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Economic Returns to Rural Infrastructure Investment

Farm Foundation

1301 West 22nd Street
Suite 906
Oak Brook, IL 60523
Tel 630.571.9393
Fax 630.571.9580
farmfoundation.org

facebook.com/thefarmfoundation
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Economically Efficient Composition of Rural Infrastructure Investment

This paper is one of six commissioned as part of the workshop, *Economic Returns to Rural Infrastructure Investment*, organized by Farm Foundation and USDA's Economic Research Service (ERS). The workshop took place April 10–11, 2018, in Washington, D.C. A seventh paper, which had already been published, was also presented at the workshop because of its high relevance to the topic.

Authors Mark Burton, Ph.D., of the University of Tennessee and Wesley W. Wilson, Ph.D., of the University of Oregon, provide an economic explanation for why public-sector infrastructure investments is economically-efficient public policy. The authors also describe why many necessary investments must be sited in and/or available to rural communities.

To read the complete paper, or any of the other six papers, visit the Farm Foundation website, https://farmfoundation.org.

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The Economically Efficient Composition of Rural Infrastructure Investment

Mark Burton
The University of Tennessee

Wesley W. Wilson
The University of Oregon

ABSTRACT

Public sentiment routinely supports public-sector investment in infrastructure. Moreover, this view exists in both rural and metropolitan settings. Often, government is expected to directly support or, at least, guide the provision of transportation, telecommunications, and various utility services by supplying some or all of the necessary facilities. The current paper, first develops a more precise economic explanation for why public-sector infrastructure investment is economically efficient public policy. Next, by specifically accounting for the spatial nature of network infrastructures and commerce, we describe why many necessary investments must be sited in and/or available to rural communities. Finally, with an admittedly speculative eye to the future, we offer tentative forecasts regarding the nature and value of efficient, forward-looking rural infrastructure outcomes.

By its very genesis, the USDA was identified with the encouragement of innovative activity and with the implicit recognition that private-sector investment alone would not suffice to achieve optimal innovation in the agricultural sector. –BRIAN D. WRIGHT, 2012[1]

1. INTRODUCTION

The quote highlighted above reflects the widely-held view that public-sector investments, while perhaps necessary everywhere, are particularly important to rural areas. It is an outlook that is seldom challenged. Perhaps, because the need for public-sector investment in support of agriculture and other rural commerce is so readily accepted, many discussions of these investments skip immediately to the form and effect of spending, with little attention to why, in rural communities, the public-sector often provides resources that would, in other settings, be supplied privately.

Brian Wright underscores the point of his quote by tracing the growth and importance of public-sector investments in agricultural research and education.[2] While not always specific, Wright often suggests that these investments were necessary because private sellers couldn't adequately capture revenues from potential customers, or because benefits were conferred to non-market participants. In short, Wright attributes the need for public investment in agricultural research and technology transfer to two common market failures—the cases of public goods and market externalities.

Here, rather than agricultural research, our focus is on public-sector investments in infrastructures that are perceived as critical to rural communities. However, rather than skipping past the motivation for these investments, we demonstrate that the desired public-sector investments are motivated by the same types of market failures that have long-justified public-sector investment in agricultural research. Further, the propensity for these failures is amplified by the network technologies often embodied in these infrastructures. Our hope is that, through this examination, we can shed additional light on both the nature and magnitude of appropriate future rural infrastructure investments.

The remainder of the paper is organized as follows: Section 2 provides a basic overview of market failures, with examples from rural settings. In Section 3, we necessarily move toward the abstract to develop a generalized network production model that illustrates how network technologies are particularly prone to market failures. In Section 4, we use these concepts to explore both the demand for and the provision of rural, public-sector infrastructure investments. Finally, Section 5 provides thoughts on additional research.

2. MARKET FAILURES

In most cases, unfettered competitive markets do a good job of allocating scarce resources. However, in some cases the market fails to achieve this outcome. The term *market failure* refers

[1] Wright, Brian D., "Grand missions of agricultural innovation," Research Policy 41 (2012) 1716–1728.

[2] Wright, p. 1717.

to a situation where, unattended, markets lead to an inefficient allocation of resources. Typically, market failures occur if firms have market power that allows them to set prices that exceed marginal costs, if externalities are present, or if the good provided is a public good.

Economic policy is generally built on the belief that intervention can yield welfare improvements, but intervention is costly, with the result that government action is not always warranted. The term *effective competition* refers to the case where the market is not competitive *per se,* but where public policy cannot improve the efficiency of outcomes through intervention.

In a 1969 treatise, Nobel winner Kenneth Arrow summarized and expanded the basis for the modern economic understanding of market failures. He holds that market failures have their roots in two basic areas—transaction costs and/or the nature of the technology by which a particular good or service is produced. Transaction costs include the cost of identifying market alternatives, any costs associated with negotiating a transaction, the costs of enforcing agreements, and the costs imposed by future uncertainty. In any amount, transaction costs can distort market outcomes and, in the extreme, they can preclude transactions altogether.

The second potential generator of market failure is a production technology that yields seemingly inexhaustible economies of scale within the relevant range of demands. This condition leads to generally falling unit production costs, whereby a single producer can satisfy market demands at a lower cost than any combination of two or more producers. Economists refer to this as *natural monopoly*. Arrow links transaction costs and scale economies by noting that (1) the effects of transaction costs are more pronounced when there is a disparity between the number of buyers and the number of sellers; and (2) there are often scale economies in acquiring information.

Finally, at every juncture, Arrow makes it clear that the presence of market failure dethrones market competition as the unchallenged, most efficient means of resource allocation; but this realization leaves no clue as to a *second-best* alternative for allocating resources. In the case of natural monopoly, the only course is to make the lone seller behave in a way that replicates the market quantity outcomes that would be observed if effective, multi-firm competition was possible. For transaction cost-related market failures, the tradeoff seems to be between intervention that replicates competitive market outcomes and policies that reduce transaction costs, regardless of what might have been produced under the competitive ideal.

In practice economists and policy-makers routinely deal with, at least five types of market failures. These are briefly described here:

<u>Natural Monopoly</u>

As noted, natural monopolies occur when the relevant production technology is such that a market can be most efficiently served by a single seller. Occasionally, this occurs entirely because demand for the good or service is particularly limited. More often, however, natural monopolies result from relatively modest demands combined with network technologies that require large fixed and unrecoverable (sunk) investments.

