

How Much Does Infrastructure Contribute to GDP Growth?

A big push in infrastructure investment may entail trade-offs and distortions that could substantially reduce the net effect on growth

Among empirical studies examining the long-run effect of public infrastructure on total factor productivity and growth in developing countries, few are convincing. This literature began with David Aschauer's "Is Public Expenditure Productive?" (*Journal of Monetary Economics* 23 [1989]: 177–200). Aschauer, using annual time-series data for the United States, calculated that with private inputs held constant, the annual marginal product of public capital was in excess of 100 percent.

Subsequent research estimating production functions used pooled U.S. state data in levels, disaggregated public capital into its main components, or used industry data and found similar effects, particularly for road and highway capital. Time-series estimates in levels might simply capture common trends. And pooled state data in levels might simply capture underlying persistent state characteristics; that is, richer states invest more in public capital. In fact, when the production function is estimated with aggregate U.S. data in differences or with state data with fixed effects, zero or even negative marginal products of public capital become typical.

This literature measures infrastructure in terms of physical stocks (for example, kilometers of roads) or pecuniary stocks constructed by accumulating spending flows. The underlying assumption is that the flow of productive infrastructure services is directly related to the size of the stock of infrastructure assets. A number of empirical studies using various approaches also find that the output contribution of infrastructure exceeds that of conventional capital, which suggests the presence of externalities associated with infrastructure services.

The literature using physical measures of infrastructure stocks reports a

significant positive effect of infrastructure on output, productivity, or their growth rate. Results are less conclusive among studies using pecuniary measures such as public investment flows or their accumulation into public capital. There is a good reason for this: the lack of a close correspondence between public capital expenditure and the accumulation of public infrastructure assets or the provision of infrastructure services, owing to inefficiencies in public procurement and outright corruption—issues probably more important in developing than in developed economies.

The recent literature tends to find smaller (and more plausible) effects than those reported in Aschauer and subsequent studies. Among recent studies using a production function approach, the midpoint estimate of the elasticity of GDP with respect to infrastructure capital lies around 0.15 for developed countries, implying that a doubling of infrastructure capital raises GDP by 15 percent. Estimates from recent studies using broader country samples are similar. But all these capture only the direct effect of infrastructure on output, given the use of other productive inputs. There may be additional indirect effects accruing through changes in the use of the other inputs because of complementarities with infrastructure.

A recent paper by Calderón, Moral-Benito, and Servén represents the state of the art in the empirical literature on the contribution of infrastructure to aggregate output. Using an infrastructure-augmented production function approach, the paper estimates the output elasticity of infrastructure on a large cross-country panel data set covering 88 countries, spanning the years 1960–2000, and containing more than 3,500 annual observations.

The paper addresses several limitations of the earlier literature. It uses a multidimensional concept of infrastructure, combining power, transport, and telecommunications into a synthetic index constructed through a

principal component procedure. The econometric approach deals explicitly with the nonstationarity of infrastructure and other productive inputs, reverse causality from output to infrastructure, and potential cross-country heterogeneity in the contribution of infrastructure to aggregate output.

The authors' empirical strategy involves estimating a production function relating output per worker to noninfrastructure physical capital, human capital, and infrastructure inputs. Their estimates, based on heterogeneous panel time-series techniques, place the output elasticity of infrastructure in a range between 0.07 and 0.10 (depending on the specification used). The estimates are highly significant and robust to a variety of experiments involving alternative econometric specifications and different synthetic measures of infrastructure. Some illustrative calculations show that the output contribution of infrastructure implied by these results is also economically significant. The estimates of the output contribution of human capital and noninfrastructure physical capital are similarly significant and in line with those reported by the earlier literature.

Tests of parameter homogeneity reveal little evidence that the output elasticity of infrastructure varies across countries. Observed differences in the ratio of aggregate infrastructure to output offer a useful guide to the differences in the marginal productivity of infrastructure. The paper also points out that increases in the quantity and quality of infrastructure, while worthwhile, are costly and take decades to implement. The fiscal distortions associated with such an effort, and the trade-offs it would entail with other needed investments, could well reduce the net growth effect substantially.

César Calderón, Enrique Moral-Benito, and Luis Servén. 2011. "Is Infrastructure Capital Productive? A Dynamic Heterogeneous Approach." Policy Research Working Paper 5682, World Bank, Washington, DC.