



STRATEGY PAPER

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An Economic Strategy for Investing in America's Infrastructure

Manasi Deshpande and Douglas W. Elmendorf

The Hamilton Project seeks to advance America’s promise of opportunity, prosperity, and growth. The Project’s economic strategy reflects a judgment that long-term prosperity is best achieved by making economic growth broad-based, by enhancing individual economic security, and by embracing a role for effective government in making needed public investments. Our strategy—strikingly different from the theories driving economic policy in recent years—calls for fiscal discipline and for increased public investment in key growth-enhancing areas. The Project will put forward innovative policy ideas from leading economic thinkers throughout the United States—ideas based on experience and evidence, not ideology and doctrine—to introduce new, sometimes controversial, policy options into the national debate with the goal of improving our country’s economic policy.

The Project is named after Alexander Hamilton, the nation’s first treasury secretary, who laid the foundation for the modern American economy. Consistent with the guiding principles of the Project, Hamilton stood for sound fiscal policy, believed that broad-based opportunity for advancement would drive American economic growth, and recognized that “prudent aids and encouragements on the part of government” are necessary to enhance and guide market forces.





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Abstract

Infrastructure investment has received more attention in recent years because of increased delays from road and air congestion, high-profile infrastructure failures, and rising concerns about energy security and climate change. The United States now has the opportunity to channel public concern and frustration into a national infrastructure strategy that promotes infrastructure as a central component of long-term, broadly shared growth. While increased spending on infrastructure is likely to be needed, this paper emphasizes the large gains that could be reaped by using existing infrastructure more efficiently and by making better decisions about how to invest in infrastructure.

For physical infrastructure, we recommend establishing pricing mechanisms such as road congestion fees and air traffic control fees to make users bear the costs of their infrastructure use more fully. At least part of the revenues from these fees should be used to offset their potential adverse distributional effects. The federal government can also promote better decisionmaking about new investments by removing distortions in its own policies and providing more flexibility to states and localities in exchange for more accountability. For telecommunications infrastructure, we propose that the government make better use of the wireless spectrum by facilitating sales and leases of unused spectrum and by introducing more flexibility in its policy of interference prevention. Further, the government should consider targeted, cost-effective subsidies to encourage private firms to expand high-speed Internet access to unserved rural areas.

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Contents

Introduction and Summary	5
Section 1. Principles for Infrastructure Policy	11
Section 2. U.S. Infrastructure Spending	17
Section 3. Reforming Physical Infrastructure Policy	22
Section 4. Reforming Telecommunications Infrastructure Policy	30
Conclusion	36
References	37

Introduction and Summary

The state of the nation's infrastructure is generating rising public attention, prompted by daily travel frustrations, high-profile catastrophes, urgent calls to address climate change and energy security, and concerns about productivity and economic growth. On the nation's roads, peak-period drivers now spend thirty-eight extra hours a year in traffic as a result of highway congestion, up from fourteen hours in 1982 (Schrank and Lomax 2007). More than one-third of drivers say that traffic congestion is a serious problem in their community (Harris Interactive 2007), and freight delays alone cost the nation's economy approximately \$8 billion annually (DOT 2005). Air travelers also are experiencing record delays, productivity losses, and frustration, with hours of passenger delay increasing by 29 percent from 2006 to 2007 (Sherry and Donohue 2008). Meanwhile, the United States ranks fifteenth among industrial nations in high-speed Internet (broadband) subscription (Organisation for Economic Co-operation and Development [OECD] 2008a), with around 10 million American households—mostly in rural communities—lacking access to broadband (Peha 2008). Broad swaths of the wireless spectrum—which allows devices to communicate—lie fallow while innovative companies struggle to find spectrum for delivering new wireless products.

These signs indicate that growing concerns about U.S. infrastructure are warranted. One significant area of concern is physical infrastructure, which includes roads and bridges, airports and the air traffic control system, water and sewerage systems, and facilities for energy production and distribution. In 2005, as in previous years, the American Society of Civil Engineers gave the nation's physical infrastructure a near-failing grade,

a rating that has been cited frequently since last year's bridge collapse in Minneapolis, a recent dam break in Hawaii, and the failure of Louisiana levees during Hurricane Katrina. The nation's continued dependence on cars and gasoline is at odds with the scientific community's alarms about climate change and national security experts' warnings about our reliance on oil-exporting nations. But America's "love affair" with the automobile has left few alternatives to driving; mass transit represents less than 2 percent of passenger miles traveled (DOT 2007a). At the same time, the reliability of the nation's electrical grid is in question, and population growth and climate change threaten to exacerbate the water shortages that have become a common feature of life in western states.

A more recent area of concern is telecommunications infrastructure, which includes the natural resource of the electromagnetic spectrum as well as constructed resources such as telephone wires, cable lines, and equipment. The rapid pace of technological progress in telecommunications and the widespread dispersion of new products and services—cell phones and wireless handheld devices, for example—may present an appearance that all is well in this sector. However, this interpretation misses crucial signs of trouble. Despite the high-tech wonders that many Americans enjoy, evidence indicates that the United States lags behind other industrial nations in broadband access and its concomitant economic and social benefits. Inefficient use of much of the spectrum hampers the development and introduction of new wireless services and reduces competition among providers of such services, costing the U.S. economy billions of dollars each year.

Rising concerns about physical and telecommunications infrastructure have moved infrastructure policy to the center of the national agenda. Some policymakers have proposed a “national infrastructure bank” that would attempt to allocate money for infrastructure projects in a systematic and efficient fashion. New York City recently became the nation’s first large metropolitan area to propose congestion pricing to ease the flow of traffic entering the city, though this proposal was ultimately rejected by the New York State government.

The United States has the opportunity to channel public concern and frustration into a national strategy that promotes infrastructure as a central component of long-term, broadly shared growth.

Reauthorization of the federal government’s most recent transportation plan (the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, or SAFETEA-LU) is scheduled for 2009 and has already spurred national debate among interest groups, frustrated citizens, and transportation experts. In addition, the Highway Trust Fund, used to pay for highway and transit projects, is projected to go bankrupt in 2009 without congressional action.

This paper draws on economic research, including new discussion papers being released by The Hamilton Project, to propose a national infrastructure strategy that promotes infrastructure as a central component of long-term, broadly shared growth. The strategy will require national leadership on two fronts: using existing infrastructure more efficiently and making better decisions about infrastructure spending. The United States can and should pursue both of these fronts with the intent of strengthening economic growth and ensuring that the benefits of growth are felt by all Americans.

For physical infrastructure, the large amount of existing capacity means that more efficient use of that capacity could have an enormous beneficial effect. Achieving more efficient use will require setting prices for use that reflect, to the extent possible, the full cost that users im-

pose on the system and on society. How to accomplish this in a practical manner and how to protect lower-income households from the adverse consequences of this pricing are crucial topics to which we return below. Of course, making better use of existing capacity will not be sufficient; any growing nation and economy requires ongoing infrastructure investment. To make better investment decisions, the federal government should remove distortions in its own funding processes and provide incentives to enhance accountability in state and local governments’ decisionmaking.

Telecommunications infrastructure raises different issues because it is largely privately provided. The role for government policy, then, is to complement private investment. Sometimes government action is needed to regulate a crucial resource such as the wireless spectrum—the part of the electromagnetic spectrum that allows wireless devices to communicate. In other cases, the govern-

ment needs to set the ground rules for private competition, especially in broadband markets with few service providers. Still other times government action is necessary to ensure that the benefits of telecom infrastructure are broadly shared, as with the expansion of broadband access to currently unserved households.

How Much Infrastructure Investment Should the Nation Undertake?

The numerous problems with our infrastructure mentioned above suggest that the optimal amount of infrastructure investment is higher than the current level of investment. However, it is difficult to determine the appropriate level of spending with any confidence.

One problem is that the effect of infrastructure on economic growth is uncertain in magnitude, even though that effect is clearly important. Infrastructure makes possible the transportation of goods and ideas across town and across the world; it brings water to houses and businesses and takes waste away; it provides heat and light; and it makes communication beyond shouting distance possible. However, the key question for public policy is not the benefits of our infrastructure as a whole, but the benefits of additional spending on infrastructure. This “marginal rate of return,” as economists call it, measures

how much each additional dollar spent on infrastructure contributes to economic growth. Unfortunately, estimating the marginal return to infrastructure is challenging and analysts disagree on the result. Recent research confirms that new infrastructure raises economic growth, but it points to a lower rate of return than some earlier work (CBO 2007). Moreover, public investment must be financed in a fiscally responsible way or, depending on the circumstances, it might crowd out private investment that would also contribute to economic growth, thereby reducing the net benefit of public action (CBO 1998). With large budget deficits looming, the need to balance competing national priorities and to use scarce resources wisely is especially acute.¹

A further obstacle to determining the optimal level of infrastructure investment is the lack of market signals. Private investment decisions are made based on expectations of demand for a good or service and the sales revenue that will flow from that demand. For most public investments, though, the signals of demand are misleading: because users of public infrastructure generally do not pay anything close to the full cost of their use, they tend to use the infrastructure more heavily than is efficient. This overuse sends distorted signals about the true demand for infrastructure.

Given these uncertainties, the right amount of infrastructure investment is often disputed. The National Surface Transportation Policy and Revenue Study Commission (NSTPRSC 2007) estimates that the nation should more than double annual public and private investment in physical infrastructure to bring the system to a reasonable level and make appropriate upgrades. The American Society of Civil Engineers (2005) estimated in 2005 that \$1.6 trillion would be needed over the subsequent five years to bring existing infrastructure up to acceptable standards. However, both of these estimates have been criticized for defining infrastructure “needs” indiscriminately and overstating the gains of infrastructure spending in their cost-benefit analyses (CBO 2008a; Peters, Cino, and Geddes 2007; Solomon 2008).

In the absence of a compelling method for calculat-

ing the appropriate level of infrastructure investment, comparisons to investment rates in other countries or to historical U.S. investment rates may be useful. Although comparable international data are difficult to obtain, it appears that infrastructure investment in the United States is close to the median of western industrial nations. U.S. public investment in transportation and water infrastructure stands at about 2.4 percent of GDP, a share that has remained consistent over the past twenty-five years. However, investment was somewhat higher in the past: the high point in the past fifty years was just over 3 percent of GDP in the early 1960s, a difference relative to the present GDP share of roughly \$70 billion per year in today’s dollars (CBO 2007). More relevant, perhaps, is net investment—that is, investment in new infrastructure less the depreciation of existing infrastructure. Estimates of net investment in physical infrastructure show a pronounced decline over time, from an average of nearly 2.5 percent of GDP in the 1970s and 1980s to around 1 percent in the 1990s (Bureau of Economic Analysis [BEA] n.d.). For telecommunications infrastructure, historical investment data are not readily available, and in any case probably do not speak meaningfully to today’s needs and opportunities.

These data suggest that infrastructure investment is likely below its appropriate level, but we do not attempt in this paper to estimate the optimal amount of infrastructure investment. Instead, we focus on ways to make better use of our existing infrastructure and of the existing flow of money into new infrastructure.

Why Does the Nation’s Infrastructure Appear to Be So Inadequate?

In addition to concerns about the overall amount of U.S. infrastructure spending, there are two principal reasons why the performance of our infrastructure is often a source of frustration and disappointment. First, we are not using existing infrastructure efficiently. The response of policymakers to road and airport congestion, for example, is sometimes to build more capacity. But economic theory predicts, and evidence confirms, that new road and runway capacity only temporarily al-

1. Unless the 2001 and 2003 tax cuts are allowed to expire, or relief from the expanding reach of the alternative minimum tax is abandoned, or substantial cuts are made in entitlement programs, the federal budget deficit will remain a substantial share of GDP in the coming decade and will worsen substantially thereafter (CBO 2008b).

leviates congestion (for example, see Noland and Cowart 2000). A better response to congestion may be to use existing highways and roads more efficiently. The key reason that highways are not used efficiently and that congestion returns even when new capacity is added is that drivers do not bear the costs of their decisions to use a road. Although fuel costs, fuel taxes, and vehicle maintenance costs rise with every mile driven, the other costs of extra driving—including accidents, pollution, and delays imposed on other drivers—are borne not by the individuals choosing to drive but by other drivers and by society as a whole. Making users pay the costs of infrastructure use more fully would lead to more efficient use of existing infrastructure and less need for infrastructure investment. The Federal Highway Administration (DOT 2007a) estimates that congestion pricing would cut annual infrastructure investment costs by 28 percent (\$22 billion). With regard to telecommunications, the wireless spectrum is a natural resource in fixed supply. Although the government cannot create more of this spectrum, it can free up more usable spectrum by improving the way in which it allocates spectrum and regulates use of spectrum.

A second reason for frustration and disappointment with our infrastructure is that we do not invest in infrastructure efficiently. Our decisions about how to invest our infrastructure dollars are not based consistently on cost-benefit analysis, are often poorly coordinated across levels of government, and are sometimes highly politicized. Under these conditions, even large amounts of infrastructure investment could be inadequate for building appropriate transportation and telecommunications systems. Despite the public attention paid to congressional earmarking, it made up only 5 percent of the last major infrastructure spending bill. The more fundamental problem is an overall decisionmaking process that lacks the appropriate incentives and accountability needed to guide resources to their highest-value uses. For example, in a recent survey of forty-three state transportation departments, the U.S. Government Accountability Office (GAO 2005) found that thirty-four cited political support and public opinion as factors of “great” importance in making investment decisions, while only eight gave as much weight to objective measurement of a project’s value through cost-benefit analysis. A related question is whether we are striking the right balance between investing in new capacity and

maintaining and repairing existing capacity. Although new projects may seem more politically attractive than maintenance, investment in new physical infrastructure capacity has declined over time relative to GDP, while operation and maintenance spending has held roughly constant.