Smaller rural markets for freight rail service often provide good examples. In many such markets, limited demands and high sunk costs leave room for only a single carrier. Inland waterways that are supported by costly navigation structures are similar in this respect.[3] Finally, although perhaps to a lesser degree, at least some rural broadband markets may also be natural monopolies.

Left unattended, a natural monopolist, like any profit-maximizing monopolist, will impose relatively high prices that constrain output to inefficiently low levels. Moreover, absent some combination of demand growth and/or technological change, competition cannot arise to correct the problem. Consequently, some form of public-sector intervention is probably appropriate. This intervention may come in many forms, but the most common involve either public ownership or economic regulation.

Market Externalities

Ideally, market transactions reflect a full range of benefits, as well as all the costs associated with the purchase of the subject good or service. In some cases, however, people outside (external to) the transaction, nonetheless attain benefits or incur costs because the transaction takes place. These are referred to as *market externalities* and can be positive or negative. In either case, however, unaffected market outcomes will allocate inefficient amounts of resources to the production of the good or service. If a transaction fails to reflect external benefits, unaffected markets produce too little; a failure to reflect external costs leads to overproduction.

Agricultural activities in rural settings can generate both negative and positive externalities, many of which are tied to environmental outcomes. For example, irresponsible livestock or soil management can impose environmental costs on rural communities that are uncaptured by the markets in which outputs are bought and sold. Alternatively, responsibly managed agricultural production can help preserve and protect rural resources and, in doing so, generate additional benefits that go beyond the simple value of the agricultural goods produced.

From a public policy standpoint, there are, again, numerous ways of *internalizing* external costs or benefits. The textbook solution to market externalities are to tax those who cause a negative externality or to subsidize those that cause a positive externality. Either way, the goal is to make private benefits and costs mirror the true societal benefits or costs.

For example, if while producing a good, a firm pollutes nearby groundwater without penalty, the result will be social costs that are higher than the private cost of producing the good, and the firm produces more of the good (and pollution) than is socially optimal. By taxing the firm for every unit of the good produced, the government increases the cost of producing the good so that it corresponds to socially optimal levels of production. This form of intervention also yields revenues that can be used to either mitigate the negative outcomes or compensate those who suffer unfair injury.

This form of intervention is reversed in the case of positive externalities. Research and development (R&D) is a classic case. Firms engage in R&D to enhance their profitability. Very often, however, the products or processes they uncover benefit others. Left unattended, this

[3] A sunk cost is a cost that is (1) fixed, that is a cost that does not vary as the quantity of output changes; and (2) is not recoverable if the firm chooses to exit the market. Sunk costs are particularly prevalent in network technologies, where the unrecoverable costs of placing the network are far greater than the cost of the materials that might be recoverable.

external benefit would not be reflected in a firm's research, so that the companies doing the research would do too little of it. Here, the typical public-sector response might involve subsidizing R&D activities through tax credits or other fiscal devices.

Within the current context, there is a subset of externalities that is particularly important. These are known as *network externalities*. In many (but not all) cases, a network's value to individual users varies directly with the number of total network users. For example, the value of the wire-line telephone service for individual households and businesses was traditionally believed to increase with the overall number of subscribers.[4] In fact, it is the existence of these externalities motivated the federal government to subsidize rural wire-line service through the *High Cost Fund* and that continue to support all forms of telephony through the *Connect America Fund*.

Public Goods

Arrow notes that in their most extreme form, transaction costs can block the formation of markets that would otherwise provide utility to both buyers and sellers. Thus, to the extent that transaction costs include the ability to secure payment from those who receive a particular good or service, the case of a *public goods* goes directly to Arrow's point. Public goods arise when a would-be seller has no way to exclude potential buyers from access to the good or service. Thus, buyers cannot be compelled to pay *any* price and the potential market will go unsupplied.

There are numerous textbook examples of public goods—such as local street systems or lighthouses—but Wright provides an agricultural example that is both fascinating and unfamiliar to those who do not know farming.[5] In his paper he describes how both public-sector and private-sector research had contributed to the development of hybrid seed for higher yielding corn. But, with regard to wheat, he writes:

> *Unlike hybrid corn, wheat was a self-pollinated plant that the farmer could replant for several years and sell (or give) extra seed to others. Given this competitive threat from potential customers, wheat breeding was privately unprofitable, and thus necessarily located mainly in the public sector*.[6]

While less than complete, the general inability to exclude the consumption of the hybrid wheat seed effectively turned the production of this seed into a public good. Without government intervention in the form of research support, this seed would have been developed far too slowly.

Informational Asymmetries

A fundamental assumption of the competitive model, so regularly associated with efficient resource allocation, is that all market participants have complete and, therefore, equal market information. In reality, this is hardly ever the case, but the competitive framework is robust in

[4] While network externalities are generally thought of as being positive, they can also be negative, as can be attested to by anyone who has struggled to maintain network connectivity in an overly busy airport.

[5] Historically, local street systems constitute public goods, because their complexities made it impossible to monitor (and potentially exclude) use and, thereby, assess use-related charges. The advent of GIS technologies now makes it possible to accurately track vehicle movements, so that the future usefulness of this example is uncertain.

[6] Wright, p. 1719.

that small deviations from the assumed perfect information create only small deviations in market outcomes. However, large informational asymmetries can and do cause large market distortions that warrant public-sector intervention.

Very often, informational asymmetries are the result of technological complexity and the relatively high cost of individually acquiring the needed technological expertise. Accordingly, typical public-sector intervention involves the centralized development of the appropriate expertise. From that point, governments either work to disseminate the expertise to market participants or intervene on their behalf. Consumer safety provides examples of both. In some cases, regulations require that consumers be informed of product characteristics. In other cases, the government simply regulates seller behaviors in ways that reflect what a fully informed consumer would choose.

Unnatural Monopoly

Natural monopolies occur when the technical structure of production dictates that market demand is most efficiently met by a single seller. However, most monopolies are attributable to firms' zest for supracompetitive profits, not the nature of the applicable technology. Accordingly, markets where firms dominate based on their behaviors, rather than market structure, can be thought of as *unnatural monopolies*.

