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Issue Report

Economic Returns to Rural Infrastructure Investment

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Commissioned papers: This paper was one of six commissioned as part of the workshop, *Economic Returns to Rural Infrastructure Investment*, organized by Farm Foundation and USDA's Economic Research Service (ERS). The workshop took place April 10–11, 2018, in Washington, D.C. A seventh paper, which had already been published, was also presented at the workshop because of its high relevance to the topic. All seven full papers are available on the Farm Foundation website, *https://farmfoundation.org*. Farm Foundation gratefully acknowledges BNSF Railway for its support of the commissioned papers.

The findings and opinions expressed in this paper are those of the authors and do not represent those of Farm Foundation, ERS, USDA or BNSF.

Economic Impacts, Costs and Benefits of Infrastructure Investment—Review of the Literature

We reviewed literature on the impacts, costs and benefits of infrastructure investments in the United States and selected developing countries.

A large literature on the productivity impacts of infrastructure investments in the United States and other countries has developed since the seminal work of Aschauer[1] was published in 1989. Much of this literature has focused on estimating the output elasticity of public capital—the percentage increase in GDP or other measures of the value of production resulting from a 1% increase in the value of the public capital stock.

A review of 28 published studies that estimated this parameter for the United States for different time periods, different levels of analysis, different types of public capital, and using different econometric specifications and methods, found a wide range of estimates—from -0.49 to +0.56—with a mean value of 0.12. This variation in elasticity estimates results in part from variations in the study focus and methods. For example, studies that estimate national level impacts generally find larger output elasticities of public capital than studies that estimate elasticities for states or regions. Studies that account for unobserved fixed factors that affect output generally find smaller elasticities.

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The literature often finds large differences in the output elasticities for different types of public capital—e.g., total public capital vs. highways or water and sewer capital. Since the marginal annual return to public capital stock from increased productivity is equal to the output elasticity multiplied by the output/capital stock ratio (which can vary greatly across types of public capital), even larger variations are found in the marginal returns to different types of public capital. The mean annual rate of return to highway capital across state-level studies was close to zero, while the mean for water and sewer capital was nearly 90%.

Table 1. Estimated employment multiplier impacts of infrastructure spending

	Jobs per $1 billion	
Type of Infrastructure	Direct & Indirect	Total (with induced impacts)
Energy	**11705**	**16763**
Gas	15976	21888
Electricity generation, transmission, distribution	9819	14515
Solar	10951	15767
Wind	10076	14880
Transportation	**13829**	**18930**
Average for roads and bridges	13714	18894
Roads and bridges: new	12638	17472
Roads and bridges: repair	14790	20317
Rail	9932	14747
Mass transit	17784	22849
Aviation	14002	19266
Inland waterways/levees	17416	23784
School buildings	**14029**	**19262**
New institutional construction	14291	19637
Repair of non-residential buildings	13768	18886
Water	**14342**	**19769**
Dams	17416	23784
Drinking water	12805	17761
Waste water	12805	17761

Source: Heintz et al (2009)

A shortcoming of productivity studies is that they do not account for the amenity benefits that people may receive directly from access to infrastructure, and that are not reflected in measures of productivity. A few studies have estimated these benefits using spatial equilibrium theory to assess the benefits reflected in interurban variations in wages and rents or housing values. One prominent study by Haughwout[2] estimated the benefits of infrastructure in 33 large cities and found that amenities account for most of the value, which was estimated to be in the range of $1.4 billion to $2.8 billion (in 1990 dollars), substantially less than the cost of the infrastructure ($4.6 billion).

A recent study by Albouy and Farahani[3] updated and extended Haughwout's approach, allowing for the effects of non-traded production, federal taxes, and imperfect mobility of households. Albouy and Farahani (2017) estimated that the benefits-to-cost ratio of infrastructure in the cities studied by Haughwout was in the range of 0.70 to 1.35; that is more than twice the benefits-to-cost ratio range found by Haughwout (2002). No studies were found that used this approach to estimate the value of infrastructure investments in rural areas.