A Strategy for Effective Infrastructure Investment and Use

The strategy advanced in this paper focuses on the two problems just identified:

- First, the United States must use existing infrastructure more efficiently. By doing so, the benefits of infrastructure for productivity and consumer well-being can be maximized, and the need for new infrastructure capacity can be reduced.
- Second, the United States must reform the way in which decisions about infrastructure investment are made. Through better decisions about how, where, and in what to invest, we can target new spending to the most cost-effective projects.

To be sure, increased investment in infrastructure may also be desirable. However, as noted above, neither this strategy paper nor the accompanying discussion papers released by The Hamilton Project directly address the overall level of infrastructure investment. Instead, both this paper and the accompanying ones focus on making better use of existing infrastructure and the money devoted to infrastructure investment. If implemented correctly, these changes can boost economic growth overall and help share more broadly the benefits of growth.

In Section 1, we describe three principles to guide infrastructure policy. As with investments in education and in research and development, infrastructure investments

- necessitate a role for the government, in part because benefits often accrue to society as a whole;
- have the potential to contribute to long-term economic growth if costs and benefits are evaluated carefully; and
- raise the standard of living of all Americans if the ad-

verse distributional effects of efficiency-promoting policies are offset, and if efforts are made to expand infrastructure access.

Section 2 presents some basic facts about infrastructure, with an emphasis on comparisons over time and across countries. Sections 3 and 4 apply our two-pronged strategy to physical infrastructure and telecommunications infrastructure, respectively. Turning first to physical infrastructure, we emphasize transportation issues and recommend the following specific policies in §3:

- Establish pricing mechanisms such as congestion fees and cost-based air traffic control fees to make infrastructure users pay a larger share of the true cost of their infrastructure use. Congestion fees, for example, would cause drivers to pay for the travel delays they impose on other drivers, thereby encouraging drivers to shift driving to other times or to reduce the number of nonessential trips. However, congestion pricing of roads would have a larger adverse effect on the budgets of low-income drivers than high-income drivers; part of the revenue collected should be used to offset that distributional impact. One proposal combining congestion pricing with compensation mechanisms for low-income drivers is presented in David Lewis's (2008) recent Hamilton Project paper, "America's Traffic Congestion Problem: A Proposal for Nationwide Reform." Although congestion pricing is controversial—as seen by its failure to be adopted in New York City—evidence from cities such as London suggests that further public education about its advantages combined with attention to its distributional effects may make it more politically palatable over time. In another recent Hamilton Project paper, Jason E. Bordoff and Pascal J. Noel (2008) advocate switching the pricing of auto insurance to a "per-mile" basis rather than the current pricing system of mostly flat rates. In "Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity," they estimate that nationwide adoption of this system would reduce total miles driven by about 8 percent and cut insurance premiums for two-thirds of families and an even larger share of low-income families.

- Manage public investments in road travel and air travel more effectively. For roads and highways, this includes allocating responsibility among the federal, state, and local governments according to the geographic span of benefits and costs arising from infrastructure issues, as well as providing incentives for directing government funding to the highest-value projects. For air travel, this includes separating the operation and regulation of the air traffic control system so that operators can use a businesslike approach to serving customers while regulators can focus on establishing rules to ensure safety. In a recent Hamilton Project paper "Creating a Safer and More Reliable Air Traffic Control System," Dorothy Robyn (2008) presents the rationale and means of implementing this change. She also makes the case for cost-based pricing for use of the air traffic control system.

Improving the nation's infrastructure will require national leadership on two fronts: using existing infrastructure more efficiently and making better decisions about how to invest in infrastructure.

Turning next to telecommunications infrastructure, our two-part strategy points to these specific policies in §4:

- Make better use of the wireless spectrum. In a recent Hamilton Project paper "The Untapped Promise of Wireless Spectrum," Philip J. Weiser (2008b) proposes steps to free up wireless spectrum for more valuable uses. One crucial step in this direction is to shift spectrum allocation from industries and firms that had good historical reasons for controlling parts of the spectrum to industries and firms that can put that spectrum to the most valuable use today. Another step is to adopt a more flexible approach to avoiding interference among spectrum users; this shift could better balance the costs of possible interference against the benefits of fuller spectrum use. The potential benefits of using spectrum more efficiently are large: one study found that only 13 percent of

the most valuable mass of spectrum was in use during any part of a four-day period in New York City (McHenry, McCloskey, and Lane-Roberts 2005).

- Consider ways in which targeted government subsidies could encourage private firms to expand broadband access to unserved rural areas. As more people gain broadband access and Internet content is increasingly designed for broadband users, Americans who have only dial-up access to the Internet will not only miss out on new opportunities, but also may eventually suffer from an outright decline in Internet usability. Just as the government has facilitated low-cost mail delivery, electrification, and the provision of other services to rural areas, so it can facilitate access

to the key information source of the twenty-first century. In a recent Hamilton Project paper, “Bringing Broadband to Unserved Communities,” Jon M. Peha (2008) presents an innovative auction mechanism for increasing broadband coverage at the lowest possible public cost.

The nation’s infrastructure problems are daunting, but solvable. The United States has an opportunity to channel public concern and frustration into a national infrastructure strategy that promotes infrastructure as a central component of broadly shared growth. This strategy paper lays out many of the key elements of a successful plan.

Section 1. Principles for Infrastructure Policy

In previous papers, The Hamilton Project has examined government policies for investment in education and in research and development (Bendor, Bordoff, and Furman 2007; Bordoff et al. 2006; Furman et al. 2007). Investment in infrastructure should be guided by the same general principles: a critical role for government, in part because benefits often accrue to society as a whole; the potential to contribute to long-term economic growth if costs and benefits are evaluated carefully; and an opportunity for public policy to promote growth that is broadly shared. We examine each of these principles as they relate to infrastructure investment.

Government Has a Critical Role to Play

Several distinctive aspects of infrastructure create a critical role for the government. First, infrastructure tends to involve high fixed costs that can deter private sector entry or competition. For example, most areas of the country require only one highway between two points. After that first highway is built, the upfront costs of building another are so high that no competitor to the first highway will emerge. Similarly, electrical power and water and sewerage services generally have only one provider in each local area, and the air traffic control system must be administered by a single organization rather than competing ones. Economists call these types of markets “natural monopolies” because the innate characteristics of the good or service imply that only one provider can operate efficiently at a time. Natural monopolies pose the same problem as all monopolies: lack of competition drives up prices for consumers and may stifle innovation. The government has two options in this situation: it can provide the good itself, as it does with most roads, or it can regulate pri-

vate providers, as it does with telecommunications and electricity distribution facilities.

Second, infrastructure often generates costs and benefits that extend beyond users and producers. The existence of these costs and benefits—termed “externalities” by economists—means that private markets alone will not generate the optimal amount of these goods and services. For example, network effects and other positive externalities mean that private markets may not produce a sufficient amount of broadband capacity. This insufficient broadband deployment, Peha (2008) explains, is one reason local municipalities have considered investing in wireless metropolitan-area networks. Meanwhile, Lewis (2008) argues that the negative externality of road congestion means that drivers will tend to drive too much, and he proposes that the government address this overuse with congestion pricing.

Third, the government intrinsically controls some key infrastructure resources, such as the electromagnetic spectrum. Finally, government action is often needed to ensure that the benefits of infrastructure are broadly shared. We return to this issue later in this section.

These motivations for government involvement in infrastructure also point to appropriate government policy, which includes responding to market failures and financing investment.

Addressing market failures. Private markets are the foundation of our economy, but governments need to step in where markets alone are not sufficient. Because many of the issues just discussed are aspects of what economists term “market failure,” the best response is

often to fix the failed market by delineating property rights, setting prices equal to costs, and using market mechanisms in other ways. For example, in managing the wireless spectrum the Federal Communications Commission (FCC) controls what kind of services and companies can operate in which bandwidths. But Weiser (2008b) notes that the FCC's approach would be analogous to the government reducing traffic congestion by mandating who can drive when. This approach would reduce congestion, but unlike the alternative approach of congestion pricing, it does not accomplish the broader goal of maximizing economic productivity from highways. Similarly, Weiser argues, the FCC should encourage private negotiation and secondary market activity regarding spectrum use to maximize the productivity of this resource.

Making decisions about investment and financing.

In addition to addressing market failures, government policy plays a crucial role in financing infrastructure investment and in deciding or influencing what investments to make. Some observers have proposed

finances current consumption without notable long-term returns.

However, opponents of this approach raise important objections. First, many types of government outlays generate future dividends, including education, health care, and defense. Thus, it seems likely that the term “investment” would be applied widely, a large share of spending would end up in the capital budget, and imposing fiscal discipline would be very difficult. Second, the analogy to private budgeting practices is somewhat illusory. The social benefits that are relevant to the government's decisions are more difficult to quantify than private benefits, and they do not always manifest themselves as more revenue to the government in the same way that private investments appear as more revenue to firms. Third, changing accounting rules does not alter the underlying fiscal constraint: the government needs to balance the present value of all expenditures (including capital expenditures) with the present value of all future revenues.²

To ensure that infrastructure investment contributes to broad-based growth, the government should compensate low-income families for the adverse effect of policies intended to promote efficient use of infrastructure.

removing infrastructure investment decisions and financing from the regular federal budget process by adopting a separate capital budget for government investments. These advocates note that capital budgeting is used by private corporations and by state governments, and they argue that a federal capital budget would promote better decisionmaking by distinguishing “good borrowing”—the kind that potentially pays for itself through the returns of higher productivity—from “bad borrowing”—the kind that

In our view, “stand-alone” projects such as toll roads that pay for themselves over time could appropriately be evaluated in a capital budgeting framework—although the distributional effect of the tolls is an important issue for government consideration. However, capital projects that do not impose sufficient user fees to pay for themselves would draw on public resources that could be used instead for other purposes. Perhaps the projects would be funded by forgoing some other immediate spending or raising current taxes; perhaps they would

be funded by borrowing against the full faith and credit of the U.S. government. Under any of these scenarios, we think that the benefits of these projects should be evaluated alongside the benefits of other uses of public money in the regular budget process.

Other observers seek to improve infrastructure decisions through a national infrastructure bank or central commission to oversee the evaluation and funding of infrastructure projects.³ We understand the appeal of

2. The President's Commission to Study Federal Capital Budgeting (1999) recommends against a federal capital budget for many of the reasons cited here.

insulating infrastructure decisions from the political process, since such insulation might reduce earmarking and promote decisions based on cost-effectiveness. However, we are unsure that these proposals would actually achieve political insulation. As the history of the Federal Reserve demonstrates, institutional independence and credibility require time, experience, and careful design. Moreover, it is not clear that centralizing decisionmaking in a federal body would produce better results than helping states and metropolitan areas improve the way in which they make decisions, given that these areas are likely to have a better understanding of their own infrastructure needs.

Indeed, we think that the quality of infrastructure decisionmaking can be improved considerably through at least three other mechanisms. First, responsibility for each aspect of infrastructure should be assigned to the level of government that best corresponds to the breadth of benefits and costs for that part of infrastructure. For example, mitigation of greenhouse gases from transportation should be part of a federal decisionmaking process because climate change extends beyond state and local boundaries. But decisionmaking regarding traffic congestion should be split among different levels of government because it affects both local productivity and national priorities such as interstate freight. Second, the federal government should remove the distortions it imposes on decisionmaking by state and local governments. For example, as we discuss in detail in Section 3, the federal government should equalize the subsidy rate for highway and mass transit projects rather than favoring the former, as is done today. Third, the federal government should use the leverage that comes with its financial contribution to infrastructure investment to hold state and local governments accountable for effective decisionmaking, especially on issues of national interest.

Another issue regarding the government's role in infrastructure investment is the appropriate interaction between the public and private sectors. As noted in the introduction, this answer will necessarily be different for telecommunications infrastructure, which is largely

privately funded, than for physical infrastructure, which is largely publicly funded. With appropriate incentives and regulations, the private sector may be quite effective at making efficient decisions, enhancing projects' cost effectiveness, and providing high-quality services. For example, public-private partnerships have become more common with physical infrastructure during the past decade. Such partnerships have the potential to share risk, improve service, and depoliticize decisions (GAO 2008). However, they also raise questions about the effect of private monopolies on consumers and about the appropriate rate of return for private companies.

In addition to public-private partnerships, another method of private sector involvement is through government incentives to accomplish specific public goals. For example, Peha (2008) recommends government incentives to private companies to continue the build-out of broadband access. Still, the government needs to decide if and how to regulate firms that effectively become monopoly providers in rural areas.

Infrastructure Investment Can Contribute to Long-Term Economic Growth

Like other investments, investment in infrastructure can yield significant benefits for years to come. Those benefits can be seen in economic growth and output as measured by statisticians. They can also be seen in aspects of household well-being not captured by conventional statistics. Moreover, the benefits can be generated both through the creation of new infrastructure and through the maintenance of existing infrastructure.

