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Transportation and the United States Economy:

Implications for Governance

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Moderator:

YU Qiao

Nonresident Senior Fellow,

Foreign Policy,

Brookings-Tsinghua Center

Speaker:

Clifford Winston

Searle Freedom Trust Senior Fellow,

The Brookings Institution

Clifford Winston：

First I will give you some basic data about the US system, and then talk about policies and governance to improve the transportation system, and then I will give observations about the Chinese system. Ideally these observations will be coming from you instead of me.

What I am pointing out now is that transportation accounts for a substantial amount of the US economic activities. But transportation system has notable inefficiencies and non-transport sectors will have really large gains by improving the efficiency of that system, much larger than conventional analysis. When talking about transportation, most people will talk about the effects of, let's say, congestions on the users of the system. But if you take a broader view and consider what we call the general equilibrium effect and external effect, you will find that those are huge numbers and should be a central part of policy discussions. However, too often they are not.

In terms of policies, privatization is something that surprisingly we haven't had that much in the US. We have deregulation, but the actual transformation from public system to private system has not occurred. So it is not yet clear what we will get from doing that experiment. There are a lot of inefficiencies we try to address, but the actual process of privatization is complicated. The area that is more important and can produce gains is improvements in technology and innovation policies. So what I really see as the main source of significant improvement in transportation that we can actually realize in the near future instead of waiting for a long time for the policy makers to come around are innovations which are going on in the private sectors. So that is some sort of my punch lines in terms of how I see things becoming better.

So going through some background—just basic data—on the system in the US economy: total pecuniary spending by firms and consumers $2.1 trillion. This information is based on paper I published on the *Journal of Economic Literature* in 2013. Government spending on infrastructure $0.26 trillion, so if we look at transportation spending in terms of GDP, it is about 17%, which is similar to healthcare's share. It is important to realize that this figure does not include the expenditures on time, which is a critical part of the users'—passengers and freight—cost in transportation. Expenditures on time (freight and travelers) amounts to $3 trillion. So a huge amount of economic resources are tied up to the transportation system, much more than people may realize.

The value of the US highways is $2.8 trillion; the value rail network—mainly private—$0.34 trillion; $0.17 trillion for pipelines; $0.57 trillion for public airways, waterways, and transit structures. So here is roughly $4 trillion in investment that the US has made. Clearly a big stake exists in improving the system, either in terms of improving the benefit of the users or in terms of getting high returns on investment in infrastructures.

Just to give you some perspectives based on what are infrastructure look like compared to other countries. You see that the US infrastructure stock's share of GDP is 64% and China is actually spending more. So transportation is a major part in your economy as well. Another point I want to make is that the importance of transportation is overlooked. Often the reason is because people are taking the misleading industry perspective—finance, government, manufacturing…you get a little pie of

transportation. People always look at revenues of companies while ignoring an awful lot of other aspects of transportation.

Thus far I have been only talk about the efficiency aspect but not the distribution part. This transportation issue affects every person, even the wealthy people cannot escape delays when their private planes are prohibited from taking off and when their limousines are stuck in gridlocked traffic. At the same time, transportation is generally considered to be a merit good—citizens are entitled to accessibility to attain a reasonable quality of life—so it is important for a system to achieve that social goal at minimum cost. What economists have to look at is: are these services being provided at the least cost? I think the correct economic way to do it is to say: "look, what we don't want to do is to distort the whole system and make it less efficient per se to accommodate low income people. Ideally we want this system to be as efficient as possible while providing vouchers for the low-income people. But if you distort the system, that can be hurting the society overall." When you use resources like that, there is an opportunity cost as they could be used in other ways to help those low-income people. So those issues are very important. When efficiency and distribution conflicts, thinking "what is the most efficient way of addressing distributional issues?" will be of help—but often that is very hard to do in the policy making process.

Given the large efficiency and distributional stakes, it is vital for transportation capital stocks to generate high returns. Public policy can contribute in three ways: firstly, it can encourage the modes to operate efficiently in their pricing, service, and innovation. Should government's regulation dictate or should we allow these things to be determined by the market? So that will involve the US' experience of deregulation the intercity system in the 1970s. Secondly, it can ensure that the infrastructure operates efficiently in pricing, investment, and technology. It brings the question that what is the best way for your infrastructure to produce efficient services—public ownership or privatization? Thirdly, technology innovation is generally considered to be among the most critical things for economic growth in any country. As we know, transportation is a source of major technology innovations—automobiles, airplanes—so technology policies to realize gains from private sector innovations are very important.

