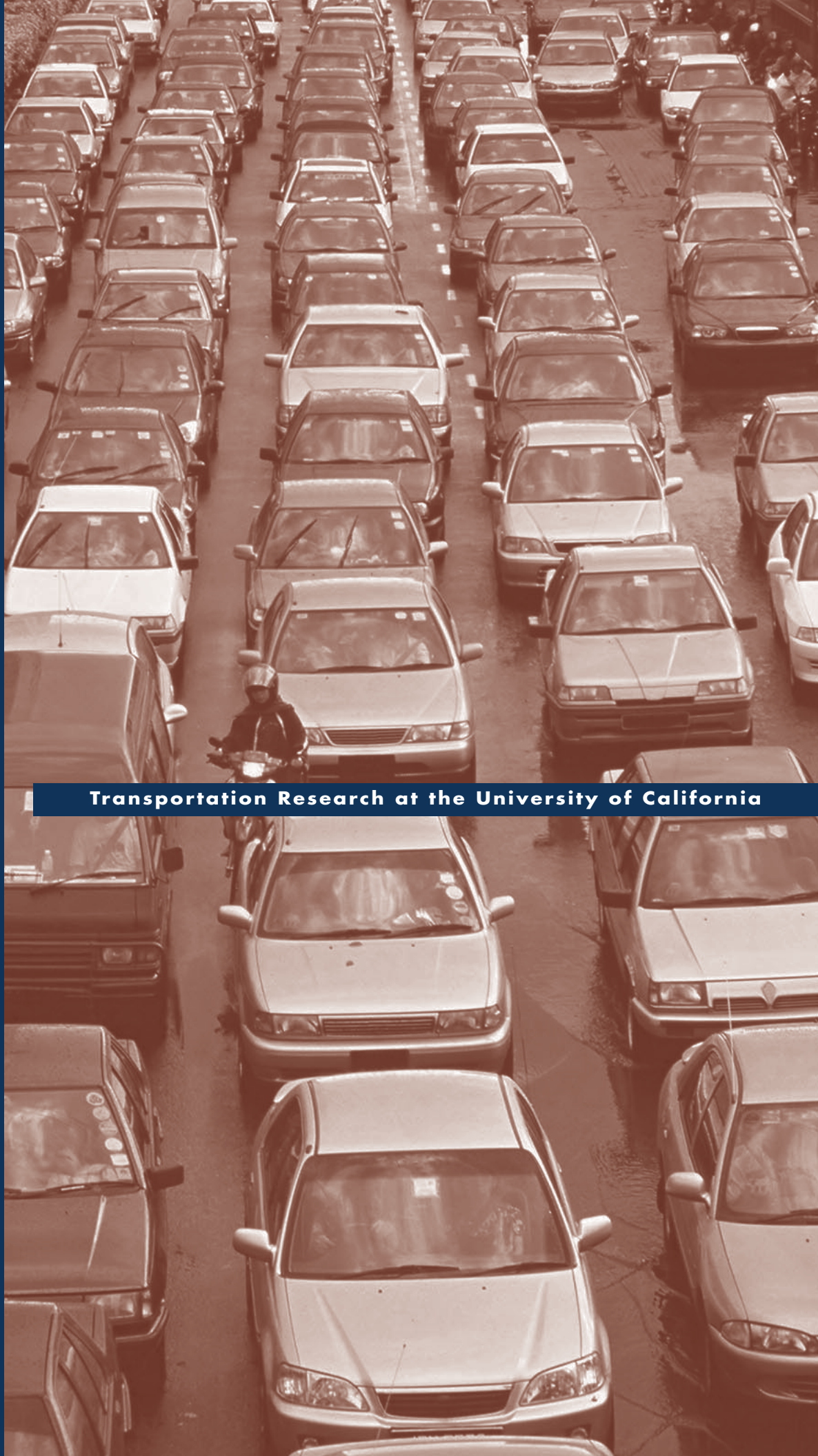
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ACCESS magazine reports on research funded by the University of California Transportation Center. The goal is to translate academic research into readable prose that is useful for policymakers and practitioners. Articles in ACCESS are intended to catapult academic research into debates about public policy, and convert knowledge into action.



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Twenty Years of ACCESS

ACCCESS is the face of the University of California Transportation Center. It is appreciated worldwide for its incisive commentary on transportation issues of the day and its nicely packaged summaries of cutting-edge UCTC research. This 41st issue of ACCESS is cause for celebration for it marks the magazine's 20th anniversary. Hooray!

Over the preceding 40 issues we've published 217 articles spanning 1,578 pages of text and illustrations. For much of the past 20 years, some 15,000 hardcopies of ACCESS have been shipped to all corners of the world, twice a year and free of charge. As society becomes increasingly paperless, more readers are accessing ACCESS online: we average around 1,000 visitors to the website per month.

Much of the credit for ACCESS's success goes to its editors. Beginning with ACCESS's founder, Melvin Webber, and continuing through to Charles Lave and now Donald Shoup, ACCESS has been blessed to have faculty at the helm with a keen eye for brevity and clarity. Perhaps what most distinguishes ACCESS is the unflagging ability of its editors and authors to distill complex research findings into readable and enjoyable articles. While the interested reader can always go to the Further Reading section to dig more deeply, for many of us the ACCESS article itself suffices in telling most of the story. In my own transportation planning classes, I've typically used three or four ACCESS articles as required readings and I know others do likewise.

Another cause for celebration is that UCTC won this year's USDOT competition for the Region IX University Transportation Center. A year ago, UCTC's future, and indeed the future of the entire federal UTC program, was uncertain. After winning the competition and with the passage of a new

federal transportation bill (MAP-21) that authorizes funding for the UTC program to 2015, we hope UCTC will be in business for at least a few more years, if not longer. We relish the opportunity to continue doing what we do best: advance knowledge on important transportation topics and challenges, and educate the next generation of top-flight professionals and scholars who can effectively take on these challenges.

UCTC 2.0 is very similar to its predecessor. In response to USDOT's Request for Proposals, however, we have made a few notable changes. One, we've extended the family. UC Davis joins the Berkeley, Irvine, Los Angeles, Riverside, and Santa Barbara campuses as a core member of the UCTC consortium. Also, four campuses of the California State University system—Pomona, Sacramento, San Bernardino, and San Luis Obispo—are now affiliate members of UCTC. Besides collaborating with UC campuses on faculty research, we look forward to partnering with the CSUs on UCTC's educational and workforce development missions.

Another change is our strategic focus. In the past, UCTC research focused on "systems analysis and policy." Our new focus is on three important, related themes: *environmental sustainability*; *economic competitiveness*; and *livability*. This shift came in response to USDOT's strategic vision of future priorities in transportation research and practice. It also reflects areas that keenly interest UCTC faculty affiliates and graduate students.

Let's collectively toast ACCESS Magazine's 20th anniversary. I suspect that two decades from now we'll be celebrating 40 years of ACCESS as the flagship publication of the UCTC program.

Robert Cervero
Director UCTC

New Automobile Regulations

Double the Fuel Economy, Half the CO₂ Emissions, and Even Automakers Like It

NIC LUTSEY

NO INDUSTRY, LET ALONE THE AUTO INDUSTRY, ASKS TO BE REGULATED. And if just five years ago you told automotive insiders—industry executives, environmental advocates, and California regulators—that *this* is how it would turn out, nobody would have believed it.

Automakers didn't ask for new regulations, but in the interest of long-term regulatory certainty, they sat down with federal regulators, discussed terms, and ultimately agreed to higher efficiency standards through 2025. The standards will nearly double fuel efficiency and cut greenhouse gas emissions from new vehicles in half over a 15-year span. Remarkably, in just five years, automakers went from vociferously fighting new standards with multiple lawsuits to seeking a compromise. In 2009 and 2011, they stood beside President Obama while he publicly announced stricter standards for 2016 and even tougher standards for 2025. The California Air Resources Board, environmental organizations, and consumer advocacy groups are also on board with the new fuel-efficiency targets.

Two new studies reveal how this outcome was achieved. The first examines automakers' fuel economy compliance data to quantify the underlying engineering factors and technical inefficiencies within the existing vehicle fleet. It reveals that many efficiency opportunities are available and that more efficiency innovations will continue to emerge in the marketplace. The second study assesses the importance of the long regulatory lead-time, which allows for investment, engineering development, technology deployment, and automaker support for the progressive 2025 standards.

Nicholas Lutsey was a PostDoc Researcher and a California Air Resources Board Research Consultant at the University of California, Davis. He is now a Program Director for the International Council on Clean Transportation (nic@theicct.org).



BREAKING THE DEADLOCK

As with previous efforts to make cleaner vehicles, it all started in California. In 2004 the California Air Resources Board regulated the greenhouse gas emissions from automobiles through 2016, forging the first major climate policy in the US. Opponents of the regulation argued that states do not have the power to regulate vehicle fuel economy. But after years of litigation, four federal courts and the US Supreme Court all ruled in favor of California's authority to regulate CO₂ emissions. Since CO₂ emissions move in lockstep with fuel consumed, regulations reducing CO₂ also increase fuel economy.

In 2009, the federal government made California's target of 250 grams of CO₂/mile, which is equivalent to a Corporate Average Fuel Economy (CAFE) standard of about 34 miles per gallon (mpg), the nationwide law for 2016. This broke a three-decade-long deadlock, during which regulatory standards for new vehicles had hovered around 25 mpg.

Before the ink had dried on those federal rules, California was working on its next big moves to achieve the far-reaching 2050 climate stabilization goals of its "Global Warming Solutions Act." Beginning in 2009, the three agencies with regulatory authority in this area—the National Highway Traffic Safety Administration, which develops CAFE standards; the US Environmental Protection Agency; and the California Air Resources Board—worked to develop new 2025 vehicle standards.

The three agencies published a pre-regulatory document that assessed the technologies and costs necessary to achieve fuel economy between 47 and 62 mpg in 2025. ➤

These standards
are the boldest
actions ever
taken to reduce
oil consumption
and carbon
emissions
in the US.

That effort spurred further regulatory stakeholder meetings with automotive engineers, suppliers, labor, and others. When the dust settled, the resulting 54.5 mpg (163 gCO₂/mile) agreement with automakers fell in the middle of the much-debated range. The final detailed provisions were hashed out in the formal regulatory process that wrapped up in October 2012. These standards are the boldest actions ever taken to reduce oil consumption and carbon emissions in the US.

ACTUAL MILEAGE MAY VARY

By now, we all know the disclaimer: “Actual mileage may vary.” A few basic adjustments will affect what the 2025 standards really mean for auto consumers. Automakers will get credit for using improved air-conditioning technologies that do not directly increase fuel economy under the standard city-highway regulatory test. The deployment of low-global-warming refrigerants will earn credits that reduce the target from 54 mpg to about 48 mpg. The standards also give automakers special credits for vehicles that employ advanced technologies like plug-in electric vehicles and hybrid gas-electric pickup trucks. The credits provide greater incentives for the development of nascent technologies, but they also further reduce the effective fuel economy targets.

The real-world fuel economy—listed on automaker advertisements, consumer labels, and government websites—has historically been 20 percent lower than the official regulatory test procedure used for automaker compliance. This gives consumers a real fuel economy of about 39 miles per gallon for the average new vehicle in 2025, as opposed to the 2011 average of 23 mpg. This 20 percent difference between the official CAFE number and actual mpg is caused by factors like US drivers’ aggressive acceleration, idling time, high speeds on the highway, and accessory use.

Beyond these basic adjustments, the announced standards also contain more complex provisions. Each automaker is subject to varying standards based on its sales-weighted average vehicle size (or “footprint”) and its mix of cars versus light trucks (like sport utility vehicles and pickups). This leads to an important point about the structure of the standards: by design, all the vehicle types are pushed to achieve about the same percentage efficiency improvement. In practice, this means that manufacturers making larger vehicles, like US-based General Motors, Ford, and Chrysler, will get less stringent absolute standards. As a consequence, the new rules push all automakers to install new technologies but they do not push for vehicles to be smaller. These provisions were necessary to achieve industry buy-in.