However, the greatest benefits will accrue only to the extent that the investment is well targeted. Creating infrastructure that is not the most useful sort, is not located in the most useful place, or is not produced in the most efficient way will make a smaller contribution than infrastructure that more clearly satisfies the criteria of usefulness and efficiency. Political support may not provide proper signals about the relative advantages of different infrastructure projects. Therefore, the key to making successful investment decisions is evaluating

3. The National Infrastructure Bank Act of 2007 proposes a national bank to vet regional and national infrastructure projects and fund selected ones through subsidies, loans, and bonds. Related proposals include a national infrastructure agency or commission to be staffed by expert project evaluators who would review proposals and provide grants and loans to states and localities for specific projects.

the costs and benefits of certain projects compared with others.

These cost-benefit calculations should encompass numerous considerations. The expected contribution to future productivity and output is important. Some of these contributions will be direct, such as new highway enhancing just-in-time inventory management in a region. Other contributions will be indirect, such as better access to online education enhancing the skills of future workers. Beyond productivity and output, the expected effects on quality of life are important, including the effects on commuting time, accident risk, pollution, access to education and medical care, and cultural and social interactions. The vulnerability of existing and proposed infrastructure to homeland security concerns is also relevant. Moreover, costs and benefits depend on how efficiently infrastructure is constructed, which in turn depends on the incentives in place for contracting firms and public managers.

One challenge in this cost-benefit analysis is distinguishing the marginal return (the benefit of an additional unit of new infrastructure) from the average return (the benefit of an average unit of existing infrastructure). The existence of high average returns does not demonstrate that marginal returns are also high. Construction of the Interstate Highway System, initiated in the 1950s, had high returns to investment because those highways connected the nation in a new way and significantly improved the efficiency with which people, goods, and ideas could move. But building additional highways at the same time would have had low returns, because the extra highways would have been largely unused. Indeed, Fernald (1999) finds that new additions to the highway system after its initial completion in 1973 had little effect on productivity growth compared with effects prior to that time. However, with the passage of time and significant population and economic growth, building more highways may have high returns again either now or in the future. Broadband deployment is now in its formative stages, much as highway development was in the 1950s and 1960s, so marginal returns to this deployment may currently be very high. Crandall and Jackson (2001), for example, estimate that faster rollout of near-universal broadband access could produce benefits of \$500 billion in net present value.

The short-term effect of infrastructure projects on employment usually should not be central in these cost-benefit calculations. Under some circumstances, creating jobs via infrastructure investment may provide desirable short-term economic stimulus, or it may protect vulnerable workers suffering from a downturn in economic activity or decreased demand for their particular skills and experience. Under normal circumstances, however, the overall regulation of the economy is best left to monetary policy, which provides general stimulus throughout the economy, rather than through infrastructure investments. In these circumstances, additional employment in some particular infrastructure project may come at the expense of employment in some other activity and may not represent an increase in overall employment.

Infrastructure Investment Can Raise the Standard-of-Living of All Americans

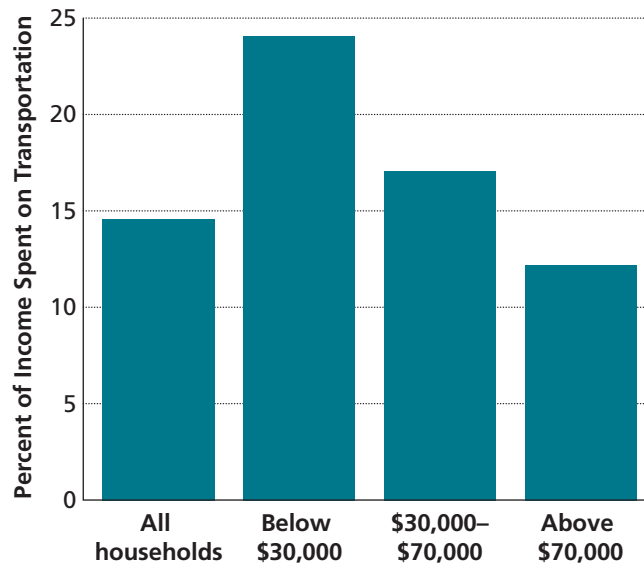
Since its inception, The Hamilton Project has emphasized that long-term prosperity is best achieved by making economic growth broad-based. The government can help ensure that infrastructure investment contributes to broad based growth in two ways: it can offset the potential adverse distributional effects of policies to promote efficient use of infrastructure, and it can make additional efforts to expand access to infrastructure. We consider these issues in turn.

Offsetting potential adverse distributional effects.

A central theme of this paper is the imperative to establish prices for infrastructure use that reflect the true cost of that use. In some cases, appropriate price signals will reduce burdens on low-income people. For example, Bordoff and Noel's (2008) proposal for per-mile auto insurance premiums would lower insurance premiums for people who drive less than average, and low-income people tend to drive less than high-income people. But since most transportation expenses are regressive, in other cases appropriate price signals will increase burdens on low-income people unless offsetting actions are taken. Figure 1 shows that households with income under \$30,000 spend almost one-fourth of their income on transportation, while households with income above \$70,000 spend just one-eighth of their income on transportation.⁴ Similarly, Roberto (2008) finds that the working poor spend 6.1 percent of their

FIGURE 1

Transportation Expenses as Percent of Household Income, 2006



Source: Bureau of Labor Statistics 2006.

income on commuting, and the working poor who drive to work spend 8.4 percent of their income, compared with 3.8 percent for other workers.

Given the regressive nature of transportation expenses, efficiency-promoting policies that increase the price of transportation could impose hardship on low-income households unless those households are compensated in some way. For example, Lewis (2008) shows that congestion pricing would impose a larger burden, relative to income, on lower-income households. To address this concern, he proposes indirect and direct mechanisms through which some of the revenue generated by congestion pricing would be returned to low-income people. Indirect mechanisms include investment in mass transit, which could work especially well in metropolitan areas like New York City that have robust transit systems used by low-income commuters. Direct mechanisms include lump-sum tax refunds, which would be especially important in metropolitan areas where low-income workers have few alternatives to driving to and from work. Since they are not tied to an individual’s driving level, these compensation mechanisms could

offset the regressive effects of congestion pricing without blunting the incentives that pricing provides to change driving behavior.

Expanding access to infrastructure. In addition to remedying the adverse distributional effects of efficiency-enhancing policies, the government should make efforts to expand access to infrastructure. Some policies of this sort would also boost the efficiency of infrastructure investment. For example, federal infrastructure funding now provides a higher match for highway projects than for mass transit projects, distorting states’ infrastructure decisions in favor of highways. Since low-income individuals are more likely to use transit, eliminating this bias toward highways could enhance both efficiency and distributional equity (Sanchez, Stolz, and Ma 2003).

Other access-expanding policies may have smaller effects on overall output and efficiency but would ensure that more Americans benefit from the infrastructure that might otherwise elude them. For example, the government should facilitate communication and trans-

4. Data from Bureau of Labor Statistics (2006). Vehicle purchases account for about one-third of transportation expenditures, followed closely by other vehicle expenses (including insurance and maintenance) and spending on gasoline. Spending on public transportation is on average less than one percent of household income.

portation for elderly individuals and persons with disabilities. As Linda Marsa points out in the *Los Angeles Times* (“Aging Under a High-Tech Eye,” October 11, 2007), broadband has made possible numerous advances in technology to help elderly Americans age in place. These advances include sensor systems to track movement and monitor vital signs, as well as webcams and videoconferencing to connect them with family members. Litan (2005) estimates that expanding broadband use among seniors and persons with disabilities would generate \$927 billion in benefits by 2030 by lowering health care costs, postponing the need for institutional care, and increasing workforce participation. To expand the benefits of telecommunications to all individuals, the government should require that telecommunications devices have universal accessibility features useful to persons with disabilities.

The government could also facilitate broadband access for people living in rural areas. Though broadband is becoming an increasingly important part of modern life, firms have little incentive to expand broadband services to rural areas since deployment costs are at least 50 percent higher per subscriber in these areas than in urban areas (Kruger 2008; Office of Management and Budget [OMB] 2005). In the 1930s, the Rural Electrification Administration was charged with promoting electrification in places where private firms had little incentive to provide services. At the beginning of the twenty-first century, it may be time to extend this goal to broadband access. With an estimated 10 million households excluded from viable access to broadband, the government would have to increase its support for broadband deployment to reach near-universal service in the twenty-first century (Peha 2008).

Section 2. U.S. Infrastructure Spending

Examining trends in U.S. spending on infrastructure can provide important context for concerns about the level and allocation of current infrastructure spending. Comparing U.S. infrastructure spending to infrastructure spending in other countries can also provide such context, although differences across countries in demography and geography complicate the interpretation of such comparisons.

One striking fact about infrastructure spending is that public outlays for telecommunications infrastructure pale in comparison to public outlays for physical infrastructure. Public spending on physical infrastructure exceeds \$280 billion per year, while direct public support for telecommunications is estimated at less than \$10 billion per year (CBO 2008a; Kruger and Gilroy 2008). This difference is partly a result of historical accident. Cable companies and telephone companies originally served distinct purposes, but they found that their existing lines could also be used to provide Internet access. Thus, competition arose in an industry that might otherwise have been a natural monopoly, reducing the need for government regulation and involvement. As a result, private provision of Internet services has become standard, in contrast to predominantly public provision of highways.

Physical Infrastructure

We examine, in turn, current spending, international comparisons, and trends over time for physical infrastructure.⁵

Current spending. The major categories of physical infrastructure are transportation, water and sewerage systems, and energy infrastructure. In 2004, total spending on transportation was at least \$210 billion, total spending on drinking water and sewerage at least \$76 billion, and new capital spending on energy \$78 billion.⁶ Ninety percent of new capital spending on energy comes from private sources. The Brattle Group estimates a need for \$1.5 trillion in energy investment over the next twenty years for distribution, transmission, and generation given increased demand (Fox-Penner, Chupka, and Earle 2008). In contrast to energy infrastructure, the vast majority of transportation spending comes from public sources; water infrastructure is also dominated by public investment.

Gross public spending on transportation and water and sewerage systems, including spending on new capital and operation and maintenance of existing capital, constitutes 2.4 percent of GDP. About 1.7 percent of GDP is devoted to transportation and about 0.7 percent to water supply and sewerage (see Figure 2). Within transportation, highways account for by far the largest share of spending at 1 percent of GDP. Spending on mass transit (minus rail) is roughly 0.35 percent of GDP, spending on aviation is about 0.25 percent of GDP, and spending on water transportation and on rail (passenger and freight) are each less than 0.05 percent of GDP.

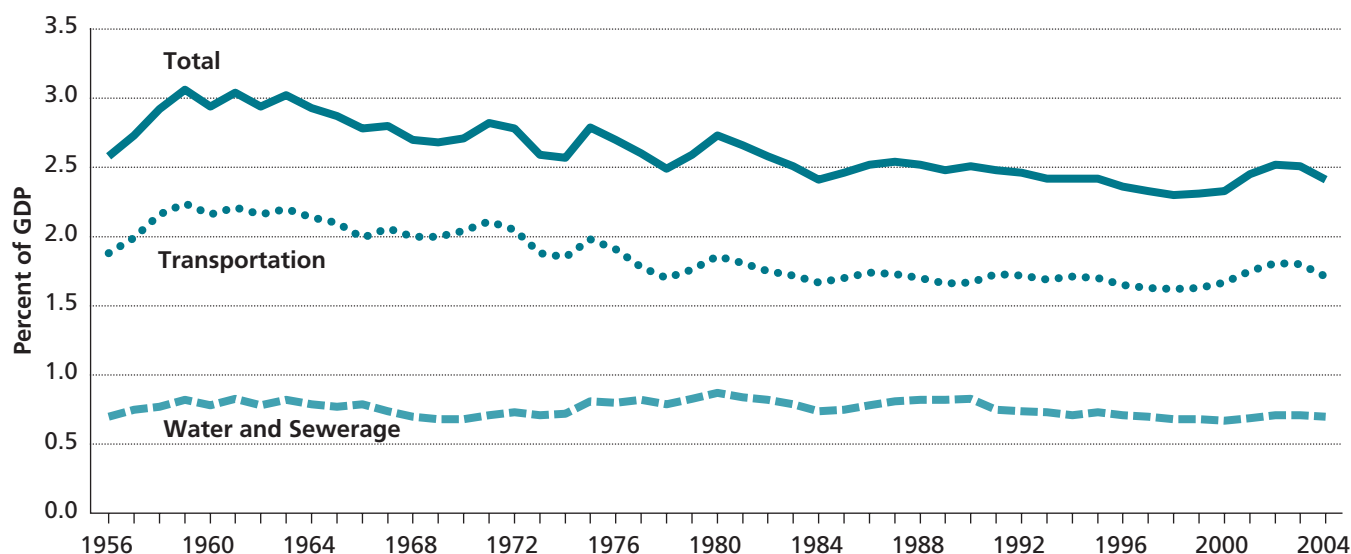
Despite the intense focus on federal earmarking and spending, the majority of infrastructure spending hap-

5. Data in this subsection come from CBO (2007, 2008a), unless otherwise noted.

6. These figures include both public and private spending. The figure cited for energy infrastructure does not include spending on operation and maintenance.