I have already touched on the big picture but I will summarize it again that we are not just talking about the transportation system, but also other sectors in the economy: labor markets—job matching, employment, and wages; international & domestic trade flows—trade costs and product variety; industry competition and efficiency—scale and scope economies; agglomeration economies in metropolitan areas. Going back to my theme, I want to point out that transport inefficiencies generate huge costs because entire economy is affected; thus, improvements in the transportation system either by private sector innovation or by policy reforms will also generate large benefits.

Let me give a sense of research before I get to the policy part by showing things I have been doing recently. I tried to integrate transportation into other sectors. My approach was a general equilibrium model which some of you might be familiar with. I weaved transportation into the performance to the economy and gave readers some sense how shocks of the transportation system can be. I weaved transportation capital stock in this conventional micro model where the former affected city-level, intercity-level and international economy with trade flow and travels; I had firms producing in a competitive monopolistic environment where variety is important; then I had consumers making

decisions where to live and work, so the transportation system could affect the distribution of residential location and the length of commute. Again, it was a conventional way setting up a model, but here transportation could affect many things that went on.

Many famous economists including Larry Summers and Paul Krugman are saying that "look, we really need infrastructural spending increasing as a stimulus to improve GDP growth." So this is a perspective that spending is an engine for GDP growth. My point is that an obvious but often overlooked difference between GDP and welfare. Spending is attractive, but we can have same or even better welfare result from improving transportation system efficiency without spending much more money on it. If we improve the system's efficiency through efficient pricing and making investment based on cost-benefit analysis and higher technological advance, though GDP will not increase, the welfare of the economy will surely go up as we don't need to finance the spending by taxation. Let's step back from investment and think: are we making efficient use of the transportation spending now before spending more money on it; let step back and reform the system at very low cost by changing political policies. So that is one perspective of my research.

I looked at California as my empirical study and tried to figure out how congestion can affect the California economy accounting for unemployment, GDP growth, wages, and trade flows. A fundamental conceptual and analytical problem one has to consider is: is there a truly causal mechanism that you can identify whether congestions have these effects? One has every reason to be skeptical about this because any unobservable that will be affecting congestion is bound to affect the economic performance variables that congestion is intended to affect. So what I need is a really persuasive instrument to purse the bias inflicted by omitted variables.

The advantage of studying California is that it has something called self-help counties—these are not that well-known even among the Americans, and I came to know them only recently. There are a minority of states that allow counties in those states to pass special legislation to raise revenues to fund very specific activities, and transportation is one of the thing. For example, California counties can pass a half percent sales tax to fund transportation work. These decisions, I would argue, are inherently political ones. Because firstly, they were put to voters and it is quite common for these things to be turned down. Political mobilization must take place before they are passed. So they are not related to things that will affect economic performance measures. Secondly, there are some exogenous advances that really affect the outcomes. For example the California Supreme Court raised the percentage of a project needed to be passed, so things passed before are no longer passed. Thirdly, there is no such kind of "flexibility" that policy makers to allocate the money in ways they thought might be better. They had to follow the rules that the money from the legislation is to go to previously decided project.

What I did is to use accumulative amount raised for highways from those self-help county taxes in California as my instrument for congestions. When I looked at first-stage regression on the cumulative amount revenue the self-help county is generating, I found that the linear term was positive, so initially when money was put into the transportation system by self-help counties, it would increase congestions. The reason is that the work has to get started so roads have to be closed up. And I predicted the square term to be negative as the money coming in over time, the self-help county is

doing what it is supposed to do—projects are completed and reduce congestions substantially. When I proceeded to analysis part, I found that congestions have substantial effect on all these variables.

The driverless car has drawn a lot of attention. One study said if you replace half the cars with driverless ones, it would reduce congestions by half. When I started aggregating that over my California counties and did some conservative extrapolations to the rest of the US that have congested urban areas, I am talking about employment of 2 million jobs, and increase in GDP for about 2 percent—these are all big macro data. So that is my point: though micro policies are quite small, they can affect large part of the economy.