The standards require about the same level of emission-reduction and efficiency improvement across all vehicle sizes and classes. In terms of carbon emissions, this is a 45–50 percent reduction in CO₂ emissions per mile. In terms of fuel economy, an average compact car today that gets 30 mpg will achieve about 51 mpg in 2025, and today’s 17-mpg-full-size pickup will achieve about 29 mpg in 2025. Makers of compact cars, crossovers, and full-size trucks will utilize an array of rather dramatic technological improvements. However, the regulation is a performance standard that allows automakers to develop their own diverse technology strategies to comply. The new standards also allow the mix of future vehicles (i.e., how many compacts, crossovers, and pickups) and their resulting mpg to fluctuate somewhat depending on market forces (e.g., the price of fuel) yet remain compliant from a regulatory perspective.

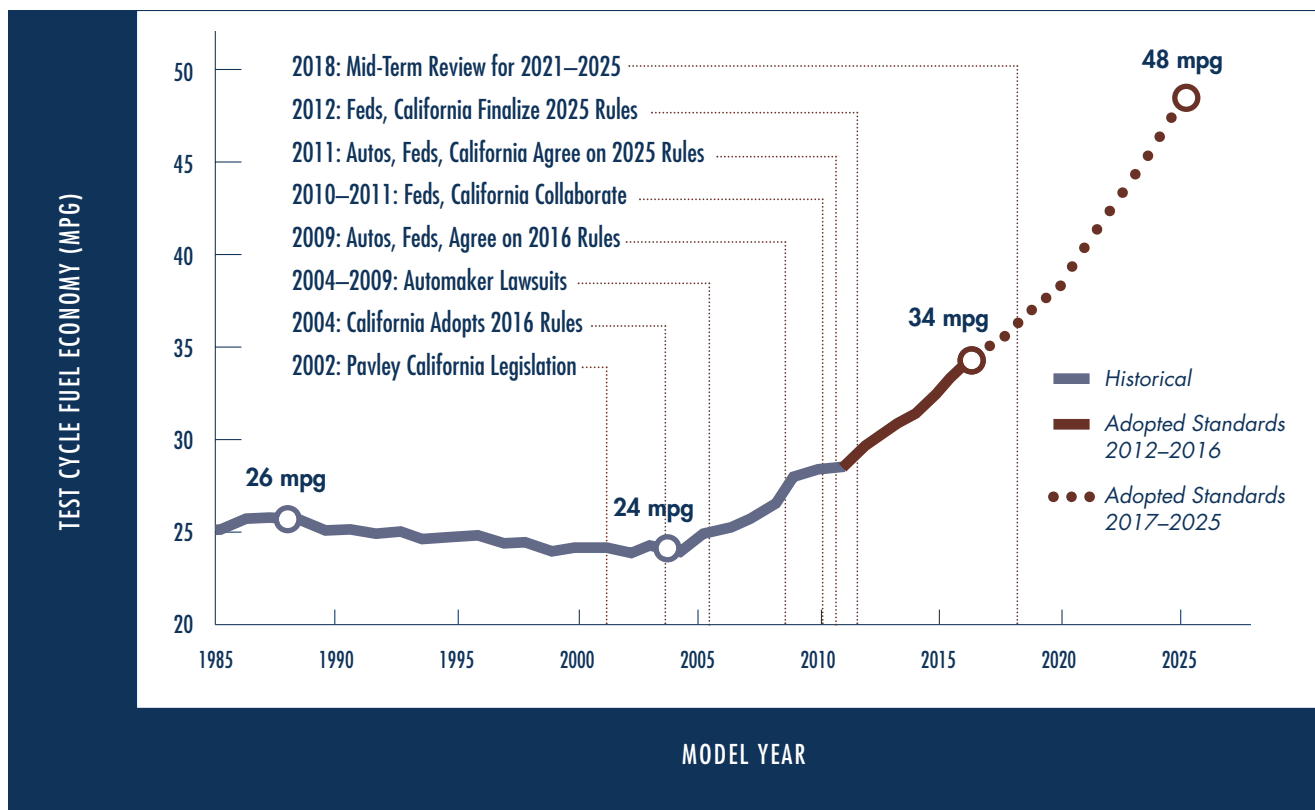


FIGURE 1

Milestones toward Efficiency and CO₂ Standards

INEFFICIENCIES AND SOLUTIONS

How will automakers achieve the new standards? Better fuel economy is, at its heart, a matter of physics, engineering, and economics.

The basic physics of the modern automobile involve an uphill battle to eke out as much energy as possible from fuel to propel the vehicle. An overwhelming amount of the energy contained in the fuel dissipates on its way to the wheels. The most prominent energy loss occurs in the engine itself. Vehicles lose over 70 percent of fuel's chemical energy to the thermodynamic, friction, and pumping losses that take place during the internal combustion process. Most of this energy turns into wasted heat instead of propelling the vehicle. After we factor in auxiliary and accessory power draws (power steering, air conditioning, electronics), idling when the vehicle is at rest, and transmission losses, about 15 percent of the fuel's energy makes it to the wheels to accelerate and maintain the desired vehicle speed.

The good news is that there are numerous technical solutions to combat those losses. Automotive engineers have developed far more sophisticated valvetrains to optimize the precise timing of fuel and air intake and exhaust. Turbocharging with gasoline direct injection is the get-more-with-less approach that can provide more power and make gasoline engines operate like fuel-efficient diesels. Transmissions with more gears and optimized controls ensure that the engine's torque and speed are consistently near their highest-efficiency "sweet spot." In fact, new dual-clutch transmissions, which eliminate the torque converter and minimize power losses between the engine and wheels, are now giving >



automatics *better* efficiency than manuals. Vehicle design improvements—sleeker aerodynamics; advanced, stronger and lighter materials; and lower-rolling-resistance tires—all mean that automakers can drastically reduce the vehicle powertrain energy requirements without degrading vehicle size, safety, acceleration, or utility.

Fortunately, all these incremental technologies are sitting on automotive engineering shelves, ready to be deployed. Their use is more an opportunity for automakers than a burden. As Chrysler-Fiat CEO Sergio Marchionne said just after the 54-mpg agreement: “It will be a huge boost for the industry. It’s like walking into a toy store, and you can use any toy off the shelf to get you there.” Federal regulators found that manufacturers can reduce the fuel consumption and CO₂ emissions of essentially every class of light-duty vehicle from subcompact to pickup truck by over 45 percent with these low-cost, incremental technologies.

In addition to deploying these near-term improvements, automakers are developing different and more exotic electric-drive configurations. They seek to match or beat the efficiency, price, and cachet of the Toyota Prius with their own hybrid and plug-in battery electric vehicle designs. The new CAFE standards, by government agency estimates, may not drive electric vehicles into the mainstream because new gasoline-driven technologies are more cost-effective. But automakers will continue to pursue advanced electric-drive technologies because they must comply with existing mandates like California’s Zero Emission Vehicle regulation, and they anticipate stiffer regulations beyond 2025. They also want to bolster their green credentials with cutting-edge “halo effect” models.

Reaching an industry-government agreement required not only that compliance was technically feasible, but also that the consumer economics made good sense. Even though consumers rarely calculate the potential fuel savings for competing vehicle models of different efficiency levels, they still tend to purchase available low-cost efficiency technologies that pay back within several years. A number of surveys have established that consumers demand higher fuel economy, support standards to force these technologies into the market, and would be willing to pay when greater efficiency technologies are offered. However, automakers have been slow to introduce efficient technologies into the marketplace.

Several factors brought about this predicament. Consumers have limited information about fuel economy and its impact on future expenses. To combat this, the EPA's new fuel economy labels will provide more comprehensive information. Still, even with better knowledge of fuel economy, a major issue is consumers' loss aversion: consumers are not willing to fully rely on possible future fuel-saving benefits in the face of uncertain future petroleum prices. Traditionally this has meant consumers have been drawn more towards other vehicle attributes (e.g., increased vehicle size, off-road ability, power for acceleration, electronic or luxury amenities) that automakers have deployed and marketed. With uncertain and unreliable consumer demand for efficiency, it's no wonder that automakers with limited technology and marketing budgets have tended to focus more on cutting costs to stay competitive.

The new US and California regulations attempt to rectify this "energy paradox," where the fuel cost savings of new technologies would quickly pay for their upfront expense but automakers are not offering them because of questionable consumer demand. The payback periods of the new regulation-induced technologies make sound economic sense. Based on university, government, and auto industry research, the 2016 standards will add \$1,000 to the vehicle cost but will increase fuel economy by 20 percent, which for the typical driver will result in a three-year payback. In future years, cost and efficiency prospects will improve as automakers and suppliers gain technology experience, innovation is unleashed, major investments are made, and economies of scale are achieved. The longer-term 2025 standards should result in another 40 percent gain in fuel economy, with an additional upfront cost of \$1,500–2,000 per vehicle, meaning another short payback period of three to four years.

BENEFITS BEYOND THE CONSUMER

The societal case for efficiency standards goes beyond the consumer into broader economic issues. As noted, consumers tend to misvalue the full costs and benefits of their vehicles, and there is an even more clear-cut market failure with respect to petroleum economics and costs associated with climate change. The true costs of petroleum dependence are not accounted for in vehicle purchasing and use choices, yet these costs impose very real burdens on the US in terms of vulnerability to price volatility and oil shocks, and the geopolitics of securing our petroleum supply. Moreover, drivers pass on the external effects of climate change to future generations. Efficiency standards, in essence, internalize these future energy and environmental costs into current vehicle technology choices.

The final case in favor of efficiency standards involves industrial policy. The United Auto Workers and other organized labor groups have hailed the regulation for ➤

The payback periods of the new regulation-induced technologies make sound economic sense.



promoting innovation and technological leadership in US manufacturing. Automotive media articles have referred to the standards as a “supplier bonanza.” Companies that make everything from turbochargers and dual-clutch transmissions to electric motors and batteries are receiving major new orders from automakers and making large investments to capitalize on the opportunity. It is precisely due to the long lead-time of the 2025 standards that the auto industry supports the regulation. The 13-year foreknowledge about the regulatory landscape allows automakers and their suppliers ample time and market certainty to make sustained large-scale technology investments in research, engineering, and manufacturing to make it all happen.

Perhaps a stronger case for standards is that the US has to make this efficiency commitment just to keep up with the other major auto markets around the world. High-efficiency diesel technology has been primarily developed and manufactured in Europe, and hybrid technology has been primarily developed and manufactured in Japan due to tough standards and complementary policies in these two markets over the past ten years. Their efficiency requirements for 2020 are similar to the US 2025 standards. And since becoming the largest national auto market, China is working on standards that would require efficiency levels higher than the US as well. In the meantime, average US vehicles have gotten larger and more powerful, but with far fewer efficiency gains.

Currently, about three-quarters of the world auto market is regulated for efficiency or CO₂ emissions. Without California's kick-starting the US market back into the low-CO₂ and efficiency improvement game, the US would be a global laggard. In this sense, the standards help prevent our domestic auto market from becoming a "technology island" with less development and deployment of the hottest new technologies than other markets.

NO PANACEA

The new regulations are not without potential pitfalls. A simple summary of the regulations' effect on vehicle operating costs illustrates some repercussions for transportation planners. Based on average vehicle statistics, consumers will spend 40 percent less on gasoline per mile with new vehicles in 2025. This cost savings equates to about a 4 percent drop in vehicle costs per mile. The demand for driving will, however, increase as the marginal cost of driving falls, exacerbating congestion.

The decreased fuel consumption will also reduce the total revenue generated by fuel taxes. At current federal and California fuel tax levels, the total government "take" would drop from 2.8 cents per mile driven for new 2010 vehicles to 1.6 cents per mile driven for new 2025 vehicles. Although pennies per mile may sound small, this revenue loss will amount to almost \$1 billion a year in California alone. If we did not already have enough incentive to restructure transportation funding, this will certainly force the issue.

Although the efficiency standards greatly benefit industry, consumers, and the environment, there are clear limitations. The standards are no panacea for our larger climate, travel demand, and congestion ills. If climate stabilization is a serious goal, we still need to make massive efforts to decarbonize our fuels.

THE ROAD AHEAD

While not a favorite policy for many economists, vehicle efficiency standards have yet again run the political gauntlet. As ever, the efficiency standards prompt many compelling research questions. How will consumers react to a richer diversity of technologies, from low-cost incremental efficiency to advanced electric-drive propulsion? How will automakers and consumers react to the efficiency standards based on vehicle size? Will pricing mechanisms (e.g., fuel taxation or vehicle feebates) eventually be needed to better align consumers' demand with the standards? With the expected dramatic drop in government fuel tax "take," how will we restructure our road taxes?