From an economic standpoint, the exercise of monopoly power (natural or unnatural) results in deadweight losses. By imposing prices that are higher than necessary, the monopolist unnecessarily reduces the amount of output to levels that rob consumers of otherwise attainable benefits. However, in the case of unnatural monopolies, the public-sector response is typically to impose antitrust statutes that guard against the acquisition and exercise of monopoly power by making specific firm behaviors illegal. These statutes are upheld both by federal and state oversight and through third-party enforcement that allows actual or would-be competitors to bring legal action.

Table 1 provides a summary taxonomy of market failures and typical policy responses.

Table 1 – Market Failure Taxonomy

Market Failure	Example	Policy Response
TRANSACTIONS COST-RELATED MARKET FAILURES		
Market Externalities	Environmental Degradation	Prohibitions, taxes, or subsidies
Public Goods	Roadways	Public provision and ownership
Informational Asymmetries	Consumer safety	Public-sector regulation
TECHNOLOGY-RELATED MARKET FAILURES		
Natural Monopoly	Utilities	Public ownership or regulation
Monopolies Attributable to Property Rights	Patents and copyrights	Bounded property rights

3. THE INFLUENCE OF NETWORKS

Transportation and utility services require extensive infrastructure investments in networks. Deciding how and by whom these investments are made is almost always a difficult policy issue. There are two very different approaches that provide divergent outcomes.

First, some networks (like highways), where use is not excludable, are treated as public goods and provided through public-sector investments. These investments are funded through tax revenues derived through user charges, such as fuel taxes, or through general funds. In contrast, other networks (rail or broadband) are paid for by the private investment of providers. While there are sometimes subsidies or other public-sector inducements that make the investments more attractive, the services are indeed excludable, with the result that the private-sector provider can compel users to pay for the transportation or communications service that the infrastructure investment supports.

In this section, we use a transportation example to provide a framework for assessing the differences between investments by a planner of a public good and the investment levels undertaken by a private firm. Throughout, the planner is assumed to maximize surplus, while private firms are assumed to maximize profits by exercising at least some market power.[7] In a very simplistic example, we look at the demand for network service from an origin to a destination (D(P)). Costs consist of operating costs and investment costs necessary to provide the infrastructure. For now, we consider only the demand from an origin to a destination, but the model can be easily extended to include different types of demanders and bi-directional movements.

We first consider the case where there is no existing link between the origin and destination. The public-sector planner will invest in the link if the total surplus gained from that investment exceeds the cost. For now, we do not include user fees and assume the cost of the network is paid from general tax revenues. In this case, the transportation supplier or suppliers do not pay for the network and will use it until profits are maximized, with prices of services reflecting marginal costs. The benefit of the link then is the sum of the consumer and producer surplus attributable to the investment in the link and its use. If the service supplier is a monopolist, the benefit of the investment will be smaller than if the service is provided competitively.

If the link is not publicly provided, but is the result of a private investment, the benefit of the investment is the profit of the monopoly firm, which presumably is sufficient to pay for the investment. At least in our example, private infrastructure providers are unconcerned with consumer surplus.

[7] Within economics, there are two sources of surplus. On the consumer side, surplus is defined as the difference between the price paid and what the maximum price the consumer would have been willing to pay for the good or service. For firms, surplus is defined as the difference between the price received and the minimum price it would have accepted for the same quantity of output.

In cases where there is already a link between origin and destination, cost-reducing investments in additional capacity can be made incrementally. If the public-sector supplies the incremental investment, it lowers the costs incurred by service suppliers; they will expand output and prices will fall based on reduced costs. In this way, policy-makers can induce additional surplus through incremental investments in the infrastructure. Again, this is true even if the service is provided by a monopolist, but the added benefits are smaller.

If the incremental investment is provided privately, the benefit will be the incremental addition to profits. As before, the costs of the incremental investment must be covered by the incremental profits.

Next, and perhaps of more relevance here, we consider the case where consumers can choose between two options. The first option is to purchase from competitive suppliers who operate over a publicly-provided network. The second option is to buy services from a monopoly supplier that operates over its own, privately-provided network. In this case, a cost-reducing incremental investment in the publicly-provided network link will generate additional surplus in two ways. Surplus will increase from new consumer use of the link, but incremental surplus will also come from shippers who switch from the monopoly-provided service to the competitively-provided service. If the investment is large enough, it can result in dramatic shifts of commerce that may result in the private link being abandoned.

Private investments follow similarly. Once the infrastructure is in place (public and private), market conditions can and do change. If there is a positive demand shift or a technology improvement, public investments, private investments or both may be warranted with the predictable results alluded to above. That is, public investments may crowd out private investments and vice versa.

Finally, we consider the case where there are differences in demanders of the transportation service. Specifically, we consider the case where demand has two elements: (1) users that produce goods in a local market, served by competitive firms that use a publicly-provided infrastructure; and (2) a set of users that export from the local market to distant markets using private network firms that make investments in the privately-owned network infrastructure.

In this setting, public investments will expand the local economy, while private investment will expand the export markets. Of course, the production decisions of local firms will be affected. That is, if there is investment in the publicly-provided network, local producers will substitute away from the export market to the local markets. If there is investment in the privately-provided network, prices of the subject service will fall, and local producers will substitute from producing for local markets to producing goods for the export market.

These admittedly simple examples underscore three important points. First, public-sector investments and private investments in network infrastructures have different underlying motives and will, therefore, produce differing outcomes. For example, public investments in roadways are a public good—at least investments that exceed revenues from toll and user fees. Since the use of the roadway is non-excludable, investments will not occur except by a public agency. These investments are made with an eye toward maximizing social surplus. In the case of privately-provided rail or telecommunication networks, profits drive the investment decisions.

Next, whether substitutes or complements, any mix of public and private network investment within the same geography imposes a complex interdependence between the two. Policy-makers and business firms are certainly aware of the sensitivity of their decisions to the decisions of each other, but awareness must be accompanied by the best possible analytical tools. The examples described here are generally static and, therefore, understate the complexity of this interdependence. Many network infrastructures are long-lived, so that policy-makers and private business interests must try to maximize benefit flows (surplus or profits) over time horizons that are measured in decades. This is a formidable task.