I will talk about ways of improving the efficiency of the transportation system, but I will give a preview here. Efficient pricing for road users instead of using a gas price on the passenger side is a very good way. On the truck side, what they do is damaging the road. The technological relationship in terms of the truck's characteristics and pavement depends on the number of axles of the truck. If you are a heavy truck with two axles, then you will do more damage to the road than a same truck with more axles. But pricing trucks is perverse. They charge either on the numbers of the axles, and more axles mean you have to pay more money; or they charge by gas taxes and trucks with fewer axles tend to have better fuel economy. Investment does not depend on cost-benefit analysis. When you build a road, what you want to trade off is upfront capital cost that will incur if you make the road thicker and more durable versus long-run maintenance costs. In short, more money spent on quality beforehand, less costs needed in the future. Unfortunately, policy makers have been short-sighted, they didn't make the decision based on cost-benefit analysis.

That's another example there of just changing your fundamental policy. There are also regulations, in the US, if you want to have a road that is constructed as part of public project in virtually all these things are, there is an act that requires you to pay the prevailing union wage rate for your labor. That's something that if we left to competition will make cost much lower. It is true that some of these things involve redistribution; but nevertheless, there will be broad social gains and efficiency improvement.

I haven't even talked about air transportation which has the same kind of problems. The way we charge airplanes in the US for using airports is by weight, so if your jumbo jet is coming in to use a US airport during congested time, your are paying based on your weight; your little private plane—a general aviation plane which weighs a lot less—will pay a lot less. The problem is, a small private probably contribute more to the delays than the big planes. The reason is little planes need a lot more separation than big planes because they can get disturbed from wake turbulence, so you get to separate them. Therefore, they (little planes) could be slower and need more space. If anything, they should be paying more, a lot more. And we can imagine who own those kinds of planes. Very powerful politically, they are very happy with such landing fees. But that's again that would be another perversity in how things work.

So I will then go through a number of the policy questions and issues. I have addressed some of them but certainly not all. On the government side, the question is how to increase efficiency. Goal is to eliminate static inefficiencies and stimulate innovation and technological advance. Deregulation was a policy that affected intercity modes, including airlines, railroads, water carriers, and trucking. Privatization, which we have not had, let me just say those. If you just look at the long history about the transportation in the US, you will find that initially everything was private in the US: roads were private,

buses were private, and even the rail systems or urban rail systems initially all were private. Usually there were some either financial shock such as the Great Depression or sometime financial calamities. That led to transfer from private to public. We haven't had things going back with one exception: there was a railroad having crisis in America taken over by the government, and then was eventually sold back and absorbed by private railroad as a part of both two other system: CSX and Norfolk Southern. That's the only instance of privatization and that was successful in sense.

But the urban transit modes and public infrastructure there for the most public, we have a tiny bit, a very tiny bit of we call public-private-partnerships and there is now one new private airport, Branson airport in the US, just in case people could follow these things. But this is a very small matter.

Technology policy promotes innovations and technological advance by the private sector to improve the infrastructure. So, let me go through those policy issues. Deregulation was very successful strategy and this will affect intercity modes and initial problems were prices were not reflective of cost. The price of airlines and trucks were set by the inventory agencies and they were not anything close to marginal cost pricing. Production costs were inflated and there was very poor service quality. A big problem that we will get to is that technological advance tends to be very small and very slow in those modes. Railways in particular were horrible. If you want to know where your shipment was during the regulated era, the way the rail tracked these things was having a camera as cars came in to a rail terminal. They would only take pictures. So shipment was constantly complained since nobody knew when it would come and because it often came very late. That was really a very technologically out-of-date system in railroads.

So, deregulations have entry of new competitors stimulating competition that led to lower costs and reduced price-cost margins. We didn't have a Southwest, a low cost carrier when regulated. But then deregulation came and Southwest airlines, which was an intra-state carrier, became an important leader of the industry airlines.

Trucking also has some new expansion of innovative trucking companies. Railroads different task really happening in railroad was the most inefficient firms tended to be absorbed in merger and we now only have four major railroads left in America. CSX and Norfolk Southern are the east coast, while the Union Pacific and Burlington Northern Santa Fee are on the west coast. Conceivably, those two could each merge and we may have two continental railroads.