With all of these new and complex questions, it is not only consumers, industry, and environmental officials who should be excited about the new regulations; the research community will be engaged in studying the deeper engineering and economic truths behind it all. Who knew it was possible to have a transformative new energy and CO₂ regulation that makes almost everybody happy? Perhaps no one anticipated it, but we'll all be reaping the benefits for decades to come. ♦

This article is adapted from the longer version, "Regulatory and Technology Lead-Time: The Case of US Automobile Greenhouse Gas Emission Standards," originally published in *Transport Policy*.

FURTHER READING

Nicholas Lutsey. 2012. "A Technical Analysis of Model Year 2011 US Automobile Efficiency," *Transportation Research Part D: Transport and Environment*, 17: 361–369.

Nicholas Lutsey. 2012. "Regulatory and Technology Lead-Time: The Case of US Automobile Greenhouse Gas Emission Standards," *Transport Policy*, 21: 179–190.

US Environmental Protection Agency and National Highway Traffic Safety Administration. 2012. "2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule," *Federal Register*, 77(199): 62623–63200.



**TWO
WAY
TRAFFIC
KEEP RIGHT**
MDC

Two-Way Street Networks: More Efficient than Previously Thought?

VIKASH V. GAYAH

ONE-WAY STREETS IN DOWNTOWN AREAS ARE RECEIVING A critical look. City officials and urban planners have started a movement to convert downtown street networks from their traditional one-way operation to two-way operation. This effort seems to be largely successful—many cities (e.g., Denver, CO; Dallas and Lubbock, TX; Tampa, FL; Des Moines, IA; Salina, KS; Kansas City, MO; Sacramento, CA) have either recently made or are in the process of making such conversions. These conversions are intended to improve vehicular access and reduce driver confusion. Many additional factors go into this decision, but the general premise is clear: travelers and residents prefer two-way streets for a variety of economic and livability reasons, while traffic engineers and transportation planners believe that one-way streets serve traffic more efficiently.

Our study uses an idealized traffic network model to directly compare the efficiency of one-way and two-way street networks. It finds that two-way streets may serve traffic more efficiently, especially when trips within the network are short.

Vikash V. Gayah received his PhD in transportation engineering at the University of California, Berkeley and was the most recent recipient of the University of California Transportation Center's Student of the Year award. He is now Assistant Professor at Pennsylvania State University (gayah@enr.psu.edu).

TWO-WAY STREET NETWORKS INCREASE ECONOMIC ACTIVITY AND LIVABILITY

The current literature on urban street network design stresses that two-way streets create higher levels of economic activity and improve the livability of downtown areas. For example, two-way streets are better for local businesses that depend heavily on pass-by traffic. Additionally, traffic signal timing on two-way streets forces vehicles to stop more frequently than on one-way streets, giving drivers more exposure to local businesses.

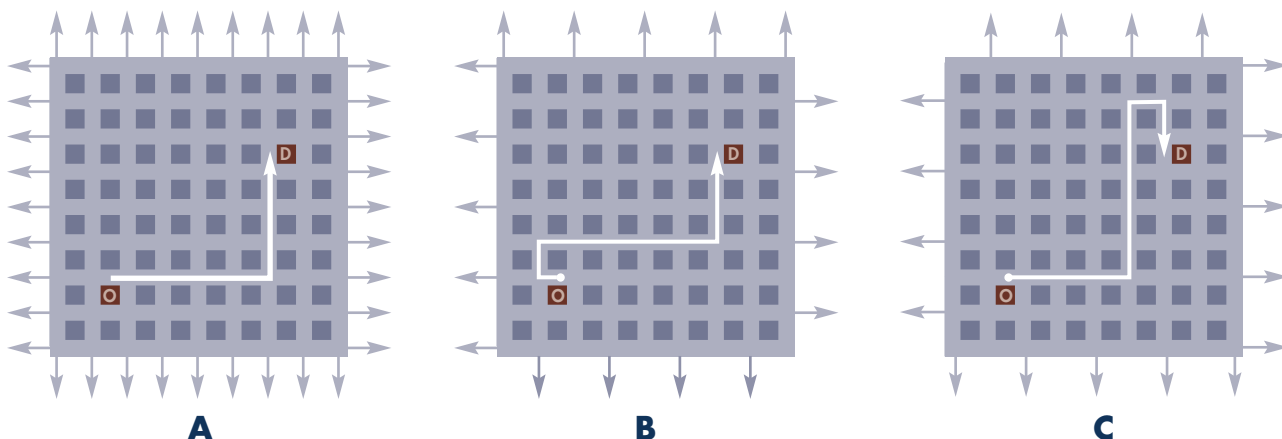
Two-way streets have also been found to be safer than one-way streets, for several reasons. Although intersections of two-way streets have more conflicting maneuvers, one-way streets correlate with decreased levels of driver attention. One-way streets also allow higher travel speeds since signal timing results in less frequent stops for vehicles. Pedestrians also prefer crossing two-way streets since drivers tend to travel more slowly on them and vehicular conflicts are more predictable.

Downtown visitors, whether they arrive by car or public transportation, prefer two-way street networks to one-way street networks because they are less confusing. Visitors driving in a two-way grid network can easily approach their destination from any direction. A one-way network may prevent drivers from approaching their destination from the most logical direction. This uncertainty can intimidate drivers and, in some cases, make them hesitant to return. Likewise, two-way streets make locating the transit stop for a return trip from downtown easier—in almost all cases, the bus stop is simply located across the street. On one-way networks, however, the stop for the return trip is usually on another street, which may confuse visitors and cause them to get lost.

Additionally, two-way street networks allow drivers to take the most direct routes from origin to destination. Consider, for example, the trip shown in Figure 1a between origin O and destination D. In a two-way network (shown by the arrows that denote travel direction), the driver can take the most direct path from O to D. Compare this route to the same trip on a one-way network, as shown in Figures 1b and 1c. The driver may have to travel some additional distance at either the origin (as in Figure 1b), destination (as in Figure 1c), or both. Thus, the use of one-way street networks increases the average driving distance between any paired origin-destination points and will result in more vehicle miles traveled (VMT). Increased VMT means increased fuel consumption, emissions, and exposure to accidents. ➤

FIGURE 1

Routes Taken Between the Same Origin-Destination Pair in:
(A) Two-Way Street Network,
(B) One-Way Street Network with Deviation at Origin, and
(C) One-Way Street Network with Deviation at Destination





ONE-WAY STREET NETWORKS INCREASE VEHICLE FLOW

One-way street networks do have one critical advantage over two-way street networks: they eliminate conflicting left-turn maneuvers at intersections. This is critical because left turns reduce maximum vehicle flows at intersections. For example, left-turning vehicles that are mixed with through traffic must wait for a gap in the opposing traffic and can block upstream vehicles waiting to go through. Separate lanes can segregate left-turning vehicles from other vehicles to reduce this blocking, but this strategy also reduces the amount of space available for the remaining vehicles to move through the intersection. Dedicated left-turn signals can be used to eliminate blocking, but their presence leads to more complicated signal timing and increases the amount of time wasted for vehicle movement at the intersection. Since intersections limit maximum network flows, it follows that one-way street networks can serve higher maximum network flows (i.e., have higher vehicle-moving capacity) than two-way street networks.

Opponents of converting one-way streets to two-way operation often cite this decrease in vehicle-moving capacity (in addition to cost and feasibility). Although two-way streets can increase prosperity and livability, decision makers fear that the loss in vehicle throughput will result in longer and more congested peak periods, lower average vehicle speeds, and increased vehicular delay. Thus, reduced vehicle capacities lower network efficiency. Worse yet, congestion arising from the loss in vehicle-moving capacity can cause people to avoid downtown and may contribute to its decline as a center of economic and recreational activity.

TRIP-SERVING CAPACITY: A BETTER METRIC OF NETWORK EFFICIENCY

The ability to move many vehicles does not reflect the ultimate objective of any transportation network. The goal is to allow people to reach their destinations as quickly as possible. The maximum rate at which people reach their destinations, also known as the network's trip-serving capacity, more accurately captures this objective. All else equal, a network with a higher trip-serving capacity will serve vehicle trips with less delay.

Therefore, even though current research and conventional wisdom suggest that one-way street networks are more efficient than their two-way counterparts, we show that one-way networks are sometimes less efficient because they restrict the rate at which people reach their destinations. When this is the case, there is a greater incentive to convert traditional one-way street networks to two-way operation.

NETWORK COMPARISON

We can directly compare the trip-serving capacities of various two-way and one-way networks. The two-way street networks differ in their treatment of conflicting left turns at intersections. Here, we consider three treatments for a network with two travel lanes in each direction. Figure 2 shows the intersection configurations for these networks. Table 1 summarizes the advantages and disadvantages of these three treatments.

The trip-serving capacities of these networks vary based on factors such as demand distribution, signal timing at the intersections, and driver routing schemes. To simplify the analysis, we compare the networks under ideal conditions, which include uniform travel patterns, dedicated left-turn signals that are timed to serve the existing left-turn demand, and the most direct driver routing. These ideal conditions facilitate an analytical solution to the trip-serving capacities of the different networks, but the results of this analysis also apply to real-world conditions where these assumptions are relaxed.

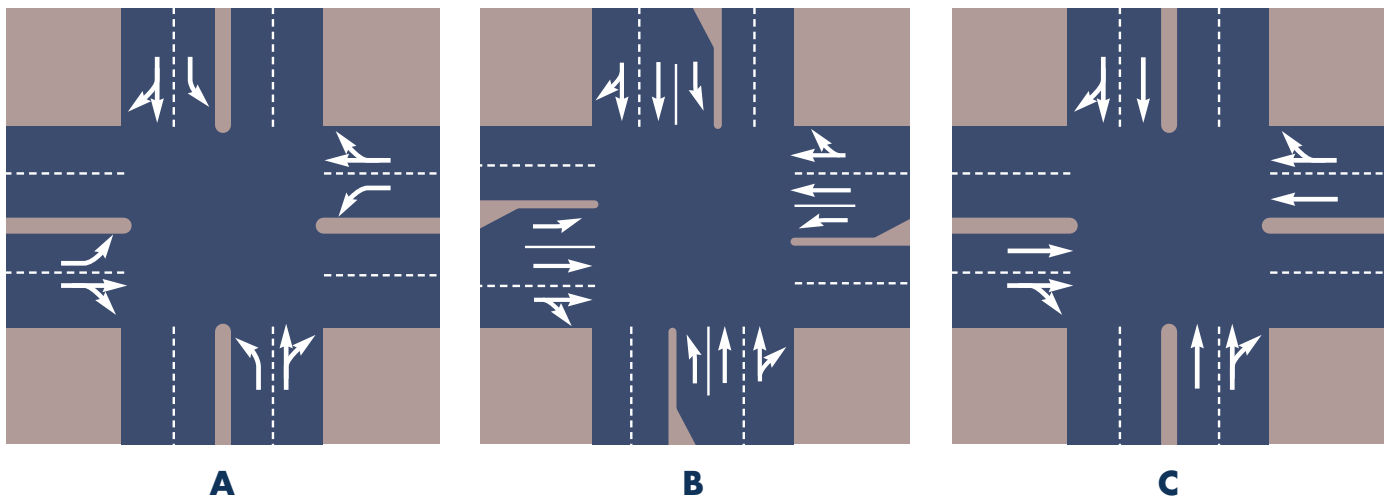


FIGURE 2
Intersection Configurations
for Two-Way Networks with:
(A) Left-Turn Lanes,
(B) Left-Turn Pockets, and
(C) Banned Left Turns

Treatment	Advantages	Disadvantages
Left-turn lanes (Figure 2A)	<ul style="list-style-type: none"> • Left-turn and through vehicles are segregated 	<ul style="list-style-type: none"> • Through vehicles discharge from one less lane
Left-turn pockets (Figure 2B)	<ul style="list-style-type: none"> • Left-turn and through vehicles are segregated • Through vehicles discharge from the same number of lanes 	<ul style="list-style-type: none"> • Lanes narrowed at intersection
Banned left turns (Figure 2C)	<ul style="list-style-type: none"> • Does not require a lane for making left turns 	<ul style="list-style-type: none"> • Vehicles must take more circuitous routes to reach destination

