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Comment Jason Furman

> Macroeconomists like infrastructure investment a lot more than the people who know something about it.
> —Ed Glaeser at some conference (according to the author's recollections)

Macroeconomists, myself sometimes included, have tended to see infrastructure investment as a solution to a wide range of economic concerns. What to do if the economy is in a recession and needs countercyclical help? Infrastructure. Worried about slower long-run growth? Infrastructure. Declining

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male employment rates? Infrastructure. Some of these same macroeconomists, who would otherwise never be caught citing an advocacy or lobbying group as an authority, have even been known to cite the American Society of Civil Engineers' (2017) grade of D+ for US infrastructure as, somehow, an authoritative assessment. In contrast, many economists who specialize in infrastructure often tend to stress a variety of downsides: the examples of cities with ample infrastructure but no growth (Glaeser 2008), the fact that transit may shift economic activity more than augment it (Gonzalez-Navarro and Turner 2018), and that the benefits of highway construction may be small relative to its costs (Duranton and Turner 2012).

Valerie Ramey steps into this debate with both of her feet firmly planted in macroeconomics; her analysis is grounded in aggregate production and demand functions with none of the texture afforded by the microeconomic literature (beyond including a more realistic "time to build" for infrastructure investment). But she approaches the debate with none of the wishful thinking and advocacy that have sometimes plagued macroeconomic pronouncements. Instead she has produced what should become the definitive assessment of both the theory and empirics of infrastructure, especially its short-run impacts.

In my original discussion of the conference draft, I used her paper as a launching point for a broader reflection on infrastructure, economic policy, and economic research, while also making some specific critiques of Ramey's models and analysis. Unfortunately, Ramey responded to and incorporated almost all of my critiques (for what they were worth), leaving me with just the broader reflections on infrastructure, economic policy, and economic research that I will make in the following four points:

1. US public investment is relatively low, but US infrastructure quality is relatively high.
2. The optimal level of public investment likely varies across types, and any assessment should factor in market failures and distortions.
3. A more granular production function may matter for assessing public infrastructure multipliers.
4. A full policy regarding countercyclical public investment needs to take into account more than multipliers.

Low Public Investment, High Infrastructure Quality

US public investment is relatively low, but US infrastructure quality is relatively high. Gross government investment has fallen from its post–World War II peak of 7.1 percent of GDP in the 1960s to a near postwar low of 3.4 percent in 2019, as shown in figure 4C.1. Excluding defense investment, the trend is similar, with a peak of 4.3 percent in the 1960s to a near-postwar low of 2.6 percent of GDP in 2019. The United States is also below average

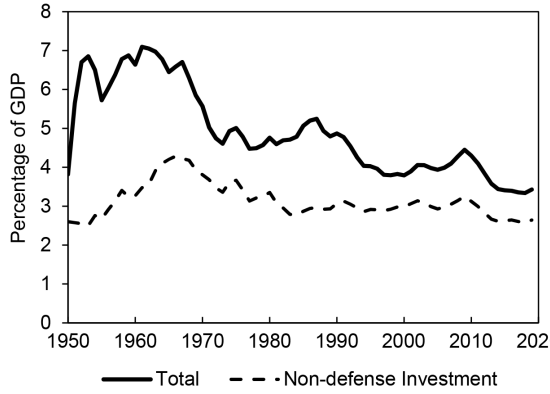

Fig. 4C.1 US gross government investment
Source: Bureau of Economic Analysis; Macrobond; author's calculations.

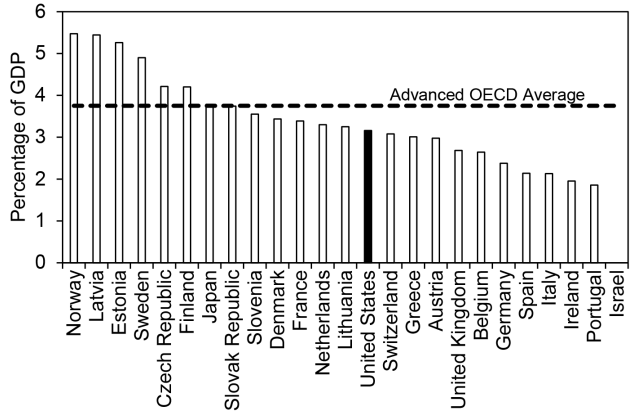

Fig. 4C.2a Public gross fixed capital formation in advanced OECD countries, 2018

compared with other advanced economies in the OECD, as shown in panel A of figure 4C.2, which shows overall public investment, and panel B of figure 4C.2, which excludes defense.

The low levels of public investment do not appear to translate into worse outcomes, at least in key measurable aspects of transportation infrastructure. Turner (2019) has shown that lane miles of Interstate Highway grew nearly continuously from 1980 to 2008 while the average smoothness of roads improved enormously over that period. The World Economic Forum rates US transportation infrastructure as better than the G7 average across multiple measures, except for railroad density, and ranks US road, air and liner shipping connectivity as the best in the world, as shown in table 4C.1.

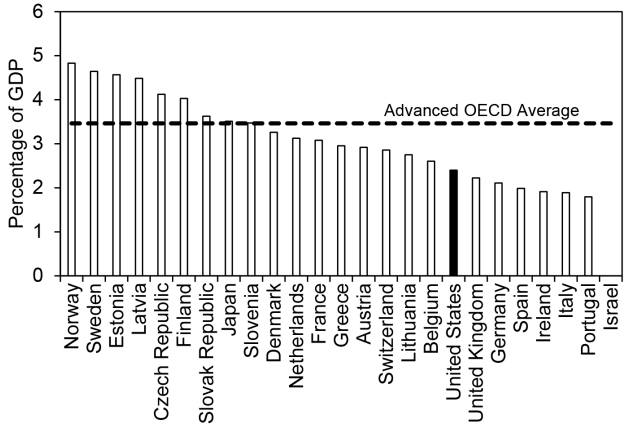

Fig. 4C.2b Public nondefense gross fixed capital formation in advanced OECD countries, 2018

Source: Organisation for Economic Co-operation and Development; author's calculations.

Table 4C.1 Quality of transportation infrastructure in G7 countries

	Canada	France	Germany	Italy	Japan	United Kingdom	United States	G7 average
Overall	66	83	84	73	88	81	80	79
Road connectivity	99	97	95	86	78	91	100	92
Quality of road infrastructure	67	74	72	57	85	64	75	70
Railroad density	13	100	100	100	100	100	41	79
Efficiency of train services	58	66	65	52	96	55	69	66
Airport connectivity	96	96	100	97	100	100	100	98
Efficiency of air transport services	72	75	75	65	87	72	80	75
Liner shipping connectivity	52	84	97	67	77	96	97	81
Efficiency of seaport services	68	69	71	61	80	69	76	71

Note: Scores are on a scale of 0 to 100, where 100 represents the frontier.

Source: Schwab (2019); author's calculations.

Optimal Level of Public Investment

The optimal level of public investment likely varies across types, and any assessment should factor in market failures and distortions. Ramey does a simple, back-of-the-envelope assessment of the optimal level of the US public capital stock and finds that it is very dependent on the elasticity of output relative to the public capital stock. Unfortunately, Ramey's review and critique of the literature leads to more, not less, mystery on this param-

eter. With an elasticity of 0.05, the US public capital stock is a little higher than optimum, but with an elasticity of 0.11 found by Bom and Ligthart (2014), the public capital stock is well below optimal. More work is needed to identify this parameter, including taking into account the time frame for output, spillovers across regions, and a range of econometric problems that result from the fact that public investment is both a cause of and consequence of output and GDP growth.

The basic neoclassical model, however, provides a relatively small set of limits for this back-of-the-envelope calculation, and a number of additional considerations would be worth taking into account in future work:

- To the degree tax distortions are associated with funding public investment, that association would suggest even lower public investment. But to the degree that the funding of public investment addresses other distortions (for example, a gas tax addressing some externalities associated with gasoline use), then public investment would be higher.
- Private investment may be suboptimal as a result of distortions associated with capital taxation, monopoly power, and failure to take into account positive spillovers. All these considerations indicate more public investment than the simple Ramsey calculation would suggest.
- Public capital is highly differentiated and may not be exactly what one would think. Highways and streets, for example, are smaller than either intellectual property products or equipment, as shown in table 4C.2. All of these forms of capital should be accounted for separately, with their own output elasticities and optimal levels, in any more complete analysis.
- To the degree there are labor market failures that are reflected in the large long-term decline in non-college-graduate prime-age male employment rates, then additional infrastructure investments may shift the composition of aggregate demand, and these additional jobs should be reflected in any optimization exercise.

Table 4C.2 **Composition of US government investment in fixed capital, 2018**

Type	Percent
Equipment	22
Intellectual property products	30
Structures	47
Highways and streets	14
Educational	12
Transportation	4
Offices	4
Other	13

Source: Bureau of Economic Analysis; author's calculations.

- Finally, parameterizing any optimization exercise against historical data implicitly identifies the optimal quantity conditional on the historical average quality of infrastructure (as reflected in the output elasticity). Should the analysis explore and try to understand how improvements in quality would increase the optimum level and what those improvements might be?

I do not know what a more complete optimization exercise addressing these points would show, but based on a range of evidence and experience I would hazard the following guesses: (1) the composition of transportation investment matters much more than the level, including more user funding, shifting from rural to urban, more transit and less highway, and possibly more maintenance and less new construction. (2) If the composition can be improved, then a higher level could be justified. (3) The United States is underinvesting dramatically in research and development.

More Granular Production Function

A more granular production function may matter for assessing public infrastructure multipliers. Ramey finds somewhat smaller multipliers than much of the previous literature, and much smaller multipliers than the roughly three found by Auerbach and Gorodnichenko (2012) for public investment. Ramey's multipliers, however, need not mean a large shift in priors for anyone who was more pessimistic about infrastructure as short-run fiscal stimulus (for example, Elmendorf and Furman [2008] wrote that infrastructure was "difficult to design in a manner that would generate significant short-term stimulus," and Furman [2020] wrote that "recent studies . . . find larger tax multipliers than spending multipliers").

Ramey mostly models public investment as an undifferentiated concept. In reality, there are many types of public investment, and they enter the production function in different ways. Econometric estimates of multipliers for each separate type of infrastructure are likely impossible, but the input-output matrix of the Bureau of Economic Analysis (BEA) provides some clues about the relative impact of different forms of infrastructure investment, with state and local transit being twice as large as water, sewage, and other systems, as shown in table 4C.3.

More than Multipliers

A full policy regarding countercyclical public investment needs to take into account more than multipliers. Although the short-run multiplier is not an encouraging argument for public investment as fiscal stimulus, several other considerations are also important. The most important, as argued force-

Table 4C.3 Input-output effects of infrastructure investment

Industry	Total multiplier
Government investment	
Federal nondefense	1.5
State and local passenger transit	3.2
State and local electric utilities	1.8
Core infrastructure investment	
Highways and streets	2.0
Electric power generation, transmission, and distribution	1.8
Water, sewage, and other systems	1.6

Source: Council of Economic Advisers (2016).

fully by Haughwout (2019) is that infrastructure investment is currently *procyclical*. The reason is that 63 percent of state highway funding is through user revenues and other taxes and fees, while only 9 percent is funded by borrowing. With taxes and fees highly cyclical, this introduces a substantial procyclicality to state highway investment. Presumably the same logic implies that other forms of state investment are also very procyclical. As a result, introducing some countercyclicality into federal infrastructure investment (Haughwout 2019), or into federal financing for states more generally (Fiedler, Furman, and Powell 2019), could be thought of less as a way to get new stimulus in recessions and more as a way to smooth investment, preventing a precipitous decline that may otherwise occur.

I would love to see Ramey take her analytic machinery and employ it to answer the question of the optimal cyclical profile of public investment. It is unlikely that a procyclical profile is optimal. In fact, a number of considerations—unrelated to multipliers—suggest that a countercyclical profile may be preferable. Specifically, the fact that interest rates are lower, and material and labor costs may be lower, in recessions suggests that, if anything, shifting more investment into periods when the economy is weak could be desirable.

In particular, any cost-benefit analysis of a new public transportation program needs to reckon with how it accounts for the employment effects of the plan. As any student of economics learns, in normal times jobs should be disregarded, because even if the program is creating gross jobs, it is not creating them on net—it is just displacing some other form of employment. In a recession, however, net jobs are created and these have a social value to the extent that the marginal product of them exceeds the reservation wage. Net job creation could easily shift a project from failing a cost-benefit test to passing one. Understanding just how easily this shift could take place, however, depends on the number of net new jobs created—which can be benchmarked by the number of jobs per $100,000 of infrastructure spending. A range of estimates for this number is provided in table 4C.4.

Table 4C.4 **Estimates of number of new jobs created per $100,000 of infrastructure spending**

Standard advocacy estimates	2–4
Chodorow-Reich (2019)	2
Ramey (2019)	0.8
Garin (2019)	0.6

Conclusion

Ramey brings much clarity to the aggregate analysis of public investment. She largely confirms that it should not be a major component of short-run stimulus and that it does have major long-run benefits, but the relationship between the overall level and social optimum remains far from clear. Extending her machinery to examine both the heterogenous varieties of public investment and the many distortions and market failures in both public and private investment would be an exciting next step to further increase the modeling's ability to yield concrete (so to speak) policy recommendations.

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