Finally, the interaction of investments by public and private entities can and do affect the nature of goods provided for local and distant markets. Thus, public-policy decisions and the resulting mix of public-sector and private network investments are likely to produce measurable economic development effects. It is, perhaps, easy to account for regional impacts when networks are simple. It is far more difficult in a global setting that contains an almost boundless set of potential origins, destinations, and service combinations.

In Section 4, we move from the world of theory toward our primary goal of discussing future network infrastructures. Still, we are hopeful that the material in these first sections will help readers to better appreciate the nature of our opinions, and why it is our fervent belief that there is a necessary public-sector role in the provision of rural infrastructure.

If metropolitan America is to drive national prosperity, metropolitan areas will need a healthy and sustainable rural economy and culture. Likewise, if rural America is to flourish, it will surely depend upon vibrant, well-functioning cities and suburbs. – BRIAN DABSON, 2007[8]

4. LOOKING FORWARD

Efficiently-functioning rural economies are important to all Americans. While it is true that 72% of U.S. citizens live in cities and towns with populations of 50,000 or more, these urban inhabitants are inexorably dependent on the resources nurtured and harvested in rural America.[9] Similarly, without the demands fostered by urban populations, rural economies would have few viable outlets for the crops and raw materials they produce. Thus, assuring efficient rural production capacity, including necessary infrastructure, is a national priority that transcends the urban-rural dichotomy.

In March 2018 Senate testimony, U.S. Agriculture Secretary Sonny Perdue stressed seven "core" rural infrastructures. These include:[10]

- Highways and highway bridges;
- Railroads;
- Navigable waterways;
- Airports;
- Water supply and waste water treatment facilities;
- Electric utilities; and
- Telecommunications, including broadband access.

Each of these infrastructure elements is characterized by network production technologies, and each has traditionally attracted public-sector involvement or, at least oversight, particularly in rural environments. Still, as the material developed above suggests, the forward-looking public role depends both on the characteristics of emerging technologies and the magnitude of rural demands for these infrastructures. Thus, each of these infrastructure elements is worthy of a closer look.

Highway Infrastructure

Excepting isolated toll roads and bridges, highways and street systems are generally treated as public goods, where there is no attempt to control or monitor access and use. Because they are integral to national mobility, major highways (Interstates, federally-signed highways, and many

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[8] Brian Dabson, "Rural-Urban Interdependence: Why Metropolitan and Rural America Need Each Other," the Brookings Institution, November 2007.

[9] Another nine percent of the population lives in cities and towns with populations between 25,000 and 50,000. See "New Census Data Show Differences Between Urban and Rural Populations," U.S. Census Bureau, December 20016. https://www.census.gov/newsroom/press-releases/2016/cb16-210.html

[10] See: "Secretary Perdue's Prepared Opening Statement on Rural Infrastructure," US Department of Agriculture, Release No. 0056.18, March 14, 2018. https://www.usda.gov/media/press-releases/2018/03/14/secretary-perdues-prepared-opening-statement-rural-infrastructure

state roads) have traditionally been funded largely through federal funds. Lesser highways and street networks are typically the responsibility of state and local jurisdictions. However, as Figure 1 depicts, actual funding is more convoluted. Federal funds for the construction and maintenance of major roadways generally requires state matching funds and, at the same time, a modest share of federal highway funding passes through states to local jurisdictions.

Whether federal or state, the majority of highway funding is derived through user fees primarily levied in the form of excise taxes on motor fuels. At the state and local levels, fuel tax revenues are supplemented by an array of other fees including vehicle registration fees, sales taxes on vehicles or driver licensing fees.

In most states, there are only very loose linkages between the location of roadway revenue collection and where expenditures are made. Thus, there is a natural tension between urban and rural communities. Rural communities feel they are denied the roadway resources that would help develop and sustain new commerce, while urban areas resent the diversion of locally-derived funds to outlying communities. This same friction exists between states with greater populations and states that are less densely inhabited. Figures 2 and 3 divide total vehicle-miles traveled (VMT) and VMT per lane-mile by urban and rural use. Together, these figures suggest that, while urban traffic volumes have increased more quickly over time, the division of roadway resources between urban and rural uses has remained quite constant.