FIGURE 2

U.S. Public Spending on Transportation and Water Infrastructure, 1956–2004



Source: CBO 2007.

Note: Total spending is the sum of transportation spending and spending on water infrastructure.

pens at the state and local level. State and local spending on infrastructure constitutes three-fourths of total public infrastructure spending. The remaining fourth originates at the federal level, with one-third of these federal funds in the form of direct federal spending, and two-thirds in the form of federal grants and loan subsidies to state and local governments. In addition to differing in magnitude, federal spending and state and local spending differ in their focus. Federal spending on infrastructure is focused on investment in new capital, while state and local spending is focused on operation and maintenance of existing infrastructure, especially highways and roads.

International comparisons. OECD data on gross fixed capital formation minus investment in housing, machinery, and equipment place the United States at about 7 percent of GDP, near the median of western industrial nations (OECD 2008b).⁷ To be sure, this highly aggregated measure should be interpreted with caution because it does not allow us to completely

isolate infrastructure investment and does not account for such potentially important factors as geographic area or population density.

Trends over time. In the past half century, U.S. physical infrastructure spending has declined as a share of the economy and has shifted in focus. In the 1960s, construction of the national highway system led to gross public investment in infrastructure of about 3 percent of GDP; that level of investment has gradually dropped to its current level of 2.4 percent of GDP. While water infrastructure investment has remained virtually constant as a percent of GDP since the 1960s, transportation investment has declined since that time, primarily because of decreased spending on highways (see Figure 3).⁸

These figures, however, do not take into account depreciation—the decline in the value of an asset because of wear and tear or approaching obsolescence. According to some estimates, net investment—gross investment

7. After removing those three components (housing, machinery, and equipment), the remaining investment consists largely of items that constitute infrastructure, including roads, bridges, airfields and dams.

8. Highway spending reached a peak of 1.75 percent of GDP in the 1960s during the construction of the interstate system; since the 1980s, it has hovered at 1 percent of GDP. Investment in mass transit and aviation, in contrast, has increased as a percentage of GDP. Mass transit spending has risen from 0.10 percent of GDP in the 1960s to nearly 0.40 percent today, while aviation spending on airports and runways has increased from 0.20 to 0.25 percent of GDP over that time. Investment in rail and water transportation has remained roughly constant over the past half-century.

minus depreciation—has been highly volatile over time. On average, however, as shown in Figure 4, net infrastructure investment fell from nearly 2.5 percent of GDP in the 1970s and 1980s to around 1 percent in the 1990s. Roughly comparable estimates suggest that net infrastructure investment may have picked up again in recent years (BEA n.d.).

Over time spending has shifted relatively from new capacity to operation and maintenance of existing capacity (see Figure 5). While gross operation and maintenance spending has remained fairly constant around 0.85 percent of GDP, gross investment in new capacity has declined markedly—from 1.25 percent of GDP in the 1960s to its 1980s level of 0.80 percent; it remains around that level today. Transportation investment as a whole has undergone a shift to operation and maintenance, but new capital spending has actually risen for mass transit and aviation while falling for highways and water transportation.

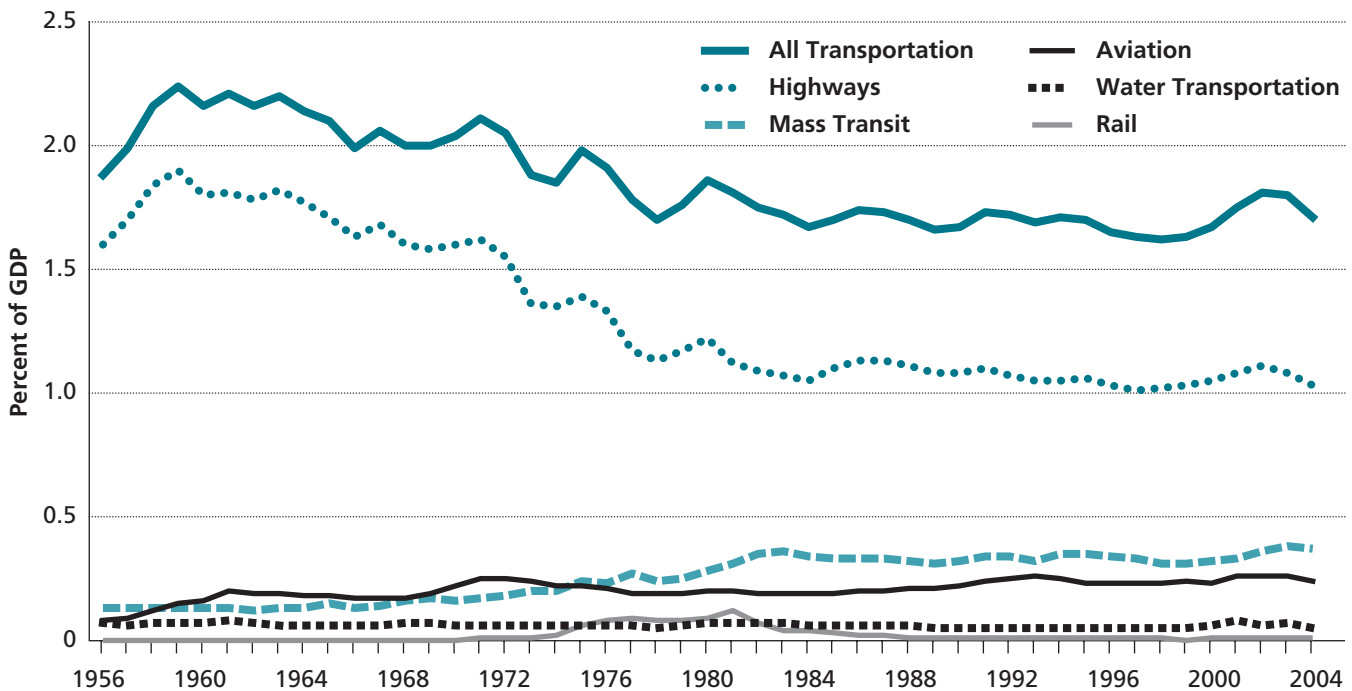
It is clear that investment in physical infrastructure has

declined over the past half-century, as has the share of investment allocated to new capacity rather than existing capacity. What is unclear is whether this trend implies a need for significant increases in investment, or whether it is a natural outcome of a developed infrastructure system and a reflection of the relative importance of other national priorities. And even if spending on physical infrastructure is increased, reforms focused on using existing infrastructure and investment dollars more efficiently would likely yield even larger returns.

Telecommunications Infrastructure

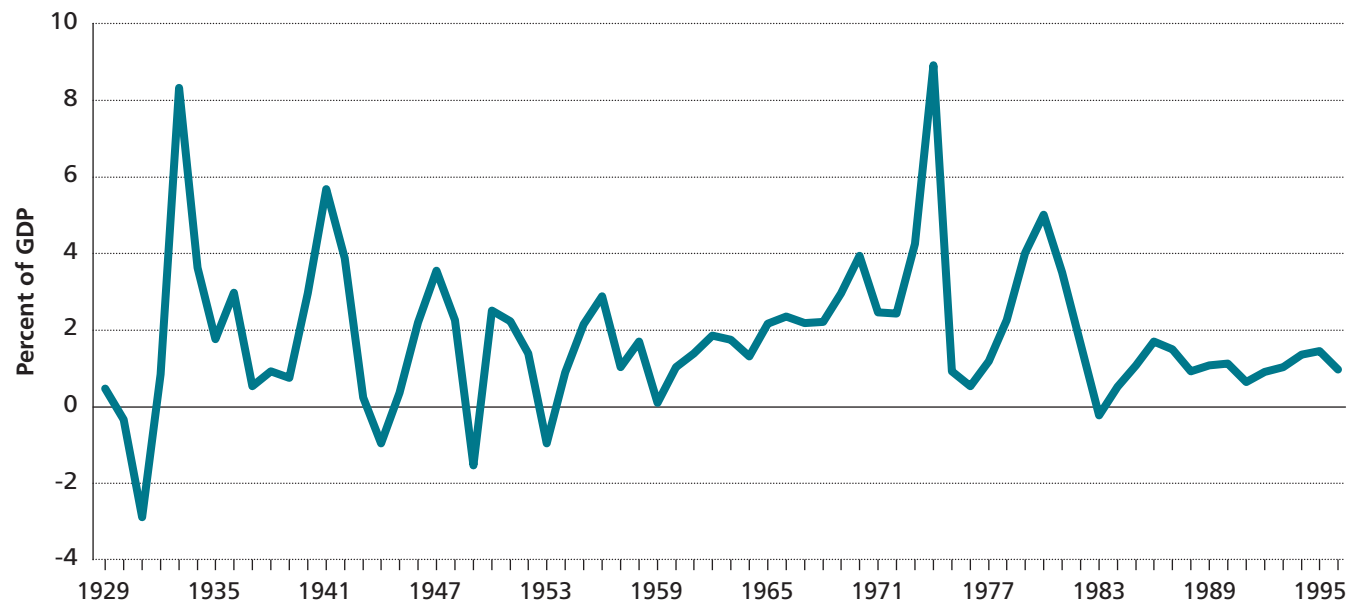
In contrast to physical infrastructure, telecommunications infrastructure has undergone important transformations in the past two decades, most significantly with advances in technology making Internet access faster, more affordable, and more portable. The vast majority of investment in telecommunications infrastructure has been from private firms racing to meet the spectrum and broadband demands of consumers. Spectrum, the natural electromagnetic radiation that allows devices

FIGURE 3
U.S. Transportation Spending by Mode, 1956–2004



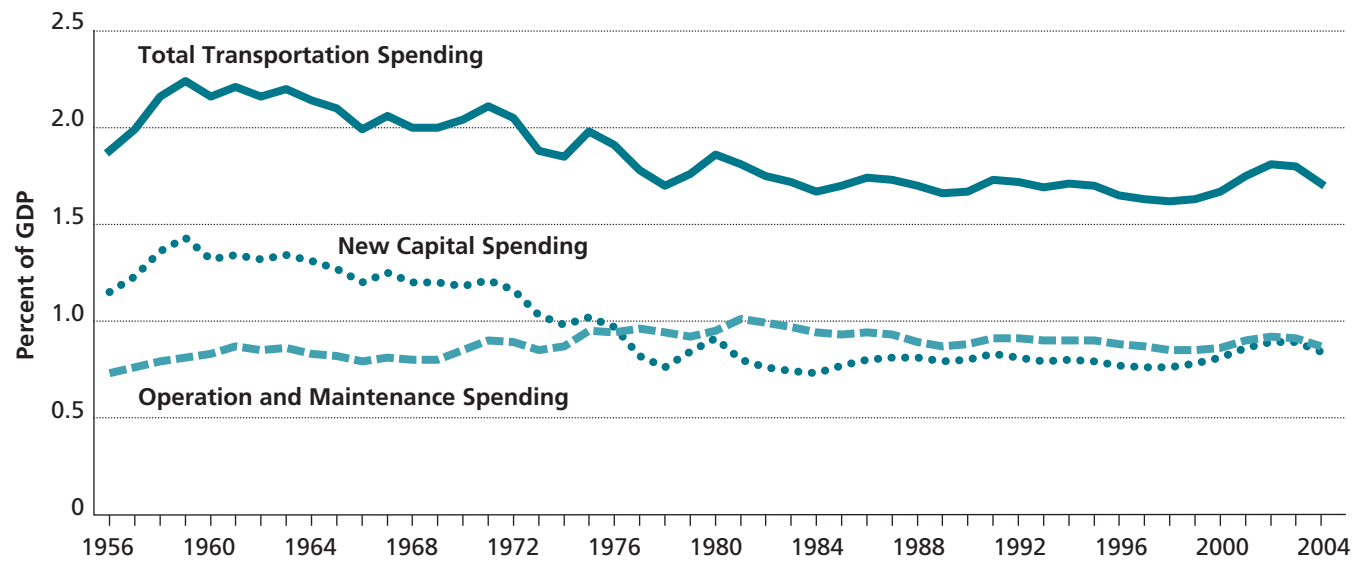
Source: CBO 2007.

FIGURE 4
U.S. Net Public Infrastructure Spending, 1929–96



Source: BEA n.d., Fixed Asset Tables.
 Note: Includes highways and streets; water and sewerage systems; transit; electric and gas facilities; and airfields.

FIGURE 5
U.S. Transportation Spending, Comprised of New Capital and Operation and Maintenance, 1956–2004



Source: CBO 2007.

to communicate, has spurred the development of new technologies and has in turn increased in value with the advent of new technologies. The wireless spectrum auction conducted by the FCC in March raised more than \$19 billion from private companies providing wireless services.

Investment in broadband and telecommunications more generally has proceeded with minimal government support. However, government has an important indirect role in telecommunications through regulatory policy. In the past dozen years, regulatory policy has shifted in focus from intramodal competition to intermodal competition among cable, telephone, and newer entrants like wireless. The federal government has largely deregulated the primary providers of broadband service; the Telecommunications Act of 1996 deregulated cable companies, while a number of more recent court decisions have deregulated telephone companies.