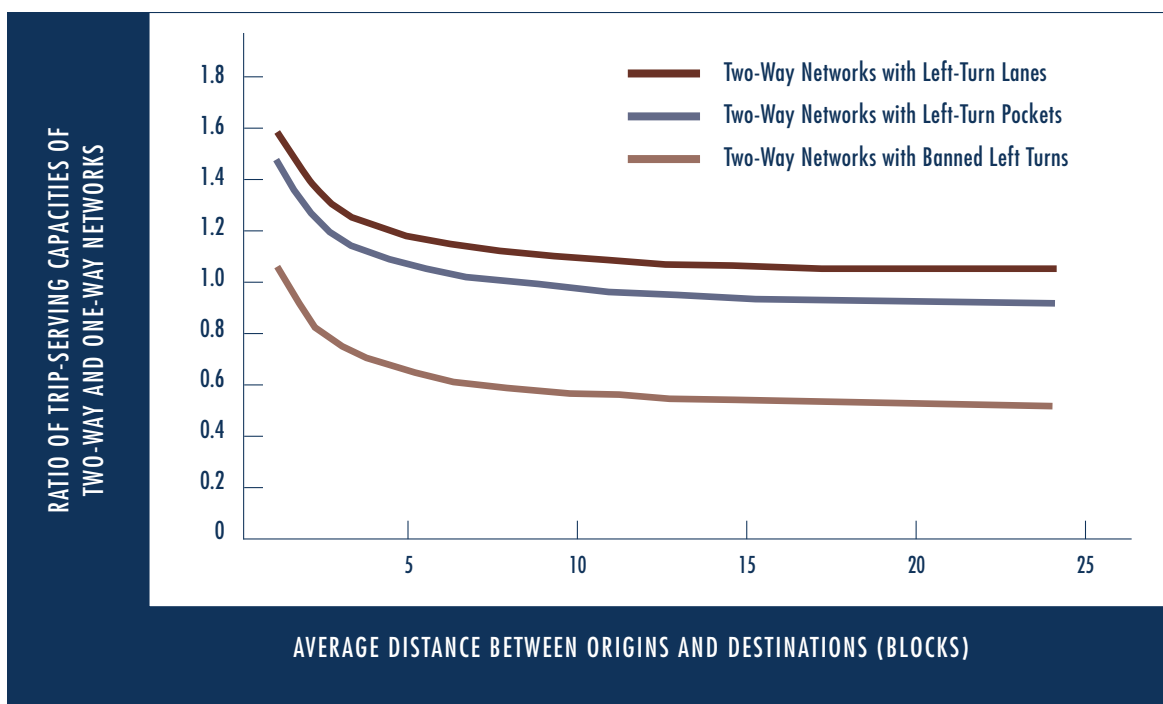
TABLE 1
Advantages and Disadvantages
of Left-Turn Configurations

A network's trip-serving capacity turns out to be a ratio of two quantities: its vehicle-moving capacity and the average trip length. The number of vehicles that can move through an intersection during a signal cycle determines the vehicle-moving capacity. Applying probability theory to the network geometry can help us determine the average trip length by determining how much farther vehicles must travel given the movement restrictions. Both quantities, and thus the trip-serving capacity of the network, turn out to be a function of two key parameters: 1) the average distance between origins and destinations in the network; and, 2) the amount of time wasted at left-turn signals. Figure 3 shows the ratio of the trip-serving capacities for the two-way street networks compared to the one-way street network for different values of these variables. This ratio measures the relative efficiency of a two-way network compared to a one-way network. Values greater than one imply that the two-way network serves trips at a higher rate, while values less than one imply that the one-way network is superior.

In Figure 3 the two-way networks that allow left turns have higher trip-serving capacities for shorter trip lengths. When trip lengths are short, the additional circuitry >

FIGURE 3

Comparison of Trip-Serving Capacities of Two-Way Networks with a One-Way Network



of one-way networks is so damaging that simpler signal timing at the intersection (and higher vehicle-moving capacities) cannot compensate for the additional travel distance. When trips are longer, however, simpler signal timing does compensate for the additional travel required by the one-way network. Since average trip length should be proportional to the size of the downtown area, a one-way to two-way conversion of a downtown network may actually *increase* the network's ability to serve trips in smaller cities. Figure 3 also shows that even if trips are long, the two-way networks with left-turn pockets can provide trip-serving capacities that are just 10 percent lower than one-way networks. The critical trip length that separates "short" and "long" trips is a function of the amount of time wasted at dedicated left-turn signals. As more time is wasted at dedicated left-turn signals, this critical trip length decreases.

Notably, the two-way network with banned left turns *always* has a higher trip-serving capacity even when trips are long. Both strategies provide the same vehicle-moving capacity (since both eliminate conflicting turning maneuvers), but the two-way network with banned left turns imposes less circuitous routes than the one-way network. In fact, the additional travel distance required in a one-way network is at least twice that of a two-way network with banned left turns. This makes physical sense since one-way networks are more restrictive and ban more vehicular movements. Thus, if left turns are banned at the intersections, converting a one-way network to two-way network operation can always *increase* the ability of the network to serve trips even for larger cities with longer average trip lengths.

CONCLUSION

Contrary to conventional wisdom and design handbooks, two-way networks are often more efficient than one-way networks. Even though two-way networks may provide lower vehicle-moving capacities, they can, in some cases, serve trips at a higher rate. This trip-serving capacity is a better metric for predicting network performance during peak periods. When trips are short, two-way networks that allow conflicting turning maneuvers have higher trip-serving capacities than one-way networks because the additional circuitry in one-way networks offsets the more efficient intersection control. Two-way networks are more competitive as the length of the signal cycle increases. Additionally, two-way networks that ban left turns can *always* serve trips at a higher rate. While both strategies eliminate conflicting turning maneuvers, two-way networks with banned left turns impose less circuitry than one-way networks.

When they consider converting to two-way streets, urban planners and traffic engineers should examine the average trip length within the network. Intuition suggests that average trip lengths tend to be proportional to the size of the downtown—larger downtowns should have longer trip lengths. Smaller downtowns should thus carefully examine the time wasted when providing dedicated left-turn signals to determine what type of two-way network configuration to use. Since the wasted time decreases with average cycle lengths, smaller cities should accommodate left turns only when cycle lengths are long, and should ban left turns when cycle lengths are short. Larger downtowns, however, should also convert to two-way operation but ban left turns at intersections. Regardless of the size of the city, however, a one-way to two-way street conversion should *always* increase the efficiency of downtown networks. Since residents prefer two-way street networks for a variety of reasons, converting a one-way street network to two-way operation can improve both the efficiency and livability of cities. ♦

This article is adapted from the longer version, “Analytical Capacity Comparison of One-Way and Two-Way Signalized Street Networks,” originally published in *Transportation Research Record*.

FURTHER READING

Carlos F. Daganzo. 2007. “Urban Gridlock: Macroscopic Modeling and Mitigation Approaches,” *Transportation Research Part B*, 41 (1): 49–62.

Vikash V. Gayah and Carlos F. Daganzo. 2012. “Analytical Capacity Comparison of One-Way and Two-Way Signalized Street Networks,” *Transportation Research Record*, Forthcoming.

Richard W. Lyles, Chessa D. Faulkner, and Ali M. Syed. 2000. *Conversion of Streets from One-Way to Two-Way Operation*, East Lansing: Michigan State University, Department of Civil and Environmental Engineering.

G. Wade Walker, Walter M. Kulash, and Brian T. McHugh. 2000. “Downtown Streets: Are We Strangling Ourselves on One-Way Networks?” *Transportation Research Circular*, 501 (F-2): 1–18.



Peering Inside the Pork Barrel

GIAN-CLAUDIA SCIARA

DURING THE LATE 20TH AND EARLY 21ST CENTURIES, Congressional earmarking played a larger role in federal transportation funding bills than ever before. Through earmarks, the US Congress directs federal funding to selected transport projects in specific places. Between 1994 and 2006, highway earmarks more than doubled. Notorious earmarks like Alaska's Bridge to Nowhere and Florida's Coconut Road together with fiscal pressures from the 2008 US economic crisis have led both the House and the Senate to adopt temporary earmark moratoria, calling time-out in the game of pork barrel politics. Yet, history—and the fact that transportation improvements can be handy, non-partisan ways for Congressional sponsors to build name recognition—suggest that this practice will resume. The current intermission in earmarking activity offers elected officials and transportation agency leaders an opportunity to analyze the practice and to improve its outcomes by making it more transparent and effective.

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Understanding the earmarking process is critical given the high stakes for any elected official or transportation agency interested in securing or spending federal funds. Earmarks transfer discretion over federal funds from local, metropolitan, state, and federal officials to members of Congress. Without earmarks, most federal dollars are available for states and metropolitan areas to fund projects they prioritize through their own selection processes. In contrast, members of Congress use earmarks to hand-pick transportation projects that may or may not reflect planning priorities articulated in metropolitan and state long range plans (LRPs) or near-term capital programs known as transportation improvement programs (TIPs).

Earmarks for projects outside these priorities create challenges for regional and state transportation agencies and local governments, yet many transportation stakeholders are unfamiliar with congressional earmarking practices and their planning and financial consequences. Outsiders have little ability to observe Congress’s process for selecting transport earmarks. Furthermore, while journalistic accounts often suggest that all earmarks deliver a funding windfall, in reality, they can create unforeseen costs for transportation organizations.

What can elected officials and agency leaders learn about earmarking now to plan more effectively for transportation investments when earmarks find favor again? How can members of Congress adjust their own practices to make future earmarks more transparent, more compatible with planned investments, and perhaps even better able to bolster politicians’ job approval?

To answer these questions, I provide a guide to how the transportation pork barrel operated during its peak and discuss the three key steps of Congressional earmarking. I also show how key distinctions among earmarks can determine who wins or loses and whether the underlying project reaches completion. Most importantly, I consider how members of Congress, congressional committees, transportation agencies, and local government officials can harmonize the impulse to earmark with the impetus for regional and state transport planning. To create this guide, I analyzed transportation spending bills and other archival materials and interviewed federal, state, and local agencies, transportation policy organizations, Congressional committee staff, and lobbyists. Here is what I learned. ➤



Appropriation Fiscal Year	Number of Earmarks	Total Value of Earmarks Constant \$ 2010 (millions)	Total Transportation Appropriation Constant \$ 2010 (millions)	Earmarks as % of Total Appropriation
1994	140	\$1,261	\$53,555	2.4%
1996	167	\$1,052	\$49,367	2.1%
1998	147	\$1,587	\$54,563	2.9%
2000	641	\$1,606	\$62,734	2.6%
2002	1,493	\$3,871	\$71,687	5.4%
2004	2,282	\$3,859	\$67,556	5.7%
2006	1,541	\$3,487	\$65,272	5.3%
2008	1,271	\$1,376	\$71,375	1.9%
2010	1,038	\$1,324	\$76,860	1.7%