Figure 1 – Highway Funding

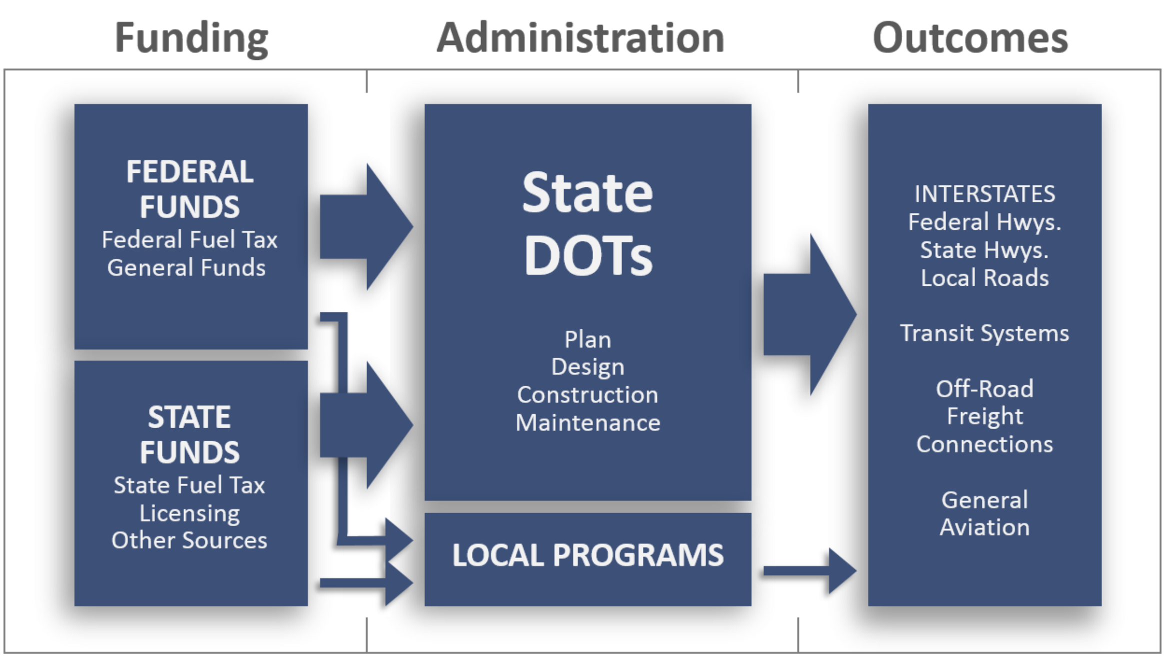


Figure 2 – U.S. Vehicle-Miles Traveled

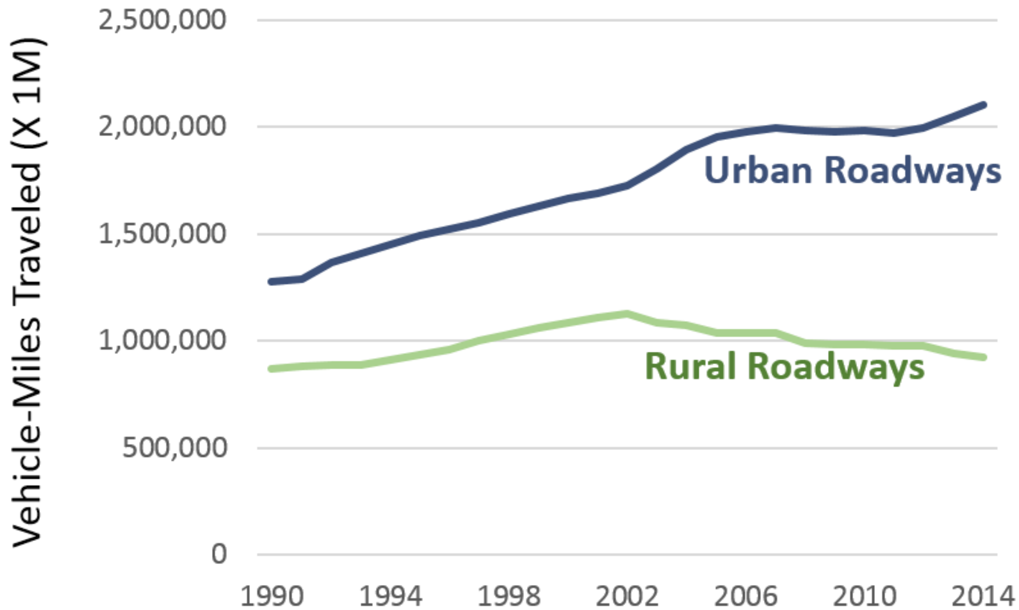
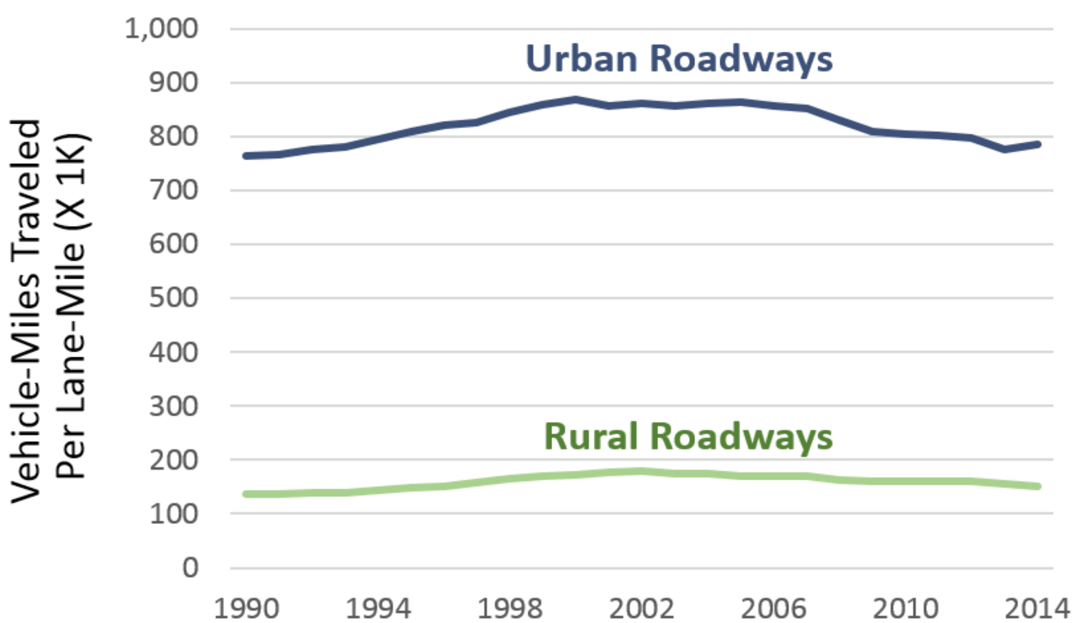


Figure 3 – U.S. Vehicle-Miles Traveled per Roadway Lane-Mile



Future rural roadway needs are tied inexorably to future land uses. As Figure 3 suggests, generally rural highways see less traffic per lane-mile than those in urban areas and can be designed and built accordingly.

However, this generalization obscures a great deal of variation in rural roadway demands. For example, rural areas that border urban regions typically require reliable connectivity to the urban center(s). Similarly, regions that support extractive industries may require that roadway network components be more robust than would be necessary otherwise. Terrain and climate can also affect the form and extent of needed highway infrastructure. Finally, both agriculture and tourism-related traffic can place differential seasonal demands on specific rural network facilities.

Many of the unknowns in the demand for future rural roadway capacities are tied to ever-emerging technologies. For decades, the improved ability to substitute reliable, advanced communications for physical transportation has improved the quality of life in many rural communities. Still, it is difficult to discern how these advanced communications have impacted the need for rural roadway capacity. On the one hand, the ability to substitute communications for physical trips related to health care, education, and employment reduces roadway infrastructure demands. Alternatively, however, increased livability and relatively lower residential costs often lead to migration from urban to rural areas, leading to increased rural populations and the need for more, not less, highway capacity.

Perhaps the greatest uncertainty affecting rural roadway demands is the probable introduction of autonomous vehicles. Advocates promise these vehicles will lead to faster roadway speeds, improved safety, and the ability to substitute autonomous vehicles for the traditional forms of transit that are scarce in most rural settings. These potential outcomes are tremendous. On the other hand, vehicle automation technologies require roadways with reasonable surfaces and consistent, well-maintained pavement markings. Affording this higher quality of highway infrastructure will be challenging in urban areas where traffic is dense. It is unclear that similar infrastructures will ever be affordable in rural areas where networks involve greater distances and less frequent use.