The federal government also provides some direct telecommunications support. The Universal Service Fund (USF), expanded by the Telecommunications

Act of 1996 and administered by the FCC, is the government's largest program for telecommunications deployment. Aimed at providing affordable universal telephone service, the USF High Cost Program helps to upgrade telephone networks in high-cost rural areas, and through these networks indirectly supports broadband expansion. In 2007, the High Cost Program provided \$4.3 billion to states to upgrade telephone networks. USF's Schools and Libraries Program and its Rural Health Care Program, which together provided \$1.8 billion to states in 2007, focus on connecting rural education and health facilities to telecommunications services, including broadband access (Universal Service Administrative Company 2008). However, as discussed later, the USF has come under substantial criticism for ineffective distribution of funds. Through the U.S. Department of Agriculture (USDA), the government also administers two funds dedicated specifically to broadband deployment. The USDA (2008) estimates that it has provided \$6 billion since 2001 for telecommunications infrastructure, especially broadband deployment, in rural areas.

Section 3. Reforming Physical Infrastructure Policy

The two central elements of our proposed infrastructure strategy are to use existing infrastructure more efficiently and to make better decisions about infrastructure spending. Appropriate price signals can enhance the efficiency with which infrastructure is used. In many cases, these prices will also raise government revenue, but that is not their purpose: once proper price signals are established, the revenue for infrastructure improvements does not need to come from infrastructure at all. Price signals can also indicate areas of greatest demand for infrastructure, helping to improve decisionmaking. However, the main route to better infrastructure investment decisions is through improving the incentives of the political process.

In this section, we apply this two-pronged approach to physical infrastructure. We begin with ways of making better use of existing roads and highways and of the existing aviation infrastructure. We then turn to ways to improve decisionmaking about investments in roads and highways and in aviation. We leave aside issues of energy, water, and sewerage systems due to a lack of space, not a lack of interest. The reliability of the nation's electricity grid affects virtually all Americans, and the eight states that depend on the drying Colorado River Basin are experiencing rapid population growth. Water and energy infrastructure, however, do have some significant differences from transportation infrastructure. Central to solving the water and energy problems is using the natural resources themselves wisely, rather than just the infrastructure that transports them. Pricing water and energy in a way that reflects the costs of their use, and making these prices visible to consumers, could go a long way to mitigating the effects of water shortages and reducing strain on the energy grid (Olmstead and

Stavins 2008; U.S. Department of Energy 2006).

Using Existing Surface Transportation Infrastructure More Efficiently

In addressing the state of the nation's infrastructure, the political system tends to reward the addition of new capacity since it is easy for constituents to take note of new construction. When politicians feel pressured to address traffic congestion, they may construct new highway lanes or alternative roads. Drivers experience a temporary alleviation in congestion, perhaps long enough to credit the politicians in charge with easing the daily strain of commuting. It may not be until these politicians have left office that the added capacity generates more demand for driving and eventually leads to a similar amount of congestion.

An alternative option for reducing congestion—using existing roads more efficiently—is often better policy but worse politics. Politicians are wary of this option since drivers see no tangible improvements to the road system. Instead, they face the prospect of paying to do something they have always done for “free.” But unlike adding new capacity, which will eventually lead to a similar amount of congestion, congestion pricing creates an efficient, long-term reduction in congestion by requiring drivers to consider the costs that their driving imposes on others. It can also depoliticize infrastructure decisions by signaling areas of greatest demand and leading policymakers closer to the optimal level and allocation of investment (Peters et al. 2007; Winston 1991).

Costs of overuse. Overuse of the nation's roads and

highways produces numerous costs to society. By far the largest costs of driving are those from congestion and accidents. Economists and urban planning experts have long lamented the productivity losses and psychological strains of traffic congestion. Lewis (2008) notes that perhaps as important as actual time delays is the uncertainty caused by these delays. Congestion also raises shipping costs as companies allot extra time for just-in-time deliveries and stockpile goods for fear new inventory will not arrive on time. By one estimate, traffic delays cost motorists, truckers, and shippers \$40 billion a year (Winston and Langer 2006); another estimate puts congestion costs at \$78 billion per year (Schrank and Lomax 2007). Accidents are another major cost of highway overuse from the perspective of other drivers. In a study of external costs from automobile use, Ian Parry, Margaret Walls, and Winston Harrington (2007) estimate congestion costs at 5 cents per mile and external accident costs at 3 cents per mile.

In addition to other drivers on the road, taxpayers and society also face external costs from an individual driver's decisions. Taxpayers, for example, must pay for the pavement damage caused by cars and trucks traveling on the road. The costs of pavement damage depend on type of road and vehicle characteristics, varying from less than 0.1 cent per mile for automobiles on rural roads to nearly 41 cents per mile for the heaviest trucks on urban roads (DOT 2000). Society as a whole faces energy security costs associated with oil use, as well as poor visibility and health risks from local pollutants and climate change from greenhouse gas emissions. Parry and colleagues (2007) estimate energy security costs of oil use at 0.6 cents per mile, local pollution costs at 2 cents per mile, and greenhouse gas costs at 0.3 cents per mile.

Reason for overuse. Overuse of highways and roads occurs largely because drivers are not required to pay the full costs that their driving imposes on other drivers and on society. Drivers do not have to ask for permission to drive more from other drivers, who

face increased travel delays and accident risks; from taxpayers, who pay for pavement damage; or from society, which faces energy security threats and suffers the consequences of local pollution and climate change. Current user fees, which consist mostly of heavy vehicle fees and motor fuel taxes, are poor proxies for the social marginal cost of road use. Motor fuel taxes are aimed at raising revenue for highway construction and do little to promote efficient use of highways.⁹ For example, only about 40 percent of reduced fuel consumption in response to higher fuel prices comes from driving less; the rest comes from switching to more fuel-efficient vehicles (Johansson and Schipper 1997). The current

The goal of surface transportation policy should be to make drivers confront the costs they impose on others, including congestion delay, accidents, pavement damage, dependence on oil, and pollution.

low level of motor fuel taxes is therefore unlikely to make an appreciable difference in driving behavior. The current average user fee is only a few cents per vehicle mile traveled (VMT), but the full costs of using highways during congested times is on average 13 to 29 cents per VMT (HDR|HLB Decision Economics 2005).

Policy response. The goal of surface transportation policy, then, should be to make drivers confront the costs they impose on others. To promote use of infrastructure that is more efficient, the government should require drivers to pay for the full costs of driving, including traffic delays, accidents, pavement damage, energy security risks, and pollution and climate change. VMT fees, for example, could address multiple externalities at once by charging based on distance traveled as well as a host of other variables. VMT fees could alleviate congestion by varying based on time of day, reduce pavement damage

9. Heavy vehicle user fees, though more targeted, still do not reflect the full extent of the pavement damage caused by trucks. Combination trucks heavier than eight thousand pounds, for example, pay only 70 percent of their cost responsibility, while smaller vehicles like passenger cars overpay by up to 50 percent (DOT 1997). Creating efficient heavy vehicle user fees would require not only increasing fees on heavy trucks but also accounting for variables, like number of axles, that affect the extent of pavement damage.

by charging more for heavy vehicles, and mitigate local pollution and greenhouse gas emissions by charging more for “dirty” vehicles. Technological advancements are making this formidable goal increasingly possible.

A national VMT fee system should start with incentives for nationwide congestion pricing. The goal of congestion pricing is not to eliminate all congestion, since some congestion is desirable for coordination of business hours and overall efficient functioning of an economy. Rather, the goal is to make drivers internalize the cost of the extra congestion they impose on others, so that they decide to drive only if their benefits from driving exceed the social costs imposed by their driving. The result would be to reduce congestion to a level that allows drivers, especially those with a high value of time, to engage in activities that are more productive than sitting in traffic. Lewis (2008) proposes that the federal government encourage congestion pricing by lowering the federal match ratio for new roads built without congestion pricing. He estimates that a national pricing system could yield net benefits between \$7 and \$16 billion annually; this number may be higher taking into account land use changes (Langer and Winston 2008).

In implementing congestion pricing, policymakers should be aware of its regional and distributional effects. This policy is valuable only for high-density areas that face traffic problems, and has little to offer for the transportation issues of more sparsely populated areas. In those areas where congestion pricing makes sense, the most important question is how the government uses the revenues from congestion pricing. Congestion pricing can make some people better off without making other groups worse off if revenues are used to compensate those who pay tolls or are priced off the roads. States and localities should use congestion revenues to compensate affected people through lump-sum rebates or through improvements in highway and mass transit systems.

Evidence indicates that drivers would be responsive to higher user fees that present them with the true costs of their decisions. Behavioral changes in response to recent high gas prices confirm that people are more responsive to higher gas prices in the long term than they are in short term. In the past year Americans have reduced their amount of driving for the first time in many years, and transit ridership has increased as

commuters weigh the costs of higher gas prices (see Figure 6). This increase in transit use has occurred not only in transit-intensive areas like New York City, but also in traditionally driving-centered metropolitan areas in the South and West. Clifford Krauss points out in an article in the *New York Times* (“Gas Prices Send Surge of Riders to Mass Transit,” May 10, 2008) that Denver experienced a 7 percent increase in its light rail ridership over the past year, while ridership in Minneapolis–St. Paul climbed by 16 percent. Higher user fees would be expected to have a similar effect to the run-up in gasoline prices.

Requiring drivers to more precisely bear insurance costs would also yield social benefits by reducing the inefficiently high level of driving. For example, most drivers now pay roughly the same amount for insurance regardless of how much they drive. If drivers were instead required to bear the private marginal accident cost of each additional mile driven, they would consider these extra costs in making driving decisions, and would likely change their driving behavior. In a recent Hamilton Project paper, Jason E. Bordoff and Pascal J. Noel (2008) analyze the effects of per-mile auto insurance, in which drivers are charged by the mile rather than in a lump-sum fee. They find that this pay-as-you-drive (PAYD) insurance policy would reduce VMTs by as much as 8 percent. They estimate that the net social benefits from this reform would exceed \$50 billion per year, mostly from reduced accidents and congestion, but also from lower greenhouse gas emissions, less local pollution, and reduced dependence on oil. Moreover, PAYD would tend to benefit low-income drivers, who generally drive less than higher-income drivers and who thus end up subsidizing the costs of other drivers in the current system. Despite the win-win nature of this policy, state insurance regulations and high monitoring and enforcement costs currently discourage auto insurance companies from offering PAYD insurance. Bordoff and Noel propose that the government promote PAYD adoption by enacting regulatory and legal reforms, increasing funding for PAYD pilot programs, and offering temporary subsidies to offset monitoring costs.

Using Existing Aviation Infrastructure More Efficiently

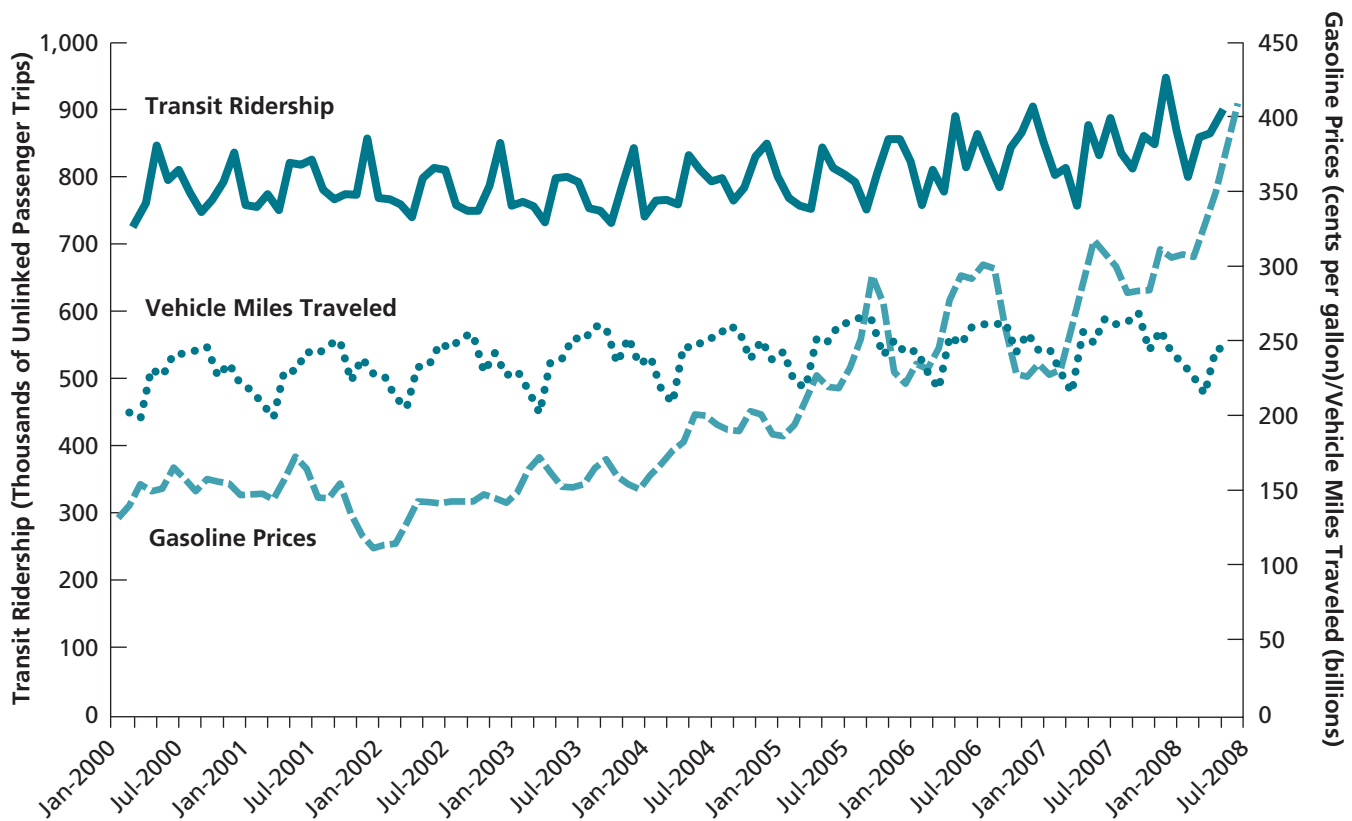
As many air travelers would attest, inefficient use of in-

frastructure has plagued the nation's air traffic system with increasing delays and productivity losses. Total passenger trip delays increased 29 percent from 2006 to 2007 (Sherry and Donohue 2008). Delays in 2007 cost airlines \$8.1 billion in direct operating costs and passengers \$4.2 billion in productivity losses (Air Transport Association 2008). Without serious action to avert it, air congestion will continue to increase in the coming decades as the system attempts to handle a projected tripling of air traffic by 2025, the result of millions of new passengers and thousands of small planes and "very light jets" expected to enter the system (DOT 2007b; GAO 2007c; Joint Planning and Development Office 2004).¹⁰ This increasing use of aviation also contributes to climate change and other forms of pollution. The Intergovernmental Panel on Climate Change (Ellis et al. 1999) estimates that aviation currently accounts for 3.5 percent of human-induced greenhouse gas emissions; this number is expected to rise to 5 percent by 2050. Failing to slow the increase of emissions due to aviation traffic could lead to increasingly rapid climate change.

