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Measuring the cost of building infrastructure over time: Very hard to do well[☆,☆☆]

Leah Brooks

George Washington University, United States of America

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ABSTRACT

To determine whether constructing infrastructure in the United States is becoming increasingly expensive, as much recent research suggests, we need a reliable way to measure the cost of building infrastructure over time. In this paper, I outline the components of an ideal measure for such a cost. I then highlight three features — adjusting for quality changes, the inclusion of markups, and the inclusion of costs incurred by the administrative apparatus of the government — that plague measurements of cost. Expenditure-based measures have the potential to capture all costs, including those incurred in-house by the government, but suffer from difficulty in measuring a constant quality unit. Price- or cost-based measures are better at measuring a constant quality unit, but often fail to include very substantial costs borne by government in excess of funds paid to private contractors. I illustrate these issues with the example of US Interstate highways, explaining each measure's strengths and deficiencies. I conclude by discussing where researchers can make the most valuable contributions in measuring the costs of transportation infrastructure.

When I was ten years old in 1986, Atari released its dominant 7800 game console, retailing for $79.80, or $250 in July 2025 dollars.[1] This console was capable of playing no more than 500 games. If my parents had bought such a game console, my sister and I would have traveled to buy it on an Interstate highway for which we paid no direct fee, and played the console in a Southern California house worth less than $200,000, or $590,000 in July 2025 dollars. In 2025, I can now purchase (but have not!) a handheld PlayStation console that can play thousands of games for about the inflation adjusted cost of the 1986 Atari console, and the Southern California house is now roughly three times its 1986 inflation-adjusted value. The Interstate highway trip, however, remains free of charge.

These comparisons hint at the difficulties in accurately measuring price changes. These challenges are particularly severe for goods, such as the Interstate highway system, where end users do not pay market prices. We have a sense that the game console has decreased in price in real terms, since the quality of the console has increased considerably. We also understand that the price of the house has increased tremendously in real terms, as its quality has not increased anywhere near enough to compensate for the increase in price. But what of the Interstate? We do not have a market price to adjust, and it may be difficult to compare the quality of new segments with old ones.

Despite these difficulties, we care very much about the cost of producing a constant quality unit of Interstate — or any public infrastructure — because economists widely view infrastructure as a key input to growth. Whether that infrastructure is highways, trains, ports, airports, power wires or broadband cables, these inputs are central to growth in both developed and developing economies. We therefore care quite a bit about the underlying cost of infrastructure, which in part determines how much infrastructure a country can afford.

In the United States, both sides of the political spectrum currently clamor to build more public infrastructure. The left is interested in building more green infrastructure, including energy transmission lines and rail networks. The right is interested in building more roads and

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E-mail address: lfbrooks@gwu.edu.

[1] I adjust all figures in this paragraph with the Bureau of Labor Statistics inflation calculator (U.S. Bureau of Labor Statistics, 2025a).

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energy output. Both sides are interested in improving the quality of American infrastructure, including airports, ports, and roads.

However, even with the large infusion of cash from President Biden's multiple generous spending packages, expert consensus is that these additional funds did little to increase the quantity of infrastructure put in place in the United States (Furman, 2025; Liscow, 2025).[2] Furman (2025) and Liscow (2025) both suggest that the supply of road builders is relatively fixed—both because the field requires significant technical expertise, and because it requires significant administrative expertise in submitting the mind-boggling paperwork required for government work. When an infusion of cash meets a fixed supply of road builders, the cost, rather than the quantity of roads, increases.

While the debate over the outputs and outcomes of the Biden-era investments is of relatively recent vintage, it fits within a broader debate as to whether the physical output the US gets per dollar of infrastructure investment is declining. Fair (2025) notes that the stock of US infrastructure, as a share of GDP, began declining in the 1970s and has trended downward since. Because infrastructure writ large — highways, ports, supercomputer centers, water pipes and the like — is a crucial input into economic growth, declines in this type of investment should raise concerns.