Railroad Transportation

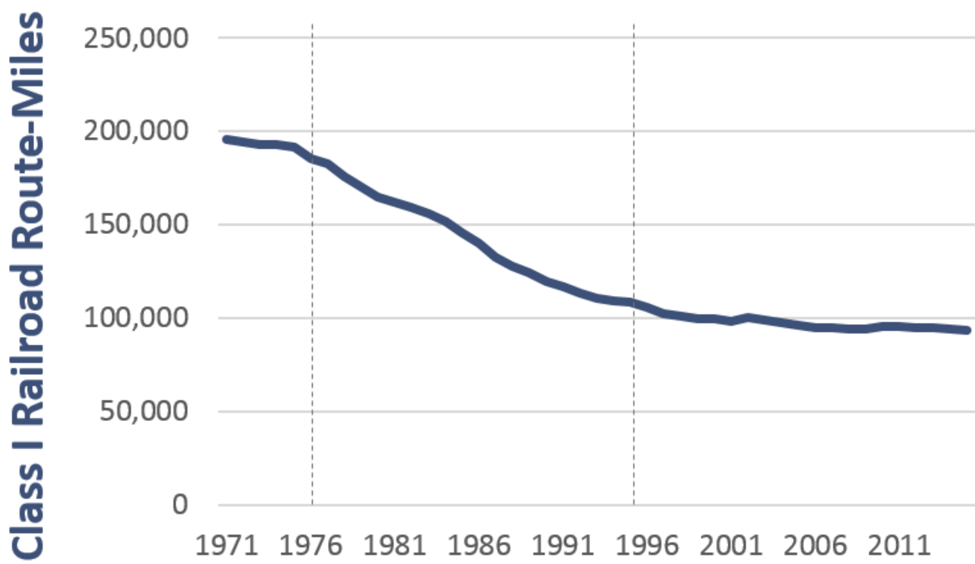
Railroad networks are sufficiently compact, so that excluding potential users from railroad infrastructure is rarely a problem. Hence, railroads are not public goods. Freight railroad infrastructure is almost exclusively privately owned by firms that operate for profit. However, some rail markets are most efficiently served by a single provider. These markets constitute natural monopolies. For this reason, private railroad pricing and operations are closely monitored by federal regulators.

The form of that oversight changed dramatically in the 1970s and 1980s, through regulatory reforms that tremendously increased the flexibility that the largest freight railroads have both in establishing rates and in offering or abandoning services. As a result, the larger railroads “rationalized” their networks by eliminating unprofitable, low-density route segments. The overall number of Class I railroad route miles is depicted in Figure 4.[11]

[11] Freight railroads are divided into classes, based on annual revenues. Currently, there are seven Class I railroads with annual revenues greater than $447,621,226. Class II railroads have revenues less than the Class I threshold but in excess of $35,809,698. Class III railroads have annual revenues less than the Class two lower threshold.

In many instances less-profitable branch-lines were sold to short-line railroads and, indeed, the number of short-lines has grown from roughly 200 in 1980 to more than 550 in 2018. Nonetheless, not all unneeded Class I route segments were suitable for short-line

Figure 4 – Class I Railroad Route Miles



operators, so a measurable number of rural communities lost freight-rail access in the early years following regulatory reform.

Looking toward the future, the regulatory changes adopted in the last half of the 20th century have produced a 21st century railroad industry that is financially healthy and in better physical condition that ever before. Still, the same technologies that are applicable to passenger vehicles are planned for trucks, as well. The speed and the extent of motor carrier automation is almost certain to create new competitive pressure on rail rates for more highly-rated freight.

At the same time, the general movement away from coal as a fuel source in electricity generation has already reduced overall freight volumes and promises further declines. Together, vehicle automation and declining coal volumes may, perhaps, threaten rail industry viability.

<u>Navigable Waterways</u>
There are currently 12,000 miles of navigable inland waterways in the United States that collectively move roughly 550 million tons of freight each year, and also provide a meaningful source of competition to rail-served shippers on or near the waterway.

Though by no means ubiquitous, the inland navigation system is a tremendous resource for the agricultural commerce that is vital to rural America. Indeed, each year approximately 10 million tons of corn and soybeans move south from the upper reaches of the Mississippi River for export from the Louisiana Gulf, and a similar amount of export corn and soybeans move south from origins on the Illinois River.[12]

Commercial navigation is sustained by approximately 175 navigation lock and dam projects that make it possible to maintain sufficient waterway pool elevations and, at the same time, transit the system. With the exception of the locks and dams on the Tennessee and Cumberland Rivers, all inland navigation locks are federally owned and all locks, regardless of ownership, are operated by the U.S. Army Corps of Engineers (Corp).[13] Actual freight services are provided by private-sector waterway operators.

It would be simple to exclude navigation lock use and, thereby impose lockage fees. Like railroads, locks and dams are not public goods. They are, however, unquestionably a natural monopoly. No competitor is likely to bring a new river system to compete with the one that currently exists. Moreover, while there are occasionally discussions about transferring lock operations and maintenance to private-sector operators, the multiple purposes served by lock and dam projects makes private lock operations unlikely.[14]

Looking toward the future, navigation capacity is a non-issue. However, system reliability and maintenance costs are problems. Most of the navigation locks have served past their design lives. While in most cases, safe operation is possible, the locks are increasingly prone to unscheduled outages that delay system traffic. Also, as the locks age, they are increasingly expensive to maintain.

Like motor carriers, towing companies pay fuel taxes, with revenues accruing to the *Inland Waterways Trust Fund*. By statute, these tax revenues are expected to fund 50% of new lock construction costs but are currently insufficient to fund a growing backlog of otherwise desirable lock replacement projects.

General Aviation (GA)

General aviation and airport access are almost always necessary to, but rarely a catalyst for, economic development. In rural settings, GA airports also can be important to agricultural production. Each year, aerial applications of pesticides, herbicides, and fertilizers are used to treat more than 71 million acres of crop land.[15]

From a policy standpoint, GA facilities are neither natural monopolies nor public goods. They are, however, a classic generator of network externalities. Each airport that is added to the national network of GA airports adds new value to existing facilities. Accordingly, federal policies subsidize the development of and improvements to general aviation airports.