Landing fees. Air congestion has close parallels to the problem of traffic congestion. Both occur as a result of misaligned incentives: users do not have to pay the full costs they impose on other passengers, taxpayers, and society. Currently, landing fees at airports are based on aircraft weight, even though small planes cause the same amount, if not more, delay than larger planes (Robyn 2001). Since small planes do not pay for the congestion costs of using airports, they have little incentive to shift to less congested airports or to fly at less congested times. As a result, they end up overusing runway capacity.

Congestion charges for airplanes, like congestion pricing on roads, would reduce delay by requiring travelers to face the costs they impose on other travelers. For airplanes, these costs vary by airport and by time of day. Airline carriers would pass congestion charges on to passengers, who would reduce less important travel and shift some travel to less congested times or airports. The owners of small private jets would also face conges-

FIGURE 6
Monthly Gasoline Prices, Amount of Driving, and Transit Ridership, 2000–08



Sources: Energy Information Administration n.d., American Public Transportation Association n.d., and DOT 2008.

10. This projection precedes the 150 percent increase in fuel prices over the past four years and thus likely overstates the expected increase in air traffic.

tion charges commensurate with the costs they impose. While congestion charges place a direct price on landings, administrators can in theory design a functionally equivalent system of slot auctions, in which they establish the number of “slots” available for landing and require airlines to bid for these slots.

Estimates indicate large gains from airport congestion pricing. Morrison and Winston (1989) find that marginal cost fees would generate net benefits of nearly \$6 billion (2005 dollars) annually in reduced delay to travelers and lower operating costs to carriers. Pricing runways can also signal the optimal amount and allocation of new investment in infrastructure. Sustained high levels of demand even with congestion pricing may signal a need for increased runway capacity at certain airports. Morrison and Winston further estimate that a combined policy of efficient congestion tolls and optimal runway capacity would generate \$16 billion (2005 dollars) in annual benefits.¹¹

As with road pricing, airport pricing faces political and legal issues that hinder its implementation. When Boston Logan Airport shifted away from weight-based landing fees in 1988, courts ruled that the new pricing system was discriminatory because of the absence of nearby alternative landing sites (Schank 2005). In addition, the general aviation lobby, which represents owners of small planes used for business and recreation, recognizes that its members would face large increases in fees if congestion charges were applied efficiently.

Air traffic control financing. The outdated air traffic control system is another inefficient use of existing infrastructure. Still functioning on its original 1950s design, the air traffic control system is increasingly unable to accommodate the increased demand for air travel. Since the system communicates with planes through radio signals that take several seconds to transmit, planes must maintain an unusually large buffer from other planes, limiting the number of planes that can occupy airspace at a given time. In addition, flights must be handed off to different regional control centers

as they fly, causing delay and wasting fuel. The Federal Aviation Administration (FAA) has proposed the Next Generation Air Transportation System (NextGen) based on satellite technology to allow for straighter routes, less buffer space, and fewer handoffs. While NextGen is scheduled to be implemented by 2025, many critics have expressed concerns about FAA’s ability to reform air traffic control (GAO 2007a).

Flight delays and outdated technology are symptoms of the underlying problem of perverse economic incentives facing the air traffic system. As with landing fees, the air traffic control system does not charge users based on the costs they impose on the system. Small planes pay less than larger planes to use air traffic services even though they require essentially the same services. According to the FAA (2008), general aviation accounts for 16 percent of air traffic control costs but contributes only 3 percent of revenues. Instead of direct funding from users, air traffic control is funded mostly by federal excise taxes as directed by Congress. In a Hamilton Project paper, Dorothy Robyn (2008) identifies governance and financing as fundamental sources of the flight delays, antiquated technology, and poor customer service associated with the current air traffic control system. In addition to being inequitable, the current financing structure creates inefficiency by encouraging smaller planes to overuse the system. Although the air traffic control system serves aircraft operators, it relies on Congress for continued funding, making it responsive to political goals rather than customer needs.

Robyn (2008) proposes user fees based on the marginal cost that users impose on the system. Like congestion-based landing fees, proportional user fees in place of current excise taxes would send proper price signals to airlines and operators of small planes and reduce the strain on the current system. In addition, user fees would allow the FAA to serve its customers rather than Congress. Proper pricing would also signal the best areas for additional capital investment, facilitating better decisions about technology and new capacity.

11. Although airport congestion is similar to road congestion, there is one important difference: unlike individual drivers, airlines absorb some of the cost of the congestion they cause because this congestion delays their own flights in addition to the flights of other carriers. There is significant debate among scholars about whether airlines internalize self-imposed delays and the implications of this result for air congestion pricing (Brueckner 2002; Daniel and Harback 2008; Morrison and Winston 2007a).

Promoting Better Decisionmaking for Surface Transportation Infrastructure

In addition to making more efficient use of infrastructure by establishing price signals, improving the state of physical infrastructure will require more efficient decisionmaking on how to maintain and expand that infrastructure. Recent surface transportation legislation reflects important trends in the U.S. economy, including growth of metropolitan areas, which presents local governments with unique challenges, and the aging of the nation's infrastructure, which implies a need to better maintain existing infrastructure.¹² The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 began providing states and localities with more reliable and flexible funding to meet their specific needs, in exchange for more accountability. It increased the flexibility of funding by allowing states to use revenues from the Highway Trust Fund for transit projects. It also allowed some federal funds to be allocated directly to metropolitan areas, rather than having states as an intermediary. The Transportation Equity Act for the Twenty-first Century (TEA-21) of 1998 continued these trends and emphasized system preservation and rehabilitation over the construction of new capacity. In 2005, SAFETEA-LU addressed congestion mitigation, allocated more money to mass transit, and allowed more flexibility for public-private partnerships.

Problems with the current process. Despite these reforms, however, much of the disconnect between federal decisionmaking and state and local incentives persists (Puentes 2008). Discussion of transportation bills tends to focus on how money will be distributed across states and modes, rather than on the best use of money to improve the transportation system. The federal government does little to monitor how states use these funds and does little to track state progress on issues of national priority. In addition, federal funding continues to show biases—for example, in providing a higher match ratio to highway projects than transit projects.

The current inefficiencies of federal funding beg the question of why the federal government should play a role in infrastructure investment at all. After all, more than 90 percent of transportation and water infrastructure spending already occurs at the state and local levels, and more than 80 percent of that spending comes from revenues generated by state and local governments themselves (CBO 2007). Evidence indicates that every dollar of federal funding reduces state spending by 50 cents (GAO 2004). Moreover, state and local governments are more likely than the federal government to make cost-effective decisions regarding projects whose benefits accrue regionally (CBO 2008a). In theory, it may seem beneficial to devolve all funding and spending responsibilities to states and localities, allowing them to make decisions based on their individual needs.

Air traffic congestion, which in 2007 cost airlines and passengers \$12 billion in expenses and lost productivity, is expected to worsen in coming decades, increasing delays and contributing to greenhouse gas emissions.

In practice, however, the federal government has an important role in shaping infrastructure policy. Most crucially, the federal government can promote issues of national priority that may not be of equal interest to states and localities, or may extend beyond state and local boundaries. State and local governments, for example, may not have the institutional capacity or willpower to provide access to highway and transit facilities for persons with disabilities. Other issues, such as greenhouse gas emissions and interstate freight transportation, fall beyond the boundaries of concern for state and local governments. Since the effects of greenhouse gas emissions produced by vehicles in a state are felt mostly outside the state, the state has little incentive to charge vehicles based on their contributions to climate

12. According to the 2000 Census (U.S. Census 2000), urban areas now contain 79 percent of the nation's population, up from 70 percent in 1960. BEA (2007) estimates that metropolitan areas account for 90 percent of the nation's economic activity.

change. Similarly, delays in freight transportation cost the nation's economy \$7.8 billion per year (DOT 2005), but states have little incentive to promote freight mobility for trucks en route to other states. The federal government is the only entity that can internalize these interstate costs and facilitate freight mobility in the interest of national economic growth.

Policy response. The goal of effective decisionmaking should be to allocate responsibility appropriately among the federal, state, and local levels of government, and then provide incentives for efficiency and accountability at each level. An appropriate way to allocate responsibility for a particular issue is to assess the geographic scope of the externalities that arise from that issue. Issues that produce externalities on a national level would fall to the federal government. As discussed above, greenhouse gas emissions and interstate transportation are examples of such issues. The federal government would either

making processes to address those issues. To address issues of national priority, the federal government should start by removing the distortions that exist in its own policies, and it should use federal leverage to help offset distortions at the state and local levels. One obvious example of poor incentives at the federal level is the bias in federal funding toward highways over mass transit. Although the ISTEA began reversing this bias, Congress later instructed the Federal Transit Administration to approve transit projects with only a 60 percent share while continuing to allow a match ratio of 80 to 90 percent for highways. In addition, transit projects must clear a number of hurdles that highway projects do not, including cost-effectiveness justifications, land-use analyses, peer and alternative comparisons, and competitive funding (Beimborn and Puentes 2003).

Federally established trust funds can also perpetuate perverse incentives. The traditional argument for trust funds, which provide a dedicated source of revenue to a specific type of infrastructure, is that they provide political support for motor fuel taxes and other taxes. However, trust funds can prevent funding from reaching the most cost-effective projects and may encourage wasteful spending and earmarking on inefficient projects (Ehrlich and Landy 2005). They may also reduce support for policies like VMT fees that promote efficient use of infrastructure, since it may be easier politically to build new highway capacity with trust fund money than to toll existing roads.

In addition to removing distortions in its own policies, the federal government should use performance metrics and performance-based federal funding to counteract political pressures and poor incentives at the state and local levels. In a GAO (2005) survey, thirty-four state departments of transportation cited political support and public opinion as factors of "great" importance in making investment decisions, while only eight said the same of cost-benefit analysis. The federal government can use its financial leverage to encourage cost-benefit analysis and efficient use of infrastructure. Congestion pricing is an example of a policy that faces significant political resistance at the state and local levels—for example, as seen in the rejection of New York City's proposal for congestion pricing. Lewis (2008) proposes

Effective decisionmaking processes should allocate responsibility among the federal, state, and local levels of government, and then provide incentives for efficiency and accountability at each level.

implement direct policies (such as a nationwide cap-and-trade system for greenhouse gas emissions), or provide incentives to states to address these problems. Issues that produce externalities encompassed within state and local boundaries would be left to state and local governments, which would have an incentive to address them. Of course, some externalities affect multiple levels of government. Urban traffic congestion may limit the productivity of local workers, but it also delays interstate freight. Lewis (2008) recognizes the importance of a federal role and proposes that the federal government provide states with financial incentives for congestion pricing. The externality approach would provide a methodical way to decide which level of government has responsibility for which issues.

Establishing the appropriate level of responsibility for issues is not sufficient without well-designed decision-

that the federal government lower the match ratio for roads without congestion pricing, using federal funding as a countervailing force to state and local political pressures. The federal government can also make its funding contingent on other important priorities, such as making infrastructure useful to persons with disabilities, by developing credible enforcement mechanisms for physical accessibility (GAO 2007b). Finally, the federal government can hold states and localities more accountable by requiring them to collect data on indicators of national significance, such as congestion and local pollution, and rewarding states that address issues of national priority (Katz, Puentes, and Bernstein 2005; NSTPRSC 2007).

Promoting Better Decisionmaking for Aviation Infrastructure

The decisionmaking process for aviation infrastructure reflects many of the same issues as surface transportation infrastructure. The Airport Improvement Program provides federal funds from excise taxes, fuel taxes, and other revenue sources for airport projects. While large and medium airports serve 89 percent of passengers, they receive only 41 percent of grant money (Morrison and Winston 2008). The Airport Improvement Program may serve as an economic development program, but it does not provide an economically efficient allocation of transportation funds. Morrison and Winston

find that in general allocating federal funds more evenly would generate more than \$1 billion in annual net gains in reduced congestion, fewer delays, and cost savings for airlines.