My first introduction to Chinese government officials occurred about thirty years ago. A delegation came to Berkley to talk with me about transportation and people said it was initially a brief 20 minutes meeting and just talked about the US system. And when it got to railroad and I said we have a recent deregulated system in 1980s; the railroad used to be losing a lot of money and have poor service. But now they dropped a lot of inefficient track which they had not used but needed to be maintained. They drastically improved their service and have contract rate with carriers and competition among them was very intense. The Chinese delegation wasn't surprised since they didn't quite conceive the fact about railroads competing. They said, "you mean you have more than one railroad?" I said yes. At that point, we had eight railroads competing.

Probably we went on for about another two hours. Things are different in this country. But a lot of countries don't really see possibility of competitive yet still efficient and financially viable railroad system. But that was what happened with the deregulation in the US.

Passengers' railroad is a different story and obviously most of you may heard about the Amtrak crash that happened in the US. Amtrak is very different. First of all, the inter-city freight system used to provide passenger service. Both passenger and freight service were money-losing services. So the railroad didn't want it anymore and shed the passenger service. So Amtrak was created as a public corporation to provide passenger service. That's what we had in US, 1971.

Now, let me stress by the way, Amtrak was supposed to be a financially self-sufficient public corporation as they called, which was not supposed to get subsidies. But we also required nationwide service from it. These two were not compatible. Amtrak has never been financially self-sufficient. But I will also suggest that probably it was not even socially desirable in most of the country, and what I mean socially desirable is comparing user benefits with subsidies. In most of the system, the cost of subsidy exceeded the user benefit. The northeast corridor is a big exception, where it is certainly socially desirable. But even there, it is certainly not financially viable yet. So this is the system that was created.

You may have heard this crash led to criticism that Amtrak was under funded and we need to put more money on the system. Among other things, that would have helped to prevent the crash. Because they would be able to put in the technology as the freight railroads had been using, to help slow the train down if it is going too quickly. But this is very misleading. I mean the system has got a lot more subsidies than ever was intend to do.

The real problem is that the truth is they are running a system that is not even socially desirable in the big chunk of it. And the truly efficient system would be just very narrow in terms of areas. American is not like China to have a high population density. We don't have the densities in most areas of the country to support this kind of system. Yet this is the nature of political lobby and it explains the pressure is putting more money to the system. We had this trouble with Amtrak; it's pretty crazy to think that high-speed railway system makes a lot of sense in the US either. That was going on deregulation and the inefficient firms were driven out.

In terms of welfare gains, there were traditional consumer surplus as prices and cost go down. There are actually some surprising profitability improvements. The rail freight story is actually interesting, because surprisingly the country appears to be making a choice when we were willing to trade off rail financial viability to possible losses in prices to shippers. The railway freight system was losing still a lot of money but congress didn't want to nationalize system, so they did not want a public sector to take it over. So the attitude of the government was to deregulate and allowed them to set the rate as they wanted. There were some caps called maximum rate regulation, but in practice it was hard for shippers to protest rates.

The cost of the railways came down drastically as shippers organized as a bargaining union; to some extent they were able to have some leverage in dealing with either one or a couple of railways. The rates also came down. So that turns out to be a surprising win-win. An interesting thing to learn is that when a market is subject to regulation, you do not know what kind of economic activity you are suppressing.

And the process of railroads effectively working as well competing with the shippers helped each other. For example, when shippers negotiated with railroads on a contract, they would arrange a return load. Since the cost of railroads is coming back empty-handed, a shipper guaranteeing to arrange a return load will increase the capacity. When you just have some regulators saying what the rates are, you will not have that kind of interactions that lead to such efficiencies. Then, with better services and lower costs, there was improvement in employment competition in great part. So this was a success and here we saw other countries pursuing their own form of deregulation, and generally it also turns out to be fairly successful in the airlines.

Now I think the real lesson is not really so much we that talk about the prices or services, but the innovations. These are things that are so hard to predict what is being suppressed in terms of the innovative technology when you have a regulated market. I mentioned the strange way of tracking their shipments. What deregulated, there were much more improvements among monitoring shipments that coincided with the improvements in information technology that was going on at the time, where you have much more real-time tracking of freight.

Some may argue that this is deregulation and that is technological advance through information—true, but the question is that deregulation gives carriers a strong incentive to adapt these innovations as quickly as possible. They wouldn't be adapted as quickly if they are still regulated. For trucks, they are improving routing and scheduling based on information technology. And again, they enable Just-In-Time Inventory to be used. The airplanes yield management programs to make more efficient use of capacity and better match of capacity to demand.