[12] For a further discussion of export grain and soybean movements on the upper Mississippi and Illinois Rivers, along with a discussion of railroad capacity in this corridor, see Mark Burton and Craig Philip, “The Impact of Unscheduled Lock Outages,” U.S. Maritime Administration and the National Waterway Foundation, October 2017.

[13] Lock and dam projects on the Tennessee and Cumberland Rivers are owned by the Tennessee Valley Authority.

[14] Locks and dams are also operated to provide flood control, irrigation, recreation, and hydroelectric generation. Operating practices are balanced to ensure that each of these purposes is fulfilled.

[15] See http://www.agaviation.org/

Regarding rural aviation's future, the most salient issue has little to do with infrastructure and much to do with aviation policy. Unmanned aerial vehicles (UAVs), more commonly called drones, have the potential to noticeably improve both productivity and access in rural settings.

There are innumerable agricultural applications that range from crop and livestock inspections to chemical applications. Drones can also be used to efficiently inspect infrastructure in remote locations. There are even plans for drone transport in rural medicine, where UAVs would be used to transport pharmaceuticals or diagnostic samples necessary to the treatment of both human patients and livestock.

Drones do, however, have an increasing potential to conflict with manned aircraft. Thus, the challenge for policy-makers is to identify UAV policies that ensure public safety, without unnecessarily limiting the productivity of unmanned aircraft.

Rural Water and Wastewater Infrastructures

Few issues are more critical to commerce and the quality of life in rural America than the quality and availability of water. Providing this resource requires the long-run, responsible stewardship of ground water; the efficient delivery of water for agricultural, residential, commercial and industrial uses; and provision of efficient and environmentally-responsible wastewater treatment.

Given water's importance, it is not surprising that it receives tremendous attention from myriad state and federal agencies. At the federal level, 10 distinct entities are responsible for various aspects of water quality management. USDA alone has 13 Rural Development Water and Environmental Programs.

While the economic resources available for the provision of rural water supplies and waste water treatment have not always been as plentiful as some would advocate, there has rarely been descent regarding the public sector's dominant role developing, operating, and regulating the associated infrastructures.

Electricity Generation and Distribution

Ensuring a reliable and affordable electricity supply to rural communities has long been a policy priority at both the federal level and among states. However, the magnitude of public-sector intervention and its effects on the generation and distribution of electricity vary considerably between regions.

At the federal level, there are five major electricity entities. These include:

- The Tennessee Valley Authority (TVA)
- The Bonneville Power Administration (BPA)
- The Southwestern Power Administration (SWPA)
- The Western Area Power Administration (WAPA)
- The Southeastern Power Administration (SEPA)

Unlike TVA, the four Power Marketing Administrations (PMAs) transmit, but do not generate electricity. Instead, they primarily purchase power generated by the U.S. Army Corps of Engineers at hydroelectric facilities. The PMAs' principal customers are local, publicly-owned utilities and rural electric cooperatives (RECs), non-profit, customer-owned organizations that have first call on PMA-managed power. In total, federal entities generate seven percent of the nation's electricity and own 14% of the nation's distribution network.[16]

Historically, both electricity generation and distribution were treated as natural monopolies. More recently, however, the two facets of electricity supply have been decoupled and electricity generation is now more often treated as a competitive industry.

Looking toward the future, rural commerce and quality of life are already influenced by two growing practices. These are the movements toward renewable fuels and distributed electricity generation (DG). While closely related, these trends are nonetheless distinct and likely to attract markedly different policy responses both at the local and federal levels.

Renewables generally include hydroelectric, solar and wind powered electricity generation. Because these energy sources avoid carbon emissions and any environmental degradation from fuel extraction, they are judged to produce sizable external benefits. Accordingly, renewables continue to receive significant subsidies. Importantly, a 2011 USDA-sponsored study observes that the expanded use of renewables is most easily accomplished in rural areas.[17] Thus, it is likely the renewables will confer a continually increasing advantage to rural America.

From a policy perspective, distributed generation (DG), is more complicated. While definitions vary, DG typically involves electric utility users who self-supply some or all of their electricity needs, but who are allowed to draw power from the grid if necessary. DG producers are also allowed to feed surplus electricity into the incumbent power system and are paid for doing so.

Distributed generation often relies on renewable fuels and, when it does, can produce the same external benefits associated with any renewables use. At the same time, however, DG poses serious equity issues. By self-supplying power, DGs reduce incumbent utility revenues, but do nothing to reduce the extent of the utility's required network.[18] As a result, non-DG utility customers are required to shoulder a larger share of the fixed network costs. Given that there are often income differences between DG and non-DG customers, policies that support distributed generation are sometimes viewed as regressive.

<u>Broadband Communications</u>

As wireline telecommunications expanded during the 20th century, the physical and demographic characteristics of rural communities led to higher service costs and correspondingly lower penetration rates. Recognizing the external network benefits attendant to

[16] See Chris Edwards, "Privatizing Federal Electricity Infrastructure," *Tax and & Budget Bulletin*, Cato Institute, January 24, 2018, Number 80.

[17] See, "Renewable Power Opportunities for Rural Communities," USDA, Office of the Chief Economist, April 2011.

[18] In fact, accommodating any DG surplus power can actually increase network costs for the incumbent utility. See Mark Burton and Michael Hicks, "Distributed Generation in Indiana: A Preliminary Policy Discussion," Ball State University, Center for Business and Economic Research, January 2014.

wider network participation, federal programs eventually sought to bring about universal service in both rural and urban areas through a variety of subsidy programs. In the case of rural wireline service, increased penetration rates were achieved by direct federal payments higher-cost rural local providers.[19]

As broadband telecommunications emerged in the 1980s and 1990s, the same arguments centered on network externalities were used to justify subsidies that promoted the nascent technology's extension and adoption within rural settings. However, added to the traditional motivation for subsidizing were pressures to accelerate broadband as a means of increasing agricultural production. Broadband telecommunications are essential to the relatively new set of technologies known as precision farming that are, in turn, important to attaining long-range agricultural productivity goals.