More fundamental to aviation policy is the current structure of the air traffic control system. The FAA currently serves both as provider and regulator of the air traffic control system. This combination discourages air traffic control from functioning like the high-tech business that it is, and it creates a potential conflict of interest since the regulatory function is not transparent to outside observers. The current air traffic control system makes decisions about the tradeoff between capacity and safety without independent oversight.

To ameliorate the inefficiency and potential conflict of interest posed by the current structure of air traffic control, Robyn (2008) argues for increased autonomy of the air traffic control system. Separating the operation of the system from its regulators would improve oversight of safety decisions and allow air traffic control to function more like a business. International experience also confirms that autonomy is crucial for an air traffic control system that makes decisions in the interest of customers rather than in response to political goals (Poole 2006).

Section 4. Reforming Telecommunications Infrastructure Policy

Compared to physical infrastructure, telecommunications infrastructure has transformed significantly in recent decades. Issues like spectrum management and broadband access have only recently assumed the national spotlight. The formative state of telecommunications means that national debates and decisions may be even more consequential for telecommunications than they are for physical infrastructure.

Unlike physical infrastructure, telecommunications services are almost entirely privately provided, at least in part by historical accident. While more government support may be necessary, spending alone will not be sufficient. The government must also make better decisions about where and how to use these funds, especially since current programs have been heavily criticized for inefficiency. Another important component of telecommunications infrastructure is using existing infrastructure—specifically wireless spectrum—more efficiently. Wireless spectrum is the natural resource that forms the basis of wireless telecommunications by providing frequencies for devices to communicate.¹³ Though the government cannot create more wireless spectrum, it can design telecommunications policy to maximize the productivity of this resource and spur technological innovation.

Here we consider a two-pronged strategy to enhance the effect of telecommunications investment on productivity growth: using existing telecommunications infrastructure more efficiently, and promoting more efficient ways of expanding broadband access.

Using Existing Telecommunications Infrastructure More Efficiently

Wireless spectrum in the United States is not used efficiently, and much of it is not used at all. In a 2004 study, for example, researchers found that only 13 percent of spectrum was used during any part of a four-day period in New York City, one of the nation's most densely populated and economically vibrant areas (McHenry et al. 2005).

The problem. The National Telecommunications and Information Administration (NTIA) is charged with managing federally held spectrum, while the FCC manages spectrum held by all other entities, including private firms and local governments. As the purveyors of spectrum, these entities oversee nearly every aspect of its distribution, with a focus on preventing interference between signals of different users. The FCC decides which spectrum frequencies can be used for which purposes. It recently conducted auctions for wireless providers to obtain a swath of spectrum vacated by UHF broadcast television, since broadcast will require less bandwidth after converting to digital signals in 2009. The FCC and NTIA also decide what rights license holders have, and specify technical and operating rules for equipment.

Some of this regulation is warranted to prevent interference among spectrum users, but much of it has perpetuated inefficient use of this resource. A major contributor

13. Wireless spectrum, also known as radio-frequency spectrum, is the part of the spectrum that enables wireless communication through electromagnetic radiation. The most useful part of the wireless spectrum lies between 30 MHz and 3 GHz, though new technologies are finding uses for higher frequencies (Weiser and Hatfield 2008).

to this underutilization is the federal government, which occupies a significant portion of spectrum without any incentive to use it efficiently (GAO 2006b).

Recognizing these inefficiencies, Congress and the FCC have taken steps to provide more flexibility on the use and transfer of spectrum. In 1993, Congress decided to end its policy of administrative allocation of spectrum and authorized the FCC to conduct auctions that require businesses to compete for spectrum. Through auctions, the market decides which entity can make the best use of a part of the spectrum, obviating the need for FCC assessments on which entity has the best case. In January 2008, the FCC auctioned to wireless providers a 52 Mhz swath of the highly desirable UHF broadcast spectrum, generating more than \$19 billion. The FCC has also opened up secondary markets to allow license holders to negotiate directly with one another about buying, selling, and sharing spectrum, though to date these efforts have had little impact (Goodman 2008). Most recently, the federal government released a plan to make government agencies reassess their use of spectrum and to open up direct market interaction among spectrum holders, but questions remain as to what impact this plan will have (U.S. Department of Commerce [Commerce] 2008).

Policy response. Although spectrum policy has moved in the right direction, much remains to be done to promote truly efficient use of spectrum. The FCC may not be the best judge of appropriate uses of certain parts of the spectrum, or, as was the case with the broadcast-to-wireless transfer, it may be tardy in making such judgments.¹⁴ Today, large swaths of spectrum sit idle, waiting for FCC pronouncements or, as is more often the case, going unused by incumbent holders such as government agencies. The \$19 billion fetched by the recent auction of UHF broadcast spectrum indicates the scarcity of spectrum as well as concern on the part of wireless companies that new spectrum may not become available for some time. Using the \$19 billion figure as a benchmark, Weiser (2008b) estimates that

the remaining 200 MHz of UHF broadcast spectrum could be worth \$80 billion if used for wireless services. But since UHF spectrum currently comes with a requirement that its owner must broadcast over-the-air signals, wireless companies cannot use this remaining spectrum to develop technology or provide wireless services. Weiser proposes that the FCC eliminate this requirement and impose a “windfall tax” on sales of UHF spectrum to prevent current license holders from reaping large profits for spectrum they received free of charge. He also recommends that the FCC require license holders to assess their use of spectrum by conducting an inventory of spectrum holdings and allowing independent entities to bring cases against license holders that leave their spectrum idle.

The government cannot create more wireless spectrum, but it can design telecommunications policy to maximize the productivity of this resource and spur technological innovation.

In addition to freeing up unused spectrum, the FCC should promote more efficient use of spectrum by reconsidering its strict focus on interference prevention (Weiser 2008b). Successful spectrum policy will require balancing the flexibility to make the best use of spectrum with defining rights and responsibilities to minimize future conflict, especially in the face of uncertain advances in technology. The FCC currently focuses on before-the-fact interference prevention by deciding which types of services or companies can use which bandwidths. Giving more flexibility to license holders would maximize the productivity of spectrum by allowing them to buy, sell, rent, or trade spectrum holdings to a point of optimal allocation. In exchange, license holders would face a greater risk of interference. With less beforehand interference prevention, the FCC (or another agency) would have to conduct more after-

14. According to one estimate, the FCC’s ten-year delay in allocating spectrum for cell phone use in the 1970s cost more than \$33 billion in lost consumer welfare (Hausman 1997).

the-fact oversight as license holders bring interference claims against alleged transgressors.¹⁵

The shift away from interference prevention would also help to stimulate more secondary market activity for spectrum. Secondary markets allow users without licenses to access licensed bands by negotiating with license holders (Hazlett 2008; Panichpapiboon and Peha 2008). The primary user would have rights to its spectrum bandwidth but could allow secondary users to operate in that bandwidth under certain conditions and at certain times. Public safety agencies, for example, could use this model to increase the productivity of spectrum that sits idle under the current system. As primary users of spectrum, these agencies could allow secondary users to operate in their bandwidth during normal times but could take control of bandwidth during emergencies. New technology is also making opportunistic access possible. Under such an agreement, secondary devices would only transmit at times when they would not cause interference.

More than anything, effective spectrum policy must have the flexibility to respond to new technologies that change the way spectrum is used. Companies and government agencies that can use spectrum more efficiently as a result of improved technology should have the ability and the incentive to release their excess holdings for more productive uses. *The Economist* reported on August 12, 2004 (“On the Same Wavelength”) that some experts predict that wideband and ultrawideband technologies, as well as smart antennae and mesh networking, could significantly reduce the need for licensing. While this vision is only a possibility, its ambition reinforces the need for a spectrum policy that can adapt to the breakneck speed of technological innovation and grant more flexibility to the private market as technology warrants.

Promoting Better Decisionmaking for Expansion of Broadband Access

The United States must also improve the way it makes decisions about building infrastructure for broadband. Over the past decade, broadband has changed the way

Americans work, travel, and communicate. Research suggests that the price elasticity of demand for broadband has fallen—implying that Americans view it more as a necessity than a luxury—perhaps because of better applications that require broadband (Alleman and Crandall 2002; Rappoport, Kridel, and Taylor 2002). Studies have also suggested a positive impact of broadband subscription on economic growth (Crandall and Jackson 2001; Litan 2005).

The government’s role in promoting broadband has been a subject of controversy for more than a decade. The government has already reformed its broadband regulatory policy with the goal of encouraging wider deployment. Opponents of more direct government involvement point to evidence that broadband has deployed as rapidly as other technological innovations in history (Owen 2002). As seen in Figure 7, the United States has made dramatic strides in recent years with minimal government involvement: 47 percent of American adults had broadband subscriptions in 2007, up from 30 percent just two years earlier (Horrigan and Smith 2007).

But recent international rankings suggest that the United States may be falling behind other countries in broadband deployment. According to the OECD (2008a), in 2007 the United States ranked fifteenth among thirty OECD nations in number of subscribers per capita, dropping from fourth place in 2001. To be sure, the OECD data have well-documented deficiencies, including a failure to separate residential broadband use from commercial use (Wallsten 2008), and can be explained in part by factors beyond the scope of broadband policy (Atkinson, Correa, and Hedlund 2008). Still, these and other estimates indicate the opportunity for progress in broadband availability in the United States. Since many of the benefits of broadband extend beyond the individuals who subscribe to broadband or provide broadband, the private market may not have sufficient incentive to invest in broadband technology.

Lack of access in rural areas. Beyond the issue of overall access, there remains a “digital divide” in the

15. Goodman (2008) discusses some of the challenges faced by the FCC in these circumstances. It would have to determine the identity of the transgressor, a difficult feat if the bandwidth has many secondary users or if it neighbors unlicensed spectrum; it would have to determine fault, a murky judgment when license holders themselves are expected to take precautions against interference; and it would have to enforce rights and responsibilities through appropriate punishment.

United States that is especially apparent for urban versus rural households, and for high-income versus low-income households. Although dial-up is available to virtually all households, broadband is not only better for many applications but is increasingly necessary because developers now create websites that require broadband access. For many households in urban and suburban areas, the problem is affordability of services; 76 percent of households with incomes greater than \$75,000 subscribe to broadband, but this number is only 30 percent for households with incomes under \$30,000 (see Figure 7). However, there is evidence that these gaps are narrowing. Subscription among households under \$30,000 has more than doubled since 2005.

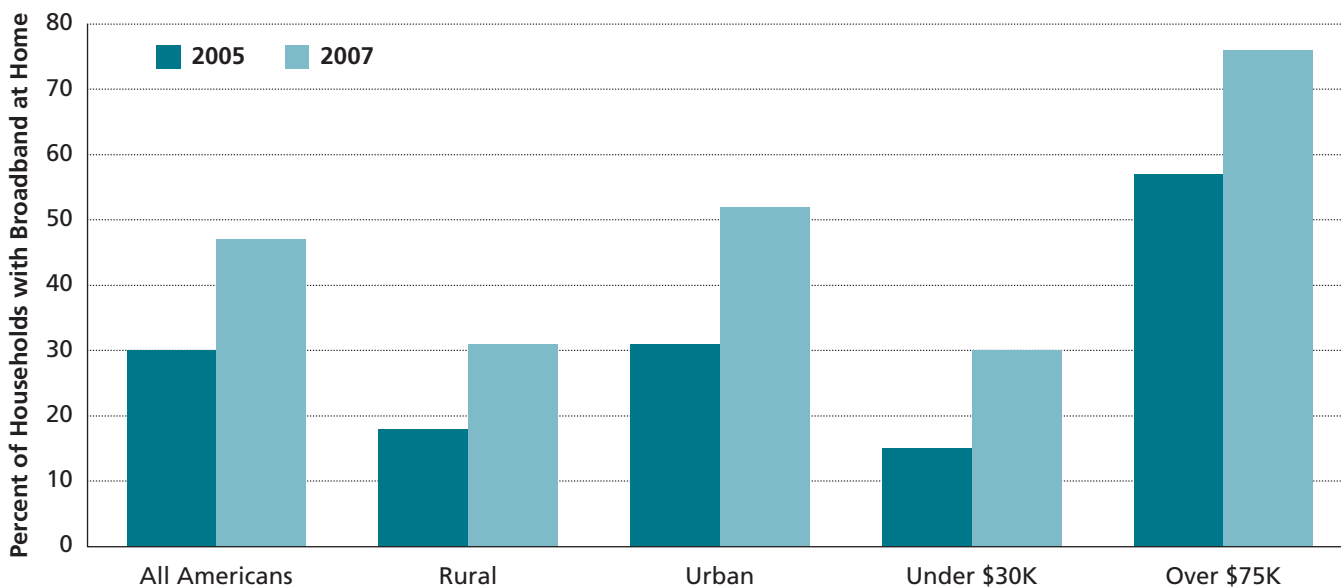
For many rural households, the main problem is lack of access to Internet with sufficiently high speeds. In 2007, 52 percent of urban households and 49 percent of suburban households had broadband subscriptions, compared to only 31 percent for rural households (Horrigan and Smith 2007). Cable and telephone companies are less likely to provide services in rural areas because they face significantly higher costs per person in these areas as a result of low population density, rugged terrain, and higher intensity of use (Kruger 2008). These costs get higher as speed requirements increase, so rural

areas are least likely to have high-speed access. Peha (2008) estimates that about 10 million households, or 8 percent of homes, have no access to broadband services beyond rudimentary satellite service. Expanding broadband access can improve the standard of living for rural communities, though more research is needed to quantify the benefits and externalities of broadband expansion.