TABLE 1
Congressional Earmarks in
Transportation Appropriation Bills

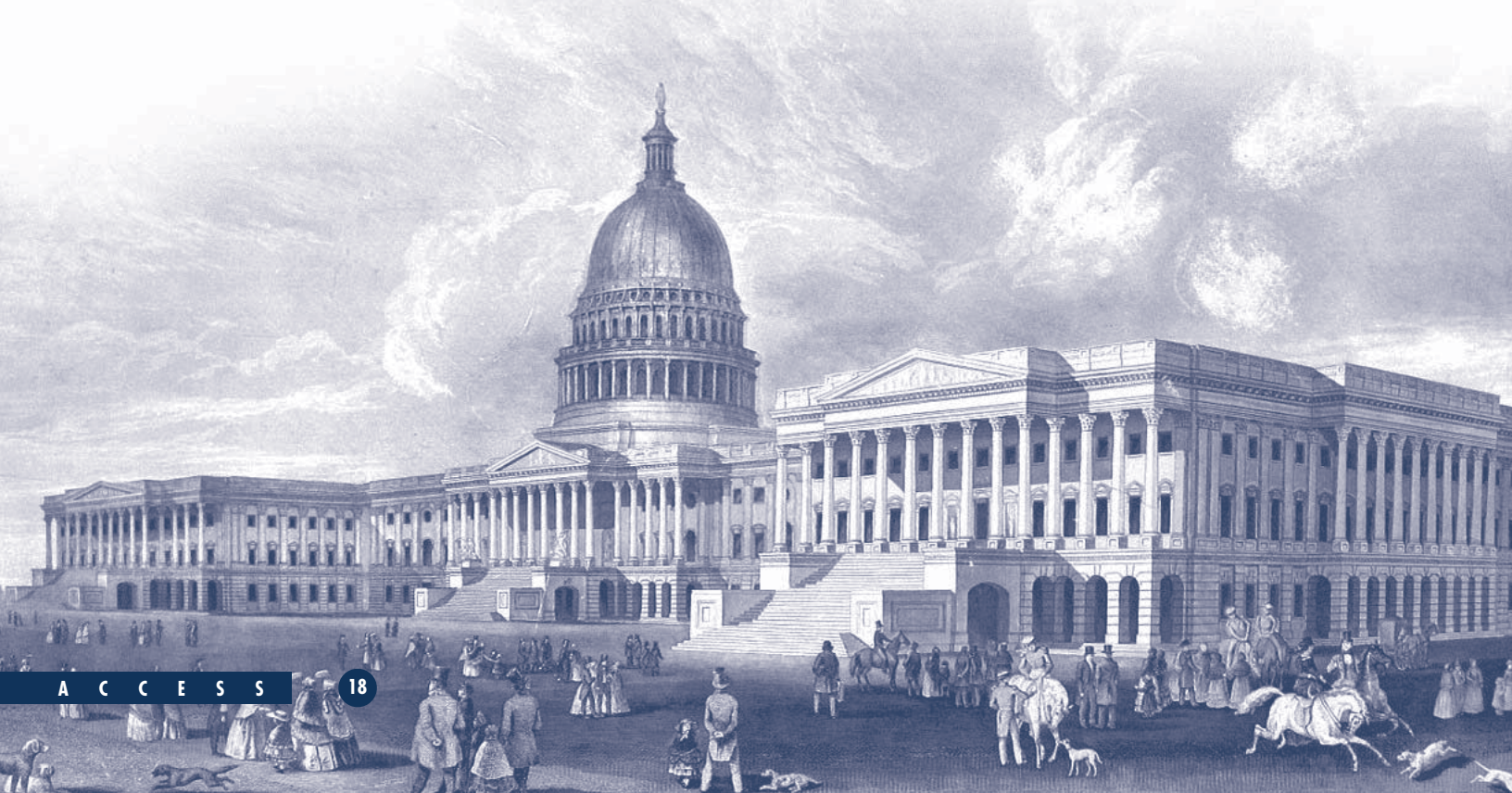
*We'll give you
\$10 million.
How do you
want that
allocation
spent?*

THE THREE STAGES OF EARMARKING

The precise path of any earmark is unique but generally unfolds in three stages as the bill passes through Congress. In the first step, members of Congress submit requests to the committees handling the transportation funding bills. As earmarks proliferated in the 1990s and early 2000s, the committees of jurisdiction formalized earmark request procedures, asking members to submit standard request forms first on paper, later on computer disk, and, ultimately, via Congressional intranet. Computer technology has simultaneously enabled and responded to earmarking's dramatic increase. Under the old system of maintaining requests on alphabetized index cards, keeping track of the 6,000-plus earmarks in the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) would have been impossible. Today's technology allows committee staff to manage far greater volumes of project requests when drafting bills and to collect more information about candidate projects. In principle, this information should allow committees to bring technical and planning considerations into the earmarking process and to ensure, for example, that earmarked projects reflect planning priorities, are financially feasible, and possess environmental clearances and public support. In practice, this has not occurred.

As individual members of Congress propose candidate projects, Congressional leadership sets the framework for earmarking in a funding bill. In this second step of the earmarking process, leaders of authorization and appropriation committees define how much money to devote to earmarks, what programs or accounts are eligible, the split of funds for the majority and minority political parties, and, ultimately, the share available for individual members' earmarks.

Congress does not openly deliberate these choices. Instead their decisions often reflect institutionalized practices. Little room exists, therefore, for state and regional bodies, local governments, and transportation agencies that might receive earmarks to influence this phase of the process. However, with greater knowledge of the earmarking process, transportation stakeholders can anticipate the chances of their congressional delegation securing earmarks and the impact of earmarking patterns on their share of federal funds.



In the annual appropriation, for instance, the subcommittee chairman—a “cardinal”—and the ranking minority member lay the ground rules for earmarking the bill. The majority party typically claims the greater share of funds, but the split can vary from year to year and between House and Senate chambers. Additionally, members of the key committees and subcommittees have greater access to earmarks than other members. To determine other members’ earmark allotments, the committee may weigh their seniority, other leadership positions, and electoral vulnerability. Partisan or personal issues may also figure in, such as “who’s been naughty or nice, who’s helped [the committee], and who’s pissed the chairman off,” explained one interviewee.

In the third and final phase of the earmarking process, individual Congress members identify their priority projects for earmarks, and the committee staff matches those requests with available funds. As House and Senate committees finalize the bill, committee staff inform members of their earmark budgets. “The member may have requested 40 projects worth \$100 million,” explained one Washington observer, “but the staff says, ‘We’ll give you \$10 million. How do you want that allocation spent?’” The member then ranks what projects to include in his or her allotment, affecting what projects appear in the final bill. A member may keep silent about this invisible step to avoid telling a constituent group that its desired project was not a priority in the final round.

Members’ final earmark choices reflect different values and preferences. Members may concentrate funds on a few projects or spread their allotment among many. Some members refuse to choose among projects, insisting instead that local transportation stakeholders together prioritize a regional set of desired projects. Still others may focus on a specific project while some may not pursue earmarks at all, or at least claim not to. House members may prefer to earmark projects located within their districts, whereas Senators may focus on larger projects that distribute benefits more widely across the state.

In the messy process of a bill’s final passage, committees make quick decisions and may change earmarks or add them at the last minute, a practice called air-dropping. Conference committee staff and members finalize the bill under great time pressure and can make mistakes, inadvertently omitting or editing earmarks. Congress can address these errors administratively or in a technical corrections bill, when they add language to clarify mishandled projects.

VARIETIES OF EARMARKS

To casual observers, earmarks appear all alike, delivering extra funds to pet projects. Yet, significant differences among earmarks can impact an underlying project’s fate and an earmark’s status as boon or bane to stakeholders.

Congress earmarks funds in transport spending bills primarily by creating new demonstration programs or by earmarking existing programs, producing different winners and losers among executive agencies, state transportation departments, and federal funding applicants. For example, Congress may build a new program ultimately just for earmarking. Earmarks in such demonstration or priority project programs are said to showcase new technologies or deliver nationally significant transportation investments. Congress designates such earmarks “above the line” or “below the line.” Above-the-line demonstration projects come in addition to the share of federal highway funds guaranteed under state-to-state funding-equity provisions, while below-the-line projects come at the expense of them. Thus, below-the-line projects can shift dollars from planned state and ➤



*Seasoned
earmark-seekers
recommend
vaguely worded
earmarks without
references to
specific tasks that
could later prove
unworkable.*

metropolitan investments to congressionally-selected projects. Both types of earmarked projects can recast the distribution of federal funds among states and within single states.

Another example is when Congress uses established discretionary programs to support earmarks. Federal agencies typically award discretionary funds based on programmatic objectives and competitive selection criteria. Earmarks, however, “take away the executive branch’s ability to choose projects,” explained a former Federal Highway Administration official. Discretionary earmarks can benefit those agencies and governments well positioned to receive earmarks vis-à-vis their Congressional delegation, but they disadvantage those whose projects would compete strongly for funding under program objectives.

Transportation earmarks also differ based on whether they appear in authorization or appropriation bills. Authorization bills structure federal transportation spending and policy over a multi-year period, whereas the annual appropriation bill makes the year’s installment of authorized funds available for spending. Since Congress passes authorizations infrequently, authorization earmarks are well-suited for projects under development that can gradually use annual installments for five to six years. In contrast, earmarked appropriation funds typically expire after a year or so, and are better suited to construction-ready projects. Earmark-seekers may pursue authorization or appropriation funds accordingly, or target the legislative process in which their representative or lobbyist has more influence.

EARMARKS’ LEGAL UNDERPINNINGS

What recourse do federal or state agencies, regional planning bodies, or local governments have when they object to a Congressional earmark? That depends. Overall, Congress has strategically phrased and positioned earmarking language in bills to guard its prerogative. Yet earmarks vary by whether they legally bind recipients to develop the project as Congress directs. Such variation determines the amount of flexibility earmark recipients or oversight agencies have to shape, amend, or reject an earmarked project.

Recipients must spend so-called “statutory earmarks” as they appear directly in the law’s text or its accompanying conference report, even though a transportation project can evolve in the period between the passage of a bill and the use of its earmarked funds. If the description in the original earmark no longer matches the project a grant recipient intends to implement, Congress must adjust the legislation. Non-statutory earmarks are easier to adjust than statutory earmarks. In either case, adjustments can burden agencies by absorbing significant staff time and political capital. If adjustments are not possible, an earmark recipient must spend the funds as prescribed or risk losing them. Seasoned earmark-seekers thus recommend vaguely worded earmarks without references to specific tasks that could later prove unworkable.

Projects that Congress earmarks sometimes do not align with the federal program designated to pay for them. The federal bus assistance program, for instance, is intended to support bus purchases, but some earmarks have directed those funds to unrelated projects. Federal agencies can block earmarks that violate a program’s legal funding criteria, but they may be reluctant to do so, fearing reduced budgets due to Congressional retaliation. To further prevent such challenges, Congress employs earmarking language to ensure an earmark will proceed “notwithstanding any other provision of law.”

TRANSFORMING EARMARKING PRACTICE

The Congressional earmarking process is dynamic. For parties who seek, administer, or use federal transportation funds, careful understanding of earmarking is paramount. Authorizers, appropriators, executive agencies, and earmark-seekers continually adapt earmarking practices in response to opportunities and threats. Each shift influences the types of earmarks created, their legal status, and their impacts on underlying projects and the agencies implementing them.

For instance, although both houses of Congress recently adopted bans on earmarking, the wording of both moratoria suggests that Congress can still direct federal funds to specific projects, provided such actions fall outside the technical definition of earmarks. Thus, so-called “soft” earmarks, which identify specific projects but not specific dollar amounts, may prevail. Members of Congress may also increase direct telephone and letter appeals to federal transportation agencies to fund desired projects, processes termed “phone-marking” and “letter-marking.”

Economic stagnation and political winds favoring federal cuts may extend Congress’s hesitation to earmark in the near term. Over the long term, however, Congress will likely reintroduce designations for special projects, which may result in new, potentially less transparent forms of earmarking. As one observer remarked, “When one door closes, there are always two or three more that they can go through.” Thus, stakeholders must remain attentive to the evolving practice of congressional earmarking.

Understanding past earmarking processes can provide insight on how to improve and streamline future earmarks. To start, congressional committees that draft transport funding bills could decline requests for projects that have not come through established ➤



FURTHER READING

Ann Brach and Martin Wachs. 2005. "Earmarking in the U.S. Department of Transportation Research Programs," *Transportation Research Part A: Policy and Practice*, 39(6): 501–521.

Diana Evans. 2004. *Greasing the Wheels: Using Pork Barrel Projects to Build Majority Coalitions in Congress*, Cambridge, UK: Cambridge University Press.

Gian-Claudia Sciara. 2012. "Financing Congressional Earmarks: Implications for Transport Policy and Planning," *Transportation Research Part A: Policy and Practice*, 46(8): 1328–1342.

Gian-Claudia Sciara. 2012. "Peering Inside the Pork Barrel: A Study of Congressional Earmarking in Transportation," *Public Works Management & Policy*, 17(3): 217–237.

Gian-Claudia Sciara. 2012. "Planning for Unplanned Pork: The Consequences of Congressional Earmarking for Regional Transportation Planning," *Journal of the American Planning Association*, 78(3): 239–255.

Gian-Claudia Sciara. 2009. "Earmark Pursuit Practices of Metropolitan Planning Organizations and Their Members," *Transportation Research Record*, 2119: 58–65.

planning processes and do not appear in approved regional or state transportation improvement programs. The TIP of a metropolitan area or state lists federally funded projects and programs ready for near-term implementation. By insisting that earmark candidates come from the TIP, committees could ensure that they earmark only those projects already vetted via public planning processes. Individual Congress members interested in good government could adopt this custom too. The practice could not only avoid the planning, financial, administrative, and legal complications of non-TIP earmarks, but also make the earmarking process more transparent.


Whatever Congress does, transportation agencies and local governments can initiate and sustain efforts to educate congressional delegations and their staffs about TIP programs and projects. Without violating ethical norms that discourage lobbying by public agencies, local government and agency officials could inform members of Congress about transport projects that are high priorities in regional and state plans. They could also explain how earmarks outside those priorities might affect planned regional and state transport system improvements.