There is something interesting going on this issue and that is the notion of break-even load factor. When airlines were regulated, the amount of capacity that is seats filled with paying passengers that were needed for the airline to earn a normal return was thought to be about 55%. So when I was travelling during the periods of regulation, generally there was somebody sitting next to me. Now, airlines are running a much higher load factor, it seems that every plane you are on is completely filled. And only recently they are starting to earn a lot of money.

A fundamental problem with airplanes—and all other transportations—is matching capacity to demand. In transportation, you have to commit your capacity in advance of demand. You can't just call up Boeing or Airbus and say "I want a plane tomorrow". That doesn't work out because things like this take time, maybe a year or two. It is because carriers often have very specific requirements on how they want their plane. Different carriers will look very different on how they configure. So you will have to predict: "am I going to have the demand to fill up the plane when I get it?" if you over-predict your demand, you will be in a big trouble—if you are a carrier, you will have to cut your prices a lot to try to fill up. And that is reason why airlines earn money and then lose money. It makes people think that deregulation seems to lead to a lot of instability. I think the question is, it takes time for carriers to learn how to manage capacity and demand. Airlines have never made money during recessions ever in the history of the US since deregulation. They now seem to finally figure it out. They are smart finally on how they react to our slow expansion coming out of the financial crisis. They didn't buy every plane in sight. In previous expansions following recessions, that is what they did—they over committed capacity. Should airlines find better ways to match capacity and demand, we will see more stability in the system.

Global air deregulation, including open skies and cabotage, would generate more gains. Open skies are basically international airline deregulation. There is a word called “cabotage right” that is allowing foreign carriers to serve domestic routes. So it means we would allow Air China to serve (the air line between) Boston and Washington, or China allow us to serve the route from Shanghai to Beijing. It is not allowed yet, but hopefully someday we can have a truly deregulated global airline industry. This is an example of further deregulation. It is probably also true that railroads can be deregulated. The US railroad can have a North American deregulated railroad system to allow Mexican or Canadian carriers to have free access to the US. Certain countries’ carriers may not be as efficient as others, and they may not survive.

Public infrastructure and transit are trickier issues. Those are things owned by the public authorities. Growing delays and congestion that increase operating costs and travel time—auto and air; budget deficits now occur, and my opinion is that these are symptoms of fundamental policy inefficiencies: pricing that doesn’t reflect cost, cars not being charged for congestions, trucks not being charged for durability; suboptimal investment not using cost-benefit…

Another issue is the allocation of funds. The way things are workings in the US is that we have trust funds funded by gasoline taxes for autos and trucks on the highway sides. Finance on the airport side depends on so-called weight-based landing fees. Those things contribute money for the trust fund of the airport. Federal governments have these trust funds, and they’d allocated the money to the states done by formulas. At best, these formulas have a loose relationship with cost-benefit analysis—often, the big states get pretty good shares of the money even though they don’t have a lot of the traffic. So money is not necessarily going to the places that have the greatest congestions. So money is misallocated. And then within a state, the money has to go to all parts of the state, so if California is getting the money, it will not just go to Los Angeles and San Francisco where are most congested. Places with much less congestion will have a good chunk of that money, too. So money misallocation through spreading out the fund so broadly instead of on cost-benefit analysis will lead to severe inefficiencies. You may have heard the expression “bridge to nowhere” , that is where it comes from. People complain that money from public funds are being used to funding these projects which anybody will hardly use.

Moreover, inflated productions costs are to blame. On the labor side, we have unions; on the capital side, we have protectionism—Buy American Act—that requires people to buy American products first. slow implementation of technological innovations is a problem as well.

The potential gains from efficient policies are large and well documented in the empirical literature. But policymakers ignore calls for efficient reforms and seek to raise revenue and spend their way out of the problems. Obama’s recent proposal of a 4 year $300 billion highway infrastructure program is an example. What happened in the congress is that nothing gets done, they don’t agree on these things and continue to have short-term extensions, so I can’t tell you what current policy is. And this whole “spending mentality” is not sustainable. There is not enough money we can raise for all the alleged spending requirements; efficient reforms are really the way to go.