A review of estimates of benefits and costs of water resources infrastructure investments, which are routinely conducted by the U.S. Army Corps of Engineers (USACE), found a wide range of benefits-to-cost ratio estimates resulting from project feasibility studies—typically well over 1.0 and often greater than 3.0. Similarly, benefits and costs of potential highway investments are regularly estimated by the Federal Highway Administration (FHWA) and show benefits-to-cost ratio estimates greater than 1.0 for a wide range of scenarios. Strengths and limitations of the approaches used to generate these estimates are discussed[4], as is the need for retrospective studies evaluating the benefits and costs of these investments after implementation.

A review of studies of the impacts of particular types of infrastructure in the United States—focusing on telecommunications (mainly broadband) infrastructure, water and power systems, and electricity systems (all focuses of programs of the USDA Rural Utilities Service)—found many studies investigating impacts of broadband or broadband programs, and few studies on the impacts of other types of infrastructure. Several broadband studies investigated impacts on labor market outcomes, such as employment, earnings and wage levels, and many find positive impacts of broadband access or adoption on such outcomes.

A few studies investigated impacts of broadband access on housing sales values, finding that broadband access can increase house values by up to 7%, depending on the available speed. Only one non-peer reviewed study was found that estimated the benefits and costs of broadband access in rural areas of the United States. The authors concluded that the benefits of providing universal access likely greatly exceed the costs.

A review of studies of the impacts of particular types of infrastructure in developing countries—focusing on roads, rural electrification, and information and telecommunications technologies (ICTs)—found a large number of studies focused on the impacts of investments in these forms of infrastructure on a wide array of economic and social outcomes. Road investments in developing countries have in many cases been found to have strong effects on productivity in general, as well as on agricultural productivity, transportation costs, commodity prices, nonfarm economic activity, employment, rural household incomes and poverty, household consumption, property values, access to health and education services.

Road development has tended to benefit men more than women. Some studies have found that the impacts of road development are greater for poor people. Positive impacts of roads are not universally found, however, and in some studies displacement of economic activities across locations has been observed. Rural electrification and ICT investments are also found to have positive impacts on outcomes reflecting rural people's economic activity, income, and welfare in numerous studies.

Ex ante studies of the costs and benefits of infrastructure investments are often required by donor agencies, but *ex post* studies are rare. The Millennium Challenge Corporation appears to be an exception in promoting retrospective estimation of costs and benefits of investments based on *ex post* impact evaluations.

Table 2. Estimated economic impacts by type of infrastructure project

Type of Infrastructure	Invest-ment amount ($B)	Direct employ-ment impact (# jobs)	Total employ-ment impact (# jobs)	Total output impact ($B)	Total jobs/ Investment (jobs/$B)	Total output/ Investment ($B/$B)
Highway and transit system	225.0	2106914	6189480	775.4	27509	3.45
Broadband infrastructure	55.0	293736	1048064	158.3	19056	2.88
Onshore exploration & devt./offshore drilling	46.5	194844	896185	145.0	19273	3.12
Drinking water and wastewater infrastructure	30.0	280922	825264	103.4	27509	3.45
Smart grid	24.0	219578	649627	82.0	27068	3.42
Nuclear energy	15.0	139145	397271	48.7	26485	3.25
Renewables (solar, wind, biofuels)	14.5	115874	337558	44.3	23280	3.06
NextGen air traffic control	10.4	30631	181921	32.1	17492	3.09
Inland waterways	2.6	32951	67100	8.1	25808	3.12
Clean coal technology	2.6	24018	66127	7.9	25932	3.10

Source: Based on DeVol and Wong (2010)

End Notes:

[1] Aschauer, D.A., 1989. Is public expenditure productive? *Journal of Monetary Economics*, 23(2), pp.177-200.

[2] Haughwout, A.F., 2002. Public infrastructure investments, productivity and welfare in fixed geographic areas. *Journal of Public Economics*, 83(3), pp.405-428.

[3] Albouy, D. and Farahani, A., 2017. Valuing Public Goods More Generally: The Case of Infrastructure. Upjohn Institute working paper; 17-272. Available at SSRN: https://ssrn.com/abstract=2981752 or http://dx.doi.org/10.2139/ssrn.2981752

[4] Office of Management and Budget (OMB). 1992. Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. Washington D.C.

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