These measures could make earmarking work more in concert with regional and state transport investment plans instead of against them. Of course, defenders contend that earmarks democratize the distribution of federal transportation funds, allowing stakeholders to advance projects in the face of regional and state planning processes that they view as inadequate or unfair. Where planning processes and bodies themselves need improvement, however, the ability to sidestep them with earmarks ultimately diminishes the urgency for reform.

Earmarks for projects drawn from regional and state TIPs also stand to enhance the very credit-claiming and name-branding opportunities for which representatives typically seek earmarks. Projects chosen from established plans and with stakeholder consultation are more likely to be well developed and have planning and environmental reviews in place. In such cases, a well-considered earmark could speed project delivery, realize the project's public benefits sooner, and make the desired ribbon cutting a safer bet. Therefore, although congressional earmarking is unlikely ever to disappear completely, its dynamic character allows for transformative changes.

With thoughtful action, stakeholders can make future earmarking more transparent and effective, to everyone's benefit. ♦

This article is adapted from the longer version, "Peering Inside the Pork Barrel: A Study of Congressional Earmarking in Transportation," originally published in *Public Works Management and Policy*.



When Do Slower Roads Provide Faster Travel?

KENNETH A. SMALL AND CHEN FENG NG

THE TREMENDOUS EXPENSE REQUIRED FOR NEW URBAN ROAD CAPACITY HAS LED POLICY ANALYSTS and decision makers to despair of “building our way out of traffic congestion.” But there is another route involving highway design that is relatively unexplored: designing more compact roads.

Consider first our network of urban expressways. It is especially expensive to build or expand high-speed expressways conforming to the stringent design standards of the federal Interstate Highway System. These standards specify lane and shoulder widths, sight distance, grade, and other characteristics that require a lot of land and extensive infrastructure such as ramps and bridges. Such roads and the high speeds they accommodate create considerable visual blight, water runoff, neighborhood isolation, and noise. Policymakers nevertheless often favor expressways built to Interstate standards because they theoretically provide safe travel at very high speeds. Yet during congested hours, cars travel at low speeds on these expressways; only off-peak drivers travel at high speeds on these extraordinary engineering investments.

But suppose we can design new roads, or reconfigure existing roads, to have lower speeds, neighborhood-friendly footprints, and higher capacity. In some circumstances, doing so can make road-building a more feasible and affordable policy, provide a more pleasant driving experience, and soften the environmental and urban impacts.

Older urban parkways, such as the Baltimore-Washington Parkway, the Arroyo Seco Parkway in Los Angeles, and an extensive parkway system on Long Island, feature architecturally interesting structures, attractive landscaping, and designs that fit into the surrounding landscape. They also provide ample capacity and are much cheaper than modern Interstates. Such designs are still possible. An advisory council for the Illinois Parkway has proposed a new toll parkway in Lake County (north of Chicago) with a design incorporating hills, curves, landscaping, and a 45 mph speed limit. The Council’s stated rationales are less noise, fewer emissions, a smaller footprint, and wetlands preservation, all considered “advantages associated with a lower operating speed.” ➤

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WIDE VERSUS NARROW LANES

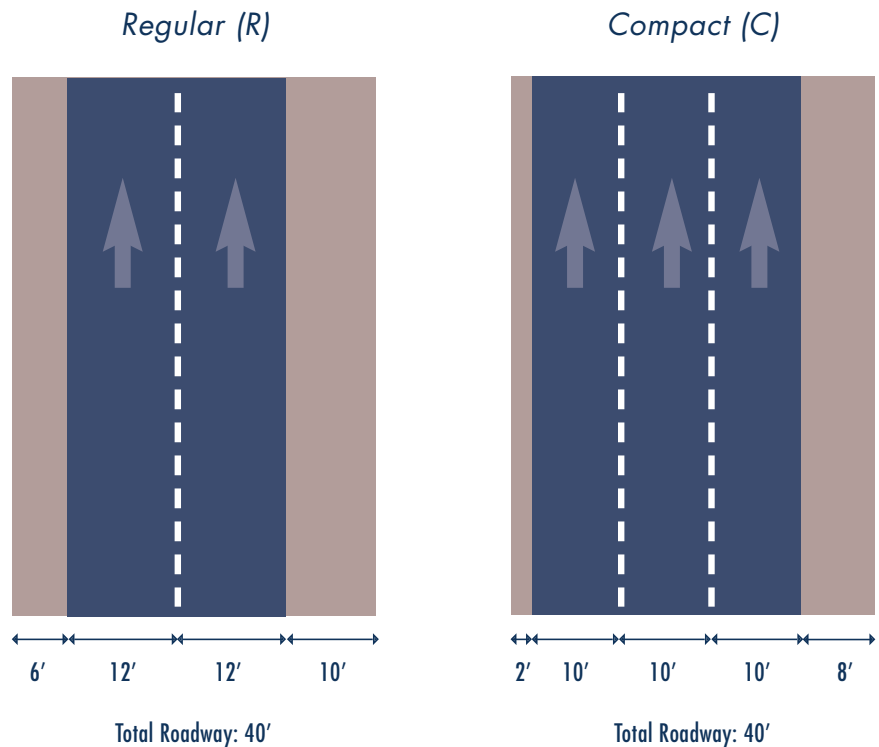
Besides being more pleasant for drivers and neighbors, a road can actually accommodate more capacity within a given right of way if the design has more but narrower lanes and reduced shoulder widths. This means off-peak travelers must drive more slowly but peak travelers can drive faster.

As an example, the standard 12-foot-wide lanes of US Interstate highways provide safety margins for mixed traffic at high speeds. But a road of the same total width can provide more lanes if the lanes and shoulders are narrower. Furthermore, lower free-flow speeds allow for sharper curves and steeper grades that better integrate into the built environment. Historical examples include not only the parkway designs just noted, but also more recent capacity expansions in which lanes were restriped to an 11-foot width, while shoulders or medians were converted to travel lanes—as was done on Interstate 405 near Los Angeles Airport in 1995.

To examine these tradeoffs in more detail, we compare two roadway designs: first, an expressway of Interstate standards with the lane and shoulder widths recommended by the American Association of State Highway and Transportation Officials; second, a more compact design with narrower lanes and shoulders. For ease of comparison, we assume that both expressways have the same total width, and would thus have similar construction and maintenance costs.

Our specification, shown in Figure 1, allows three lanes in the compact expressway compared to two in the regular expressway. The speeds and capacities of these expressways, shown in Table 1, are based on the Transportation Research Board's widely used 2000 Highway Capacity Manual.

FIGURE 1
Regular and Compact
Expressways



	Expressway R: Regular Lanes and Shoulders	Expressway C: Narrow Lanes and Shoulders
ROAD DESIGN PARAMETERS		
Number of Lanes	2	3
Lane Width (ft)	12	10
Left Shoulder Width (ft)	6	2
Right Shoulder Width (ft)	10	8
Total Roadway (ft)	40	40
Length (mi)	10	10
SPEED AND CAPACITY		
Free-Flow Speed (mi/h)	65.5	60.4
Speed at Capacity (mi/h)	52.3	51.2
Capacity per Lane (veh/h/ln)	2,114	2,068
Total Capacity (veh/h)	4,228	6,204
TRAVEL TIME		
Free-Flow Travel Time (min)	9.2	9.9

TABLE 1

Specifications for Example
Expressways

With its wider lanes and shoulders, the regular Expressway R has a higher free-flow speed (65.5 mph) than the more compact Expressway C (60.4 mph). Thus, under light traffic conditions, it would take nearly 10 minutes to travel 10 miles on Expressway C but only 9.2 minutes on Expressway R. As traffic volume increases, however, travel speed falls on both roads due to queuing at bottlenecks. The decline in speed occurs sooner and more sharply on Expressway R with its fewer lanes.

We can compare average travel times on these roads under various traffic conditions. To illustrate, here we assume that the peak period occurs for four continuous hours per day, six days per week. If traffic volume exceeds capacity, a queue forms at the entrance of the road, resulting in delays. At the end of the peak period, the queue gradually dissipates.

Figure 2 shows the resulting average travel time on each road, as a function of average daily traffic (ADT, measured in vehicles per day), when the peak traffic volume is twice the off-peak. The figure confirms that the regular expressway has shorter average travel times (compared to the compact expressway) when daily traffic volume is low. This advantage quickly dissipates at higher traffic volumes because then the regular expressway experiences more queuing. In fact, the average travel time on the regular freeway exceeds that of the compact freeway when ADT is only slightly higher than the value at which queuing begins (at about 40,000 vehicles per day).

Repeating these calculations at different traffic levels and peak-to-off-peak ratios, we find the compact design performs better under all conditions in which there is appreciable queuing. Most strikingly, the compact design increases time savings very ➤

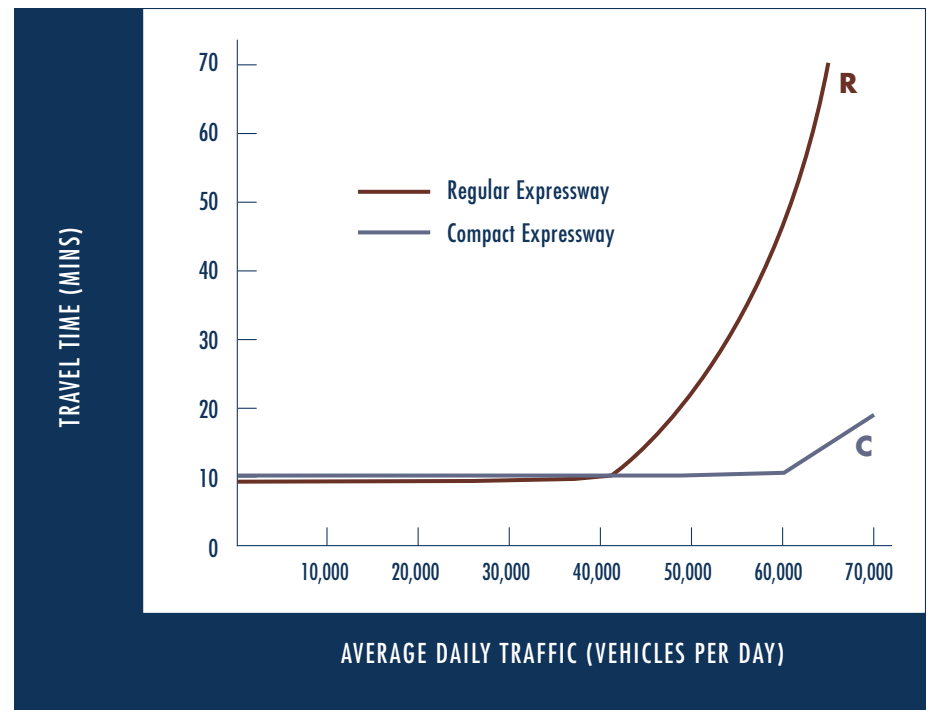
rapidly as traffic increases, reaching 50 minutes savings when the ADT reaches 65,000 vehicles per day. By contrast, the regular design for light traffic volumes saves very little time—at most, 0.8 minutes. The reason is simple: the advantage of the compact design depends on the significantly delayed onset of queuing, whereas that of the regular design depends on the small difference in free-flow speeds.

Of course, this example does not depict the full range of relevant alternatives. We have elsewhere compared two roads of different widths but similar capacities: an expensive full-fledged expressway and a cheaper but reasonably fast urban arterial. For example, Lake Shore Drive in Chicago has entrance and exit ramps and bridges for cross traffic but also a few at-grade intersections with traffic signals. Such urban arterials are much less costly to build than grade-separated expressways, and this cost saving can be measured against longer travel times. This comparison will again depend strongly on the peak-to-off-peak ratio, because during congested peak periods the speeds are virtually identical on the two roads, whereas the more expensive road will provide some off-peak time savings.

These comparisons do not consider induced demand, the well-documented phenomenon that lowering congestion on a particular road, or sometimes even in an entire area, attracts more traffic—which in turn undermines the congestion relief. Suppose we replace a regular facility with a compact one of greater capacity, thereby lowering the amount of congestion. Newly attracted drivers will indeed undermine some of the travel-time savings. Nevertheless, the facility is now serving travelers who previously were deterred by congestion, so they are getting some benefits even if others are getting fewer benefits than shown in our simpler calculations. If some of the newly attracted traffic was previously using other highly congested roads, people on those roads also benefit.