So this leads to calls for privatization—public sectors aren't getting the job done, while efficient reforms tend to be stymied by what we call a “status quo bias”—alright, let’s get the government out. It depends on the market power of the private firms, their incentives, and whether the consumers can exert

competitive pressure. I gave you examples of competitive pressure about railroads and bargaining. Same kind of bargaining could exist when privatizing a highway and have prices arranged through some bargaining and negotiation where consumers, automobiles and governments are all represented. However, evidence in the US is basically non-existent, while evidence on the effects of privatization in different parts of the world is mixed. Thus, it is a very difficult thing to identify causalities. The British Case is a well-known case of privatization on rails and there is a major problem on safety where the operator of rail track are to blame for lots of serious problems. But people who have closely studied this said: "look, it is not so simple. The privatization could have worked, but the way government managed this was really problematic. "So my point is: experiments are crucial to the implementing of privatization correctly.

Getting experiments is crucial in the US both for political support for deregulation and have at least some basic understanding about how it is going to work. The experiments I am talking about is that, in the US, there are differences between intra-state and inter-state regulatory policy. In California, for example, intra-state carriers are not regulated. So if you want to fly within California by carrier, it really was not a subject to the national regulation on interstate carriers; but if you want to fly the same distance from Boston to Washington DC, you are subject to the inter-state airline regulations. What people notice is that fares are a lot lower on that California route, and that is a support to show what deregulation would do. The pursuit for privatization should go along that line. Airports are more natural places where you can have some competition. In the US, there are a number of places where multiple airports serve multiple regions. In Washington, there are 3 airports that I can use.

I have done some work with a Chinese economist. We have written two papers, one is on highway privatization, the other is on airport privatization. Both of our papers pointed out possible strategies under which privatization can be a win-win in the sense that consumers do benefit and welfare can be improved. Of course, such a consequence does not necessarily come true in reality, but we did point out the importance of having experiments.

There are things in highway that will greatly improve travel, and they are available now. General purpose technologies such as GPS navigation services and specific technologies such as Weigh in Motion could be used to improve road pricing, investment, and safety. A satellite-based air traffic control system would reduce travel times and operating costs while improving safety. However, authorities are impeding technical change by not implementing recent innovations.

Privatization is a possible policy but most governments are certainly not interested in that. Meanwhile, we have lots of inefficiencies in infrastructure and transit systems. There are technologies to improve the system but governments do not use them. I am now turning to the private sectors as a possible source for significant improvement in our systems.

Before there were highways, there were cars. Before airports, there were airplanes. But more importantly, if you look at what cars and roads were look like when first introduced, you will see changes in both. However, cars continue to innovate and change, while roads haven't changed all that much even though there were opportunities for the authorities to adapt innovations and made roads better. We are now in a stage where there is a major leap in the modes of technology. Autonomous vehicle is certainly one of these. I have actually ridden one of the Google cars, and they really work. Operated by

computers, they have the potential to prevent collisions and reduce delays by creating a smoother traffic flow. Estimates of the benefits depend on market penetration—50% penetration yields annual benefits of $200 billion from reducing externalities.

A problem with the car is that it obeys the traffic rules, but others don't. For instance, in California, if you are a pedestrian and you step outside the crosswalk, cars are supposed to stop and let you go. So google cars will stop but other cars may not, so they may end up hitting it. There are some experiments going on in the UK—London and Oxford are doing some experiments on driverless cars. I think things that are holding them back are liability concerns and appropriate safety regulations.

Now I am going to summarize my presentation. A nation's transportation system is a large and vital part of its economy. Transport affects many sectors besides the users and suppliers of transportation. Unfortunately, many parts of the transport system have been compromised by inefficiencies. The inefficiencies from public policies toward infrastructure and transit cannot be denied. Current inefficiencies compromise spending proposals and lower their returns. Still, spending on infrastructure can generate significant benefits accounting for the economy-wide effects but they entail the costs of taxation and the misallocation of public funds.

Status quo bias indicates it is unlikely that efficiency improvements will be generated by policy reforms. Alternatively, private modes have led infrastructure—cars were introduced and entrepreneurs built private roads; airplanes were developed and private airports emerged. Thus the private sector can contribute to transportation efficiency improvements through modal innovations, such as driverless vehicles and satellite-based ATC. Infrastructure performance would then improve, generating benefits throughout the economy.