While broadband access is vital to precision farming and to other forms of rural commerce, broadband capacity development continues to lag in rural communities. Quoting U.S. Telecom from 2017:

> *While broadband is widely deployed across the United States, availability continues to lag in rural areas compared to urban and suburban areas. . . There is variation across rural areas in terms of deployment, speeds, and competition. While there are gaps in rural broadband, there is no single "rural broadband gap." Rather, availability lags in targeted rural areas either where broadband is not yet available due to challenging geography or network costs or the economics do not support frequent upgrades of existing networks.*[20]

The release containing this text also summarized the Federal Communications Commission (FCC) data depicted in Figure 5.

The roll-out of higher capacity broadband in rural areas is not happening as quickly as many believe it should. At the same time, it is difficult to identify any way(s) in which the markets for advanced telecommunications are failing to perform efficiently.

The markets for broadband access are not public goods. Issues surrounding competition are, perhaps, more relevant. While competition for patrons is robust in urban and suburban communities, the extent of competition in rural settings is less certain. It is possible a lack of competition may, for now, keep prices unnecessarily high and, thereby, dampen adoption rates. Still, any competition-related lag in rural broadband development is likely to be transitory. As rural broadband use increases and these markets grow more dense, competitive entry by new market participants seems likely so long as regulatory policies don't preclude it.

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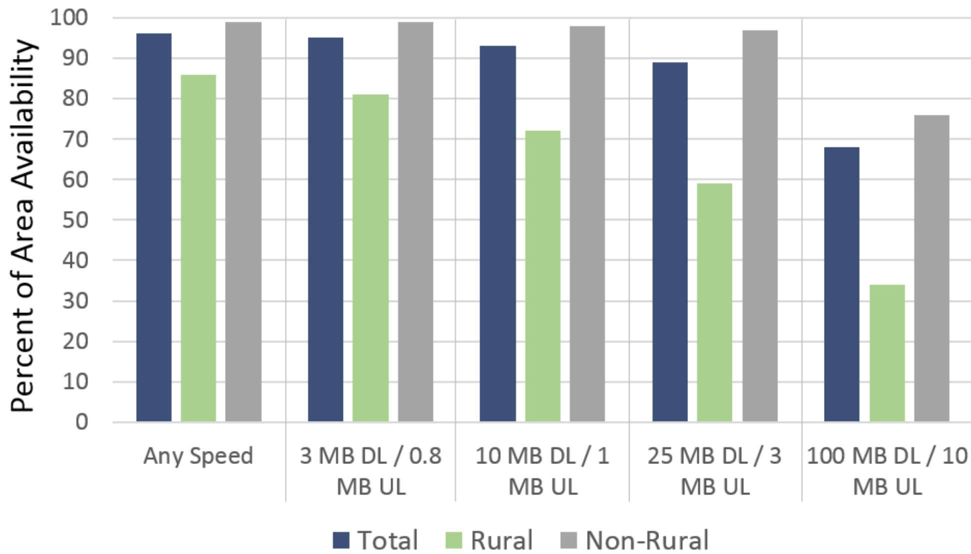
[19] Originally titled the High-Cost Support program, more recent rural universal service efforts are undertaken as a part of the Connect America program. For a cursory summary of federal universal service programs see: https://www.fcc.gov/general/universal-service

[20] https://www.ustelecom.org/blog/gaps-remain-broadband-availability-rural-vs-non-rural-areas

Figure 5 – Broadband Availability



Finally, early in rural broadband applications, there were informational asymmetries that drove a wedge between anticipated demand and service adoption. However, these differences between stated preferences, and the preferences ultimately revealed by rural broadband subscribers are largely gone. In view of these issues, there are many who suggest that public-sector programs should also be transitory.

That there is some amount of controversy surrounding the extent of the public sector's promotion of rural broadband is not surprising. Every element of universal service programs has, at one time or another, endured considerable scrutiny. If nothing else, these controversies point to the importance of robust, defensible estimates of benefits (returns) to informed policy discussions.

5. CONCLUSIONS AND FINAL THOUGHTS

The information gathered and presented here supports, at least, four conclusions.

1. Market failures, or perhaps more accurately, market *underperformance*, can lead to situations where economic outcomes may be noticeably improved through public-sector intervention. Moreover, the demographics of rural areas, combined with the network nature of many technologies, often mean that market failures are more common in these areas.
2. Addressing the opportunities to improve efficiency through appropriate publicly-led investments in rural infrastructure is important to all Americans and, therefore, should be among the nation's priorities.
3. Both the need for and nature of future public infrastructure investments are affected by rapidly changing technologies, so that simply replicating past policies without additional scrutiny is perilous, at best. Now, more than ever, maintaining as much flexibility as possible in the form and timing of publicly-sponsored infrastructure investments is important.
4. The limited resources available for infrastructure funding compared with much greater wants and needs means that developing the tools that facilitate appropriate comparisons is tremendously important to good policy. Assuring adequate rural infrastructure investment will likely depend on effectively measuring and communicating the importance of this investment to all Americans.

The magnitude of the United States' infrastructure deficit is remarkable. The America Society of Civil Engineers (ASCE) estimates that we need to spend $4.6 trillion between now and 2025 just to catch up.[21] That equates to roughly $5,000 per year for every U.S. household. It is unlikely that the public sector can raise such sums through traditional fiscal tools. It follows that private investors must be attracted to the infrastructure arena and that user charges must be sufficient to reward those investors.

This leads to mention of the often touted, but rarely understood public-private partnerships (P3s). It is important to better understand the interactions between public and private motives and decision-making processes. Investment behavior by the private sector in isolation is largely understood, and there has been at least some work on investment decisions by the public sector. Still, a better understanding of the linkage between infrastructure characteristics and the two possible sources of finances will help determine when and under what conditions private-sector participation can be expected.

Finally, it is unclear where P3 strategies can be as effective in rural settings as they are hoped to be in a more urbanized environment. The typically slower rural build-out would seem to have implications on early period paybacks that may make rural opportunities for private-sector funding relatively less attractive. If this is the case, then advocates for rural infrastructure development may want to focus more heavily on public- sector funding sources.

[21] See, ACSE 2017 Infrastructure Report Card: A comprehensive Assessment of America's Infrastructure, American Society of Civil Engineers, https://www.infrastructurereportcard.org/wp-content/uploads/2017/10/Full-2017-Report-Card-FINAL.pdf