FIGURE 2

Average Travel Time When the Ratio of Peak Traffic to Off-Peak Traffic is 2:1





SAFETY CONSIDERATIONS

Roads with wider lanes and shoulders are usually considered safer, for several reasons. They provide some leeway if drivers wander, maneuver to avoid an accident, or make an emergency stop. They also offer longer sight distances and give drivers confidence that nothing will inadvertently enter their lane.

Yet a sizeable empirical literature presents mixed evidence on whether wider roads are actually safer. One reason for the disparate findings may be that most studies compare a wider design with a narrower one with the same speed limit. Instead, our proposal would have lower speed limits on the compact roads. Furthermore, drivers may compensate for an apparently safer environment by paying less attention, speeding, driving close to the vehicle ahead, or making unnecessary stops on the shoulder. These are examples of the well-known Peltzman effect: safety improvements are at least partially offset by more aggressive driving.

Thus, it is uncertain whether the compact road design will reduce or increase safety. The most important factor is likely the speed chosen by drivers, which suggests a policy response: reduce the speed limits on compact roads and add other measures to discourage speeding. Evidence shows that drivers are more likely to accept such measures if the road design makes the need for them intuitively clear. Drivers in some European countries, for example, have accepted in-vehicle speed controls. ➤



We believe that newer technology designed to prevent accidents, such as automatic braking to maintain vehicle spacing and automatic steering to prevent lane wandering, may have a greater positive effect on both safety and capacity when the roadway is more compact. The closer vehicle spacing required or encouraged by compact road designs is just what these technologies are intended to cope with. Furthermore, the technologies can work more successfully if they do not have to counteract aggressive driver behavior.

CONCLUSION: SLOWER CAN BE FASTER (AND NICER)

The choice of lane width leads to a tradeoff between free-flow speed and capacity, but the tradeoff is not symmetric. We find that squeezing more lanes into a given road width produces large time savings during congested peak periods. By contrast, wider lanes and shoulders offer only slightly higher off-peak speeds. Thus, the compact design with higher capacity often results in shorter total travel times. Furthermore, people find congested travel especially onerous, making it even more likely that a system of urban roads carrying people at modest speeds will make travel more pleasant.

Compact roads also have considerable environmental advantages. They integrate better into urban landscapes because they accommodate tighter curves and steeper grades. They require smaller structures and less earth moving. Neighborhoods suffer less disruption, an advantage accentuated by the lower free-flow speeds. Therefore, urban residents are likely to benefit from the smaller environmental footprint of these roads as well as from their superior ability to carry high-peak traffic flows. ♦

This article is adapted from the longer version, "Tradeoffs Among Free-flow Speed, Capacity, Cost and Environmental Footprint in Highway Design," originally published in *Transportation*.

FURTHER READING

American Association of State Highway and Transportation Officials. 2004. *A Policy on Geometric Design of Highways and Streets, 5th Edition*, Washington D.C.

Blue Ribbon Advisory Council. 2012. *Illinois Route 53/120 Project: Blue Ribbon Advisory Council Draft Resolution and Summary Report*.

Douglas W. Harwood, Karin M. Bauer, Karen R. Richard, David K. Gilmore, Jerry L. Graham, Ingrid B. Potts, Darren J. Torbic, and Ezra Hauer. 2007. "Methodology to Predict the Safety Performance of Urban and Suburban Arterials," *National Cooperative Highway Research Program, Transportation Research Board, Web-Only Document 129: Phases I and II*.

Ben Lewis-Evans and Samuel G. Charlton. 2006. "Explicit and Implicit Processes in Behavioural Adaptation to Road Width," *Accident Analysis and Prevention*, 38(3): 610–617.

Chen Feng Ng and Kenneth A. Small. 2012. "Tradeoffs Among Free-Flow Speed, Capacity, Cost, and Environmental Footprint in Highway Design," *Transportation*, 39(6): 1259–1280.

Sam Peltzman. 1975. "The Effects of Automobile Safety Regulation," *Journal of Political Economy*, 83(4): 677–725.

Transportation Research Board. 2000. *Highway Capacity Manual 2000*, Washington D.C.



Will China's Vehicle Population Grow Even Faster than Forecasted?

YUNSHI WANG, JACOB TETER, AND DANIEL SPERLING

IN 2010, CHINA SURPASSED THE US AND ALL OTHER COUNTRIES IN VEHICLE SALES, and will no doubt retain its number one ranking for decades. But how big will China's vehicle market become? The answer is of great importance for the entire world. Rapid Chinese motorization has alarming implications for both the environment and global energy resources. China is already the world's largest CO₂ emitter and second-largest oil importer. Yet its vehicle ownership rates are still a fraction of those in the US—58 vehicles per 1,000 persons in 2010 compared to 804 per 1,000 in the US. Clearly, the market for vehicles in China will grow. Most forecasts anticipate Chinese growth leveling off at an ownership rate of about 200–300 vehicles per 1,000 persons in 2030 or later. But what if vehicle growth is even faster? Could vehicle ownership rates reach Western European and Japanese levels of about 600 vehicles per 1,000 persons?

Past research on this question gives cause for concern. In the last decade, several major studies forecasted growth rates and ownership levels in the Chinese vehicle market. All of these studies projected 6 to 11 percent annual growth in Chinese vehicle ownership—far lower than the 19 percent annual growth during the past decade. Were the recent high growth rates a temporary aberration related to a surge in China's economic growth? Or were forecasters too conservative in their estimates? ➤

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THE HERD INSTINCT

The majority of forecasts anticipate relatively slow growth in China's vehicle population. China's fast growth in motorization may threaten global oil supplies and exacerbate climate change. Indeed, if China's vehicle ownership rate reaches 600 to 800 vehicles per 1,000 persons, equivalent to rates in Europe and the US, respectively, then China's total vehicle population would approach one billion—more than four times the number of vehicles in the United States today. Even at a much lower level of 300 vehicles per 1,000 persons, the worldwide impact would be huge: Chinese vehicles alone would consume 12 to 18 percent of the total oil produced today. Fear of the consequences of faster growth rates and higher overall vehicle ownership seems to pervade and inhibit most forecasts.

Further contributing to the conservative forecasts of vehicle ownership may be the reality that forecasters in large, developed countries have not seen rapid economic growth anytime in their professional lives. From their vantage point, a sustained 6 percent annual growth rate in GDP is very high, even though all major car-producing countries in the world exceeded such growth rates for decades during their industrialization phases.

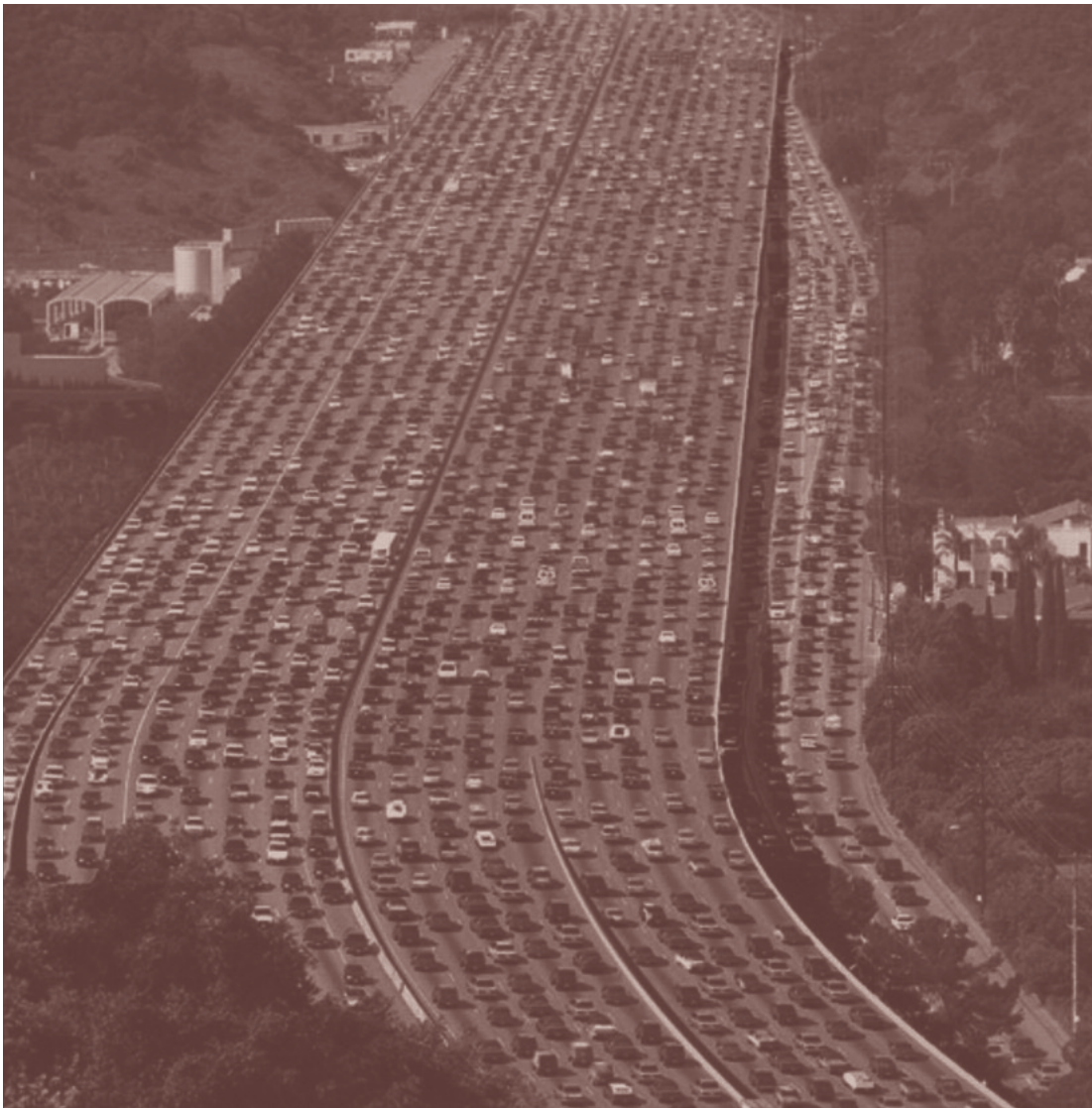
To understand how and why these forecasts tend to be so conservative, we examined the assumptions and methods underlying previous forecasts. First, they all base their forecasts on China's GDP growth. Using GDP as a predictive variable, forecasters generally assume that vehicle sales will start slowly at low levels of per-capita GDP, accelerate as the nation prospers, and then slacken as the market matures. Almost all successful new products and technologies follow this trajectory. Although this "S" curve construct is a conceptually sound analytical framework to forecast the market for new products, the details are subject to great uncertainty.

One challenge of using a GDP-based approach starts with the accuracy of the GDP forecasts themselves. Forecasters rely upon official projections of China's GDP growth, which are heavily influenced by Chinese bureaucrats' conservative GDP growth targets. Since China's political leadership promotes local officials for achieving and surpassing their own targets, local officials have an incentive to under-predict GDP growth. Using these low-balled growth rates, forecasters projected real GDP growth of 8.6–9.5 percent in the years following the baseline (typically the year 2000), but then used lower rates of 7–8 percent and 4–6 percent in the following 20 to 30 years. Although China's GDP growth rate dropped a few percentage points in early 2012, it remains to be seen whether the slow-down will continue.

The second and more problematic challenge of using the S-curve approach is estimating the relationship between GDP and vehicle purchase behavior. Based on historical analyses, it is widely accepted that vehicle ownership growth rates rapidly accelerate at incomes around \$3,000 to \$5,000 per capita per year (in year 2000 dollars). Vehicle ownership growth rates then typically peak around \$10,000, followed by a slow decline.

Will China follow this same pattern? China's current rate of vehicle ownership is higher than that of comparable countries when they were in the same stage of economic development. At the income level of \$2,000 per capita, only Thailand surpassed China's ownership rate of 38 vehicles per 1,000 people.

Even if the general S-curve relationship between income and car ownership were to hold in China's case, the steepness of the growth rate remains uncertain as China



approaches per-capita GDP of \$10,000. Simply put, Chinese vehicle growth rates may not begin to slow at this per-capita GDP. It is difficult to specify this relationship accurately. In fact, the shape of the S-curve varies greatly across countries, as one might expect given countries' unique histories, geographies, and policies. When the US began to motorize a century ago, for instance, the country's GDP had already surpassed \$5,000 per capita. Forecasters find predicting China's vehicle growth rate challenging because few countries can serve as models or analogs to China, and different income-vehicle relationships produce vastly different vehicle population outcomes.