To understand whether the US has an infrastructure cost problem, we must first agree on a viable measure for infrastructure cost over time. In this paper, I first discuss how one might measure the cost of infrastructure over time. I provide a framework that compares and highlights differences across existing measures of cost. The issues I raise in this paper about how we calculate price indices are general and apply regardless of national income. That said, the problem of rapidly increasing costs seems specific to the United States, perhaps extending to other former Anglo-Saxon colonies to a lesser degree. For example, Goldwyn et al. (2023) suggest that the cost to build trains, stations, and bus routes in the United States exceeds that in other developed countries.

I begin by outlining what an ideal measure of infrastructure cost should contain. In particular, I highlight three issues that trouble many index measures. First, does the measure capture the cost of producing a constant quality unit? Second, does the measure include markups that private contractors charge the government? And finally, does the measure include the government's own costs in the production of highways? I call these government specific costs those of the administrative apparatus.

To illustrate the issues of infrastructure cost measurement, I use examples from cost measurement of Interstate highways. That said, the framework I lay out and the issues I raise are not unique to highways, roadways, or even transportation infrastructure. I focus on Interstate highways in the United States because they are among the easiest types of infrastructure to compare across places and over time. While a 1950s highway is surely different from a 2010s highway, the two are more comparable and more amenable to a common denominator than airports, dams, or other large public investments. I focus on the flow of costs, not on the stock, with the goal of understanding how to create an index that could better measure the cost of producing infrastructure relative to producing everything else in the economy.[3]

Using the case of Interstate highways, I then follow with a discussion of what existing price and expenditure measures actually capture, and where they fall short of the ideal. Notably, the expenditure measure suggests higher cost growth than price or cost measures. I cover the Federal Highway Administration's National Highway Construction Cost Index, the Bureau of Labor Statistics' Producer Price index for roads and highways and the Bureau of Reclamation's Construction Cost Trends. I also discuss the expenditure based measure that Zachary Liscow and I present in Brooks and Liscow (2023). To illustrate the extent to which these issues are unique to transportation, I relate the distinction between price and expenditure measures to a similar difference in the measurement of housing and construction costs. I conclude by discussing the most promising avenues for researchers to improve on existing deficiencies in measurement.

1. An ideal measure of cost

Before discussing what existing infrastructure cost measures capture, I turn in this section to describing the properties of an ideal infrastructure cost measure. Most simply, an ideal infrastructure cost index should report the cost of building a constant quality unit of infrastructure in a given period. Put differently, for any period t, the index completely describes all components of the relative price, P_t, at which the government can build a constant quality unit of infrastructure.

1.1. Simple price index

To make the discussion below easier to follow, I now introduce some simple notation. My goal is to create a price index P_t that measures the relative price of producing one unit of a good of constant quality at time t. In any period, P_t is the price relative to a base period p_0, so that

$$P_t = \frac{p_t}{p_0} \ . \tag{1}$$

A price index is generally a weighted sum of multiple component prices. Here I index components with i, and allow for N total components, so that $i \in \{1, \dots, N\}$. I denote each component price at time t as $c_{i,t}$. An index combines component prices using weights, and I denote the weight for each component i as $w_{i,t}$. In any given period, these weights sum to one:

$$\sum_{i=1}^{N} w_{i,t} = 1 \ . \tag{2}$$

Thus, to construct a price index, we need both component prices and their relative importance to the final output, as expressed by the weights. In a given period, this gives us a price p_t that we can relate to the initial period:

$$p_t = w_{1,t}c_{1,t} + w_{2,t}c_{2,t} + \cdots + w_{N,t}c_{N,t} \ . \tag{3}$$

In this paper I abstract away from important discussions about the particular flavor of price index: Laspeyres, Paasche, Fischer, or other. I do so because I believe that the choice has few material implications for long run changes in infrastructure cost. The Federal Highway Administration provides an excellent explanation of the differences between these index flavors (Federal Highway Administration, 2025).

1.2. Terms of engagement

Throughout this paper, I take the choice of what to build as given, and focus on measuring the cost of per-unit provision. This per-unit provision cost is separate and distinct from a — also important — cost–benefit analysis. An ideal price measure, multiplied by units produced, is the cost part of a cost–benefit analysis across time and place.