Policy response. In the 1930s, the Rural Electrification Administration promoted universal electrification of rural areas, and other policies have promoted more widespread access to services such as running water and paved roadways. Broadband is likely to be a key part of a twenty-first century bundle of standard services to rural areas.

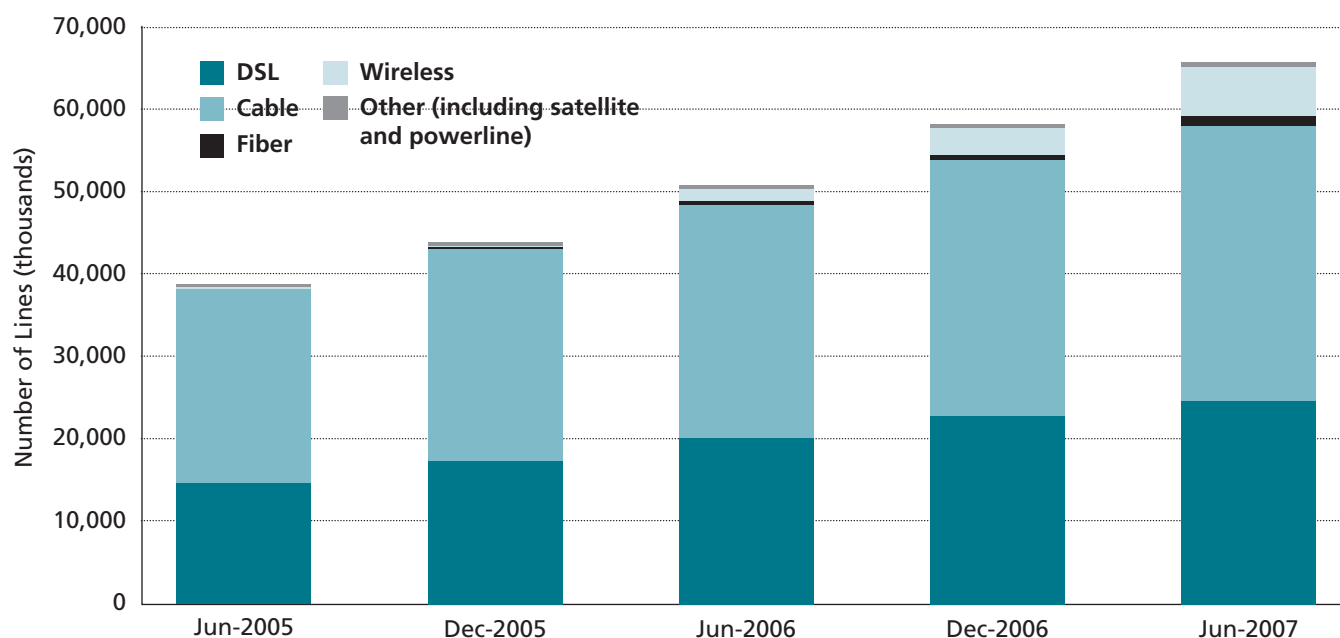
In promoting rural broadband access, the government should take a number of steps to minimize costs to taxpayers. First, the FCC should reform spectrum policy to allow for increased wireless broadband deployment. Wireless technology is particularly suitable for rural areas where cable and telephone lines are difficult to deploy, and its use has increased in recent years (see Figure 8). But expanding wireless services will require additional spectrum. As discussed earlier, the FCC and

FIGURE 7
Home Broadband Adoption across Various Demographics, 2005 and 2007



Source: Horrigan and Smith 2007.

FIGURE 8
U.S. Residential Broadband Subscription, June 2005 to June 2007



Source: FCC 2008.
 Note: Residential high-speed Internet access is defined here as speeds achieving 200 kb/second in at least one direction, a lower requirement than the most current definition of broadband.

NTIA can make more spectrum available by requiring government agencies to defend their use of spectrum and by opening up secondary markets.

Second, the government should reform its universal service programs to promote cost-effective expansion of broadband to rural areas. Goolsbee (2002) finds that the most cost-effective way for government to expand broadband use is to provide subsidies for deployment in unserved areas, rather than by subsidizing usage in existing markets. However, current government programs intended to subsidize deployment are poorly designed, have little accountability, and fail to target those areas most in need. USDA's Rural Utilities Service, which administers two broadband programs, has rejected many potentially viable applications, spending only 28 percent of its available funds in 2004 and 5 percent of its funds in 2005 (GAO 2006a). In a 2005 report, the USDA's Office of Inspector General notes that many loans are going to communities that already have service providers or are not actually in rural locations (USDA 2005). The USF has also been criticized for inefficient distribution of its \$7 billion annual budget (Crandall and Waverman 2000).

Several alternatives and reforms to these existing programs have been proposed. The FCC (2007) recently proposed a Broadband Fund that uses reverse auctions, in which firms bid for the lowest government subsidy for broadband projects in rural areas. At conferences held by the Aspen Institute in 2007, technology experts estimated that expanding service to 10 million unserved households over 10 years, if done efficiently, would require a total subsidy amount of \$20 billion, achieving near-universal access at a lower cost than the current USF program (Weiser 2008a).

Whatever the exact funding method, the government can take steps to ensure that better decisions are made before, during, and after deployment. Prior to deployment, a national approach to broadband should establish realistic goals and adopt a definition of broadband that evolves with advances in technology.¹⁶ Maintaining a realistic outlook may mean setting forth different goals of broadband access and speeds for urban areas versus rural areas, given the higher costs of rural deployment (GAO 2006a). The government should not attempt to provide broadband to every community,

16. The FCC recently revised its definition of broadband to be Internet with speeds above 786 kb, but no standard definition exists.

and should recognize that some isolated rural areas will have to depend on satellite as their sole source of broadband access until better forms of broadband become cost effective in these areas. In addition, better mapping techniques are needed to identify and target unserved regions in the United States (Weiser 2008a). Many regions currently chosen for subsidies either have existing providers or encompass such a large area that they inadvertently include urban or suburban areas that do not need government support. Mapping technology can help target subsidies to those rural regions cut off from broadband.

The government should also consider how it administers subsidies for broadband deployment. The policy of reverse auctions, for example, would minimize the amount of taxpayer money spent on each project without sacrificing quality. To improve the performance of reverse auctions in practice, the recent Hamilton Project paper by Peha (2008) proposes auctioning tradable service obligations, a specific type of reverse auction that would allow companies to share and trade responsibilities and complete milestones on a flexible timeline.

Importantly, since the goal is to encourage access, these subsidies should cover upfront deployment costs only, rather than postdeployment subscription costs. As with physical infrastructure, the federal government should consider devolving administration of these universal service programs to state governments, which have a

better understanding of local needs and can more easily measure and evaluate progress (Weiser 2008a).

Finally, the government should consider how to regulate service providers after subsidized deployment in situations where these companies effectively become monopoly providers. Peha (2008) notes that providers could charge higher prices and discriminate against or block certain content or applications. He proposes including some requirements on pricing and treatment of content and applications as part of subsidy eligibility

In the past, the U.S. government has promoted widespread access to services such as electrification in rural areas. Broadband is likely to be a key part of a twenty-first century bundle of services to rural areas, promoting improved health care, education, and quality of life.

criteria. To enforce this policy, scholars have suggested staggering the upfront subsidy payments over time to hold providers accountable for meeting deadlines and providing quality services at nondiscriminatory prices (Weiser 2008a).

Conclusion

Infrastructure investment has received more attention in recent years because of road and air congestion, catastrophic events, and urgent warnings about climate change and energy security. The United States has the opportunity to channel public concern and frustration into a national infrastructure strategy that promotes infrastructure as a central component of long-term, broadly shared growth. To that end, this paper proposes reforms to use existing infrastructure more efficiently and target infrastructure spending more effectively. While increased spending on infrastructure is likely to be needed as well, an effective government can reap the greatest benefits by making better use of what we have already built and what we are already spending.

For physical infrastructure, more efficient use of existing resources could have large benefits, given the amount of infrastructure that has already been developed. The most important policy is sending price signals to users that reflect the costs of infrastructure use more fully, and using at least some of the revenue from these fees to offset their adverse distributional effects. To make better decisions about infrastructure spending, the federal government should remove biases in its own policies,

and it should provide incentives for state and local governments to reform their own policies.

Telecommunications infrastructure is fundamentally different from physical infrastructure in that it is largely a privately provided good. The role for government, then, is to step in where private firms will not. Expanding broadband access to the last 10 million unserved households in the United States would require a coherent federal policy that targets only those areas in need, lowers costs through market principles, and releases idle spectrum for wireless services. More generally, reforming spectrum policy to make better use of this natural resource would stimulate technological innovation.

Physical infrastructure and telecommunications infrastructure have important differences. But they are guided by the same principles of investment, and together form the basis of a comprehensive national policy for infrastructure investment. Public concern over infrastructure offers a unique opportunity to break from the desultory tradition of infrastructure decisions and establish a principled approach guided by cost effectiveness and long-term growth.

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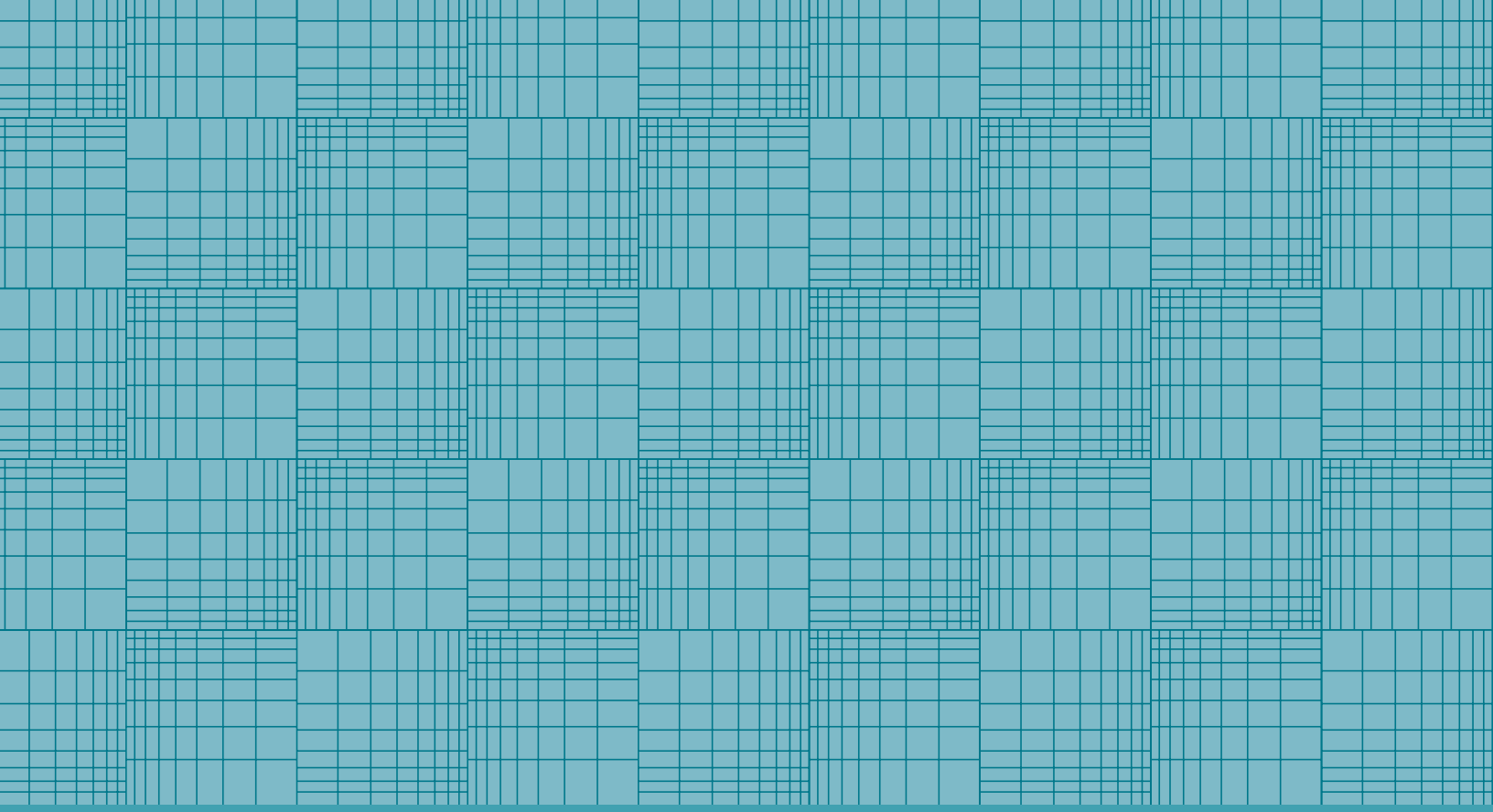
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