A third challenge in using an approach based on the S-curve is determining the level at which vehicle ownership reaches saturation—when the curve flattens out. Choosing the correct saturation level is crucial since this decision determines the steepness of the curve over time, and thus how fast vehicle sales will grow in the future. When forecasters assume a high saturation level, they lengthen the steep part of the curve to predict steady vehicle growth rates for a longer time. With a low saturation level, growth rates are ➤

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lower. In most studies of Chinese vehicle growth, forecasters assigned saturation levels much lower than those observed in the US and generally lower than those observed in Europe and Japan. One study predicted a Chinese saturation level of only 292 passenger vehicles per 1,000 persons, far below the saturation level of almost every nation in the developed world.

In their choice of saturation levels, forecasters seem to assume that the current growth rate is unsustainable. Based on that assumption, growth rates would soon slacken and ownership rates flatten out at levels far below those of the US and Europe. Forecasters appear to fear that the world (and China itself) cannot accommodate the resulting energy demand and greenhouse gas emissions. Regardless of their reasoning, forecasters seem reluctant to grapple with the implications of more robust vehicle growth in China.

Fourth, in previous studies, forecasters built prediction models based on data from 45 to 122 countries, many of which are tiny or do not have their own automotive industries. We suggest that the experiences of countries such as Singapore are irrelevant in predicting China's vehicle growth. The dynamics of market development are very different in countries with large auto industries. Countries with large car-producing industries tend to support the development of their domestic production and thus experience much higher vehicle growth than other countries.

Finally, almost all previous studies derive vehicle growth rates from inappropriate time periods. Most previous forecasts relied on World Bank or International Monetary Fund data only as far back as the 1960s. Thus, forecasters' projections ignored the 1950s and earlier when many large vehicle-producing countries rapidly motorized. For example, one study using post-1960s data estimated income elasticities of vehicle ownership (vehicle ownership growth rate divided by GDP growth rate) of only 1.43 for Thailand, 1.98 for India, and 2.2 for China from 2002 to 2030. In contrast, we found that income elasticities for large vehicle-producing countries during their rapid growth periods were over 2.6. Higher income elasticities mean many more vehicles purchased.

OUR ANALYSIS

Given these many methodological and data pitfalls, we took a conceptually simpler approach. We mapped onto China the historical growth patterns of large vehicle-producing countries and benchmarked the motorization trajectories of these countries to the date when they historically reached China's current vehicle-per-capita ownership. We selected countries that 1) had large populations, 2) were major vehicle producers, and 2) were at a higher stage of industrialization and motorization than present-day China. Countries were excluded if they 1) had distorted market development, such as former Eastern Bloc countries, or 2) had slow economic growth over a protracted period, since that did not match China's experience. The seven countries that remained were Brazil, Germany, Italy, Japan, South Korea, Spain and the United States.

An important distinction between our analysis and other studies is that we drew upon the early motorization experiences of Europe, Brazil, Japan, South Korea, and the US. By selecting fewer benchmark countries and putting greater effort into finding data from the 1950s and earlier, we captured experiences analogous to China's current situation. We conclude that the findings of all previous studies—with projected annual vehicle growth rates in China of 6 to 11 percent from the early 2000s to 2020—are conservative. With our approach, we forecast that China's vehicle population will increase by 13 to 17

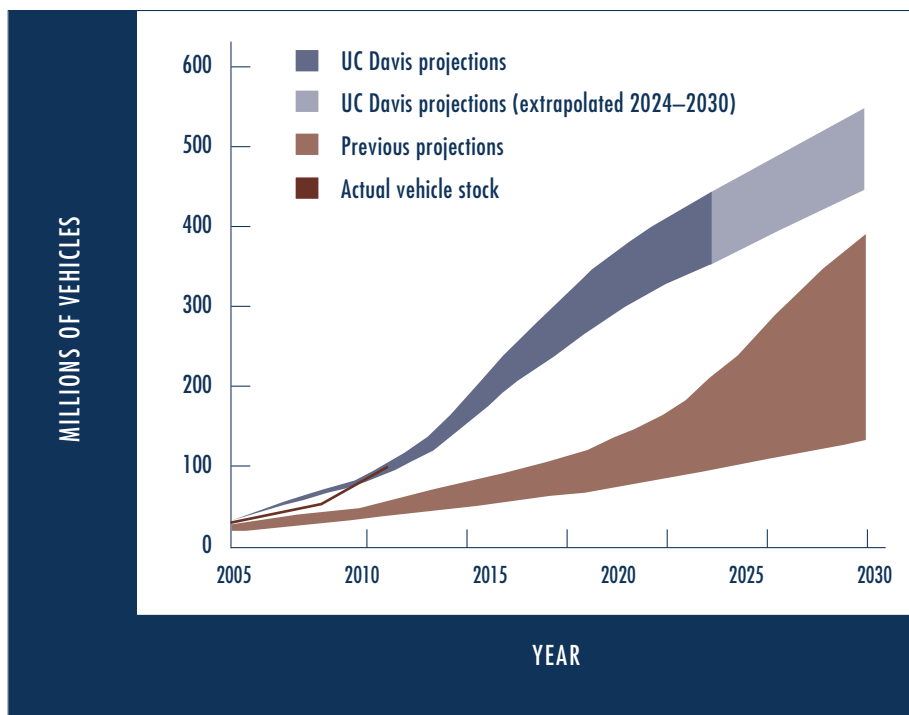


FIGURE 1
Projections of Chinese
Vehicle Growth

percent per year, well above what others forecast, reaching as many as 419 million vehicles in 2022.

Our forecasts may be too high, and China's vehicle growth rate may be slower. This will only happen, however, if the Chinese economy stagnates, as Brazil's did in the 1980s and 1990s, or if China intervenes aggressively to restrain vehicle ownership, as four Chinese cities have already done. If the Chinese economy continues to boom, and China does not aggressively restrain car ownership, then our scenario of higher vehicle growth will likely prevail. If that happens, actual global oil use and carbon emissions will undoubtedly be far greater than the International Energy Agency and others have forecasted.

We hope that we are wrong. ♦

This article is adapted from the longer version, "China's Soaring Vehicle Population: Even Greater Than Forecasted?" originally published in *Energy Policy*.

FURTHER READING

Daniel Sperling and Deborah Gordon. 2010. *Two Billion Cars: Driving Toward Sustainability*, Oxford University Press. Translated into Chinese and published by Shanghai Jiaotong University Press.

Hong Huo and Michael Wang. 2012. "Modeling Future Vehicle Sales and Stock in China," *Energy Policy*, 43: 17-29.

Paul N. Kishimoto, Sergey Paltsev, and Valerie J. Karplus. 2011. "The Future Energy and GHG Emissions Impact of Alternative Personal Transportation Pathways in China," The Massachusetts Institute of Technology Joint Program on the Science and Policy of Global Change, Report 231.

Yunshi Wang, Jacob Teter, and Daniel Sperling. 2011. "China's Soaring Vehicle Population: Even Greater Than Forecasted?" *Energy Policy*, 39(6): 3296-3306.

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The Transit Metropolis
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Small, Kenneth A. and Erik T. Verhoef
The Economics of Urban Transportation
Routledge, 1992 and 2007

Goulias, Konstadinos G., ed.
Transport Science and Technology
TRANSTEC Athens 2004 Conference: Elsevier, 2006

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Planning for High Speed Rail

MARTIN WACHS

CALIFORNIA IS CONTENTIOUSLY DEBATING WHETHER OR NOT TO build a high speed rail system and, if so, how to build it and where to start. This debate reveals enormous differences among Californians. Surprisingly, it also suggests that planning studies and technical analyses increase, rather than resolve, our differences.

A succession of business plans and forecasts for the proposed system teach us more about planning and policymaking than they tell us about the future of fast trains. The decision making process has been fraught with confrontations among worthy constituencies insisting they are right and their opponents are wrong. Patronage and cost estimates are dissected and forecasters have been criticized for failing to use “best practices” and for their conflicts of interest. While finding “right” answers could inform one of the most important decisions about infrastructure the state will make in the next hundred years, we seem to be short on collective wisdom about how to proceed.

Why has planning for high speed rail in California been so troubled? It could be that forecasts and favorite routes cannot be effectively evaluated. The planning and political processes seem incapable of accepting the obvious truth: the future cannot be foretold with anything approaching certainty. Events, policies, technologies, and demographics cannot be projected with accuracy beyond a few years. Important choices must be made that will shape California’s future, yet decision making and governance are failing in large part because they are not designed to deal with enormous projects that will be constructed over decades. Decision tools are predicated on finding the right choices using factual information, but for huge and long-term projects, accurate information is in short supply. Society will change dramatically in unknown ways before the first train rolls. Assumptions largely form the base of all forecasts, and these are riskiest for large and longer-term projects.

Although forecasts of ridership, patronage, and environmental impacts are certain to be inaccurate, the law and precedent require public officials to behave as though they

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were accurate. This approach creates endless debate and is unlikely to succeed. The state must learn to make important choices without actually knowing which forecasts history will prove to be right and which to be wrong.

Decision making for an uncertain future is not unusual in public policy. California adopted a water system and decided where to put the ports and freeways many decades ago. We hardly consider today whether forecasts of costs and the demand for their services made fifty or eighty years ago were “right.” Have you ever thought about the alternative freeway routes rejected sixty years ago or what the state would be like had the Port of Los Angeles been located in Santa Monica, as was seriously proposed? Forecasts were made by competing interests and were all incorrect. The invention of the internet, thousands of new products, economic globalization, air travel, and the aging population have all affected the state’s relationship with its infrastructure, but no one predicted these correctly when planning past infrastructure. History offers a lesson for the ongoing debate on high speed rail. The world in thirty years will be very different from today; no doubt current estimates of ridership, costs, and environmental impacts will be incorrect.

The current debate is divisive precisely because improved data and models cannot provide a better glimpse into the future. Rational methods of analysis cannot deem high speed rail to be either needed or frivolous. There is no test to declare a particular cost estimate or ridership forecast to be the right one. One can muster facts and forecasts to support a position and deride those of opponents, but we cannot resolve differences through analysis because so much more is unknown than can be modeled. While ➤



today's fights appear to be about facts and figures, high speed rail's fate will be determined by political power and compromise, not by proving one set of statements about the future right and another wrong.

We can and should consider an alternate way of approaching policymaking for enormous and costly projects that will take decades to realize. California could explicitly accept that the future for which it is planning is highly uncertain. Admitting that it cannot foretell the future with precision is not at all an admission of failure. Because many citizens and elected leaders favor it, the state could adopt a vision of a future California built around a desired high speed rail system and then adopt policies to incrementally make that vision a reality. Each incremental step can bring value to its citizens along the path to that longer-term vision. Officials can plan communities around a spine of potential future high speed rail with links to existing urban transit systems. Changes to land use regulations in central cities and outlying areas can further redirect growth toward the system, increasing its ultimate usability and effectiveness. These actions themselves will increase the probability of realizing this vision, while improving the quality of life in the communities participating in the planning process.

In addition to taking these early steps, the state should also start to monitor and measure changes. If changes in population, business patterns, telecommunications technology, and travel patterns indicate the state is on a path to realizing a successful evolving system, future decisions can continue to support the march to developing the rail network. If enormous changes, however, take the state farther from a future in which high speed rail could succeed, California would have to hedge its bets and reevaluate its course ten, twenty, or thirty years from today.

Planners are using decision-making processes based on deterministic forecasts of the future that are far better suited to smaller projects. These traffic forecasts and benefit/cost comparisons work well for decisions about widening roads or adding stations to an existing rail network. For "megaprojects" like high speed rail, however, uncertainties always dominate. An uncertain future is not an inconvenience that makes planning messy—it should be central to the process of planning.

The recent decision to create useful operational segments of a rail system is a first step in the right direction. A state law mandating a maximum travel time between two cities is a giant step in the wrong direction. California should plan more extensively and explicitly to embrace uncertainty and stop arguing over whose incorrect forecast is better. The state can invest in shaping its future while delivering useful service improvements in the next few years.

California should make plans to shape a desired future. It should not forecast and then fight about what may come to pass but likely won't. The state should monitor social, economic, and behavioral changes over time, hedging against trends that don't support what seem today to be the most desirable futures. Investments must aim toward a desired future while staying ready to veer toward another course if future events make that necessary. Incremental but informed planning is the only rational choice when the future is largely unknown. It can be a rich and rewarding enterprise. ♦

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