In this paper, I discuss price, cost and expenditure indices. If measured consistently, all these indices would give similar results. We will see that they do not, at least in the case of Interstate highways.

Throughout, my focus is on the final cost to the citizen, which is the same as the total cost to the government. Citizens "buy" highways

[2] Tedeschi and Nostrand (2025) argue otherwise, suggesting that Furman used the incorrect deflator, and that with the correct deflation spending increases. I side with Liscow's interpretation that Furman's choice of the National Highway Construction Cost Index is likely the superior one, for reasons I detail below.

[3] A useful body of work discusses the even more difficult goal of measuring the stock of infrastructure and is deeply concerned with how to measure of depreciation; see Fraumeni (2007), Bennett et al. (2021), Kornfeld and Fraumeni (2024), Fraumeni and Kornfeld (2024).

and other publicly provided transport infrastructure by electing representatives who make policy decisions. Conceptually, my ideal measure is most akin to a consumer price index, which measures the cost of a final good to the consumer. Consider the simpler case of apple juice. The consumer price index for apple juice measures the price of apple juice when sold to the final consumer. My goal is to approximate this final price to the consumer.

Alternatively, one might focus on a measure of input prices, akin to a producer price index. In the case of apple juice, the producer price index measures the costs of inputs — apples, crushing machines, labor — to the apple juice producer. In the apple juice market, the division between the juice producer and the final retailer, usually a grocery store, is fairly clear.

In contrast, for government outputs, the distinction between producer and consumer is less clear. When the government produces infrastructure, it is both the producer of infrastructure and the final purchaser. Citizens, who fund the government and for whom the government acts as representative, are the final consumers. In general, states build highways, airports, ports and bridges by commissioning production from private contractors who build the structures. Beyond these direct payments to the private contractor, state governments incur additional costs. For example, states entitle land, plan routes and provide initial engineering drawings for projects. These are costs borne by the government as a producer, but not by the private contractor as a producer. Therefore, cost measures that include only the costs to private infrastructure producers, rather than total costs for the government — here the final consumer — are inadequate for our ideal cost measure. That said, a proper measure of all input costs should be the same as the sum of all output costs.

This ideal price measure for a constant-quality unit of infrastructure to citizens is also distinct from total spending. Total spending is the product of a price index, P_t, with political choices about Q_t, or how much to build. How much to build is a crucial question, and one outside the scope of this paper. That said, decisions about how much to build are surely influenced by the cost of building. Politicians choose to allocate limited funds across multiple categories and the costs of producing output in any given category influence allocation decisions.

2. Three factors that plague calculations

In thinking about an ideal measure of infrastructure cost, I highlight three issues that are longstanding measurement challenges for price indices and which may be particularly tricky in the case of infrastructure: quality, markups, and the administrative apparatus.

2.1. Quality

The goal of any price index is to measure the price of providing a constant quality unit over time. Before I discuss how to account for changes in quality in a constant quality index, I consider what “quality” means for publicly provided infrastructure. First, consider how we measure quality in the case of a privately produced good sold in the private market. Here, economists are interested in the price at which producers sell to consumers. When markets are perfectly competitive, this price reflects costs. When markets are imperfectly competitive, this price reflects costs and markups.

For example, the Bureau of Labor Statistics adjusts for car quality in their new car price index by adjusting for safety changes that impact car occupants, changes in electrical or mechanical features that modify the vehicle efficiency for the operator, changes in design that improve efficiency or durability, and changes that affect convenience and comfort. They explicitly do not consider changes that impact a car’s emissions for which the operator receives no direct benefit: “Adjustments are not made for … [c]hanges made solely to meet air pollution standards on models introduced in January 1999 or later and that do not otherwise provide direct value to the consumer. Price increases associated with such modifications are treated as increases in the index” (U.S. Bureau of Labor Statistics, 2025c).[4] Thus, for private goods, the purchaser receives private benefits and the price reflects those private benefits.

For publicly provided goods, a parallel definition of “quality” is not so clear. For example, the “quality” of a public transit system depends on the frequency of train arrivals and the cleanliness of trains. But part of the “quality” a transit system delivers is the benefits it provides to non-riders in the form of lowered driving time (Anderson, 2014). It is precisely this external benefit of transit that makes broad public funding of narrowly used transit feasible. Not all publicly provided goods yield positive externalities. For example, highways provide benefits to drivers but environmental costs to nearby residents.

Limiting the definition of quality to be the quality experienced by the purchaser does not solve this definitional dilemma. If we think of taxation as the primary method of purchase for publicly provided infrastructure, then we are interested in the quality experienced by the public at large. This quality should necessarily include both positive and negative externalities from the purchase.

Given this dilemma, which “quality” should a price index attempt to hold constant – the “quality” to the direct user? Or the “quality” to the taxpayer as purchaser? I do not believe that there is a right answer to this question. Instead, the answer depends on the goal of the measurement. A measurement that holds the direct characteristics of a good constant — train frequency, or road width — measures the price of providing the good to the direct consumer of the good. A measurement that holds the direct and external characteristics of the good constant — the traffic benefits of transit or the noise pollution from the highway — measures the price of providing a constant quality good to the final purchasers of that good: the taxpayers.[5]

Suppose, then, that we agree on a basket of “quality” features. Given this basket, a constant quality price index should report the weighted average of input prices in proportions that combine to produce a constant quality unit over time. In the case of highways, capital inputs include asphalt, concrete, steel, construction equipment, and many other smaller items. While these inputs may seem basic or simple, all have had substantial quality changes over time. For example, the addition of new modifiers to asphalt starting in the 1980s decreased rutting and increased durability. Indeed, the 2003 chair of the National Asphalt Pavement Association testified in his inauguration address that “In my time, hot-mix asphalt has changed dramatically” (Keunnen, 2003). To take another example, technological improvements between the 1970s and 1990s increased concrete’s compressive strength enormously, creating concrete that sets more quickly (Stix, 1993). An ideal measure should take these quality changes into account.

If we consider a more expansive definition of quality that includes externalities, this basket of quality features should also include features aimed at mitigating externalities. For example, port features that limit truck idling and the associated pollution, or transmission wire construction that limits fires, are part of quality when expansively defined.

One way to modify input weights ($w_{i,t}$) to address issues of quality is to use hedonic estimation. The Bureau of Labor Statistics and Bureau of Economic Analysis uses hedonic methods to assess product components and links items based on shared components (U.S. Bureau of Labor Statistics, 2018; Moulton, 2001). These types of adjustments have been

[4] As best I understand, this rubric for adjustment is not unique to motor vehicles. For example, household paper goods have incorporated more recycled content over time, but the Bureau of Labor Statistics makes no quality adjustments to “household paper products” at all.

[5] An anonymous referee queried whether the process of deciding about infrastructure could itself be part of a higher quality highway—not the better designed highway, but the better process in and of itself. This strikes me as outside the scope of even this more broadly defined quality measure, as it does not explain the quality of the good beyond the direct or indirect consequences of the infrastructure.

particularly important for certain types of computer technology, where quality changes are enormous (U.S. Bureau of Labor Statistics, 2022).

In the case of highways, a hedonic or other type of adjustment could yield a constant-quality price over time, to the extent that all quality components are measurable. To use a hedonic adjustment, analysts would have to observe, for example, concrete's strength, durability, pourability, and any other key features over time in order to adjust for their value. Concern over constant quality measures is ongoing, with active research in this area (Ehrlich et al., 2024).

2.2. Markups

In addition to adjusting for quality, a constant quality price index should include markups taken by private firms when selling to the government. Because governments "build" virtually all projects by commissioning work to outside contractors, government cost includes the firm markup. To be precise, the constant quality price index should measure the price at which the outside contractor sells to the government, not the prices at which outside contractors purchase inputs.

The most straightforward way to deal with this issue is by measuring the prices at which outside contractors sell to the government. These prices include any markups the outside firm extracts, as well as the costs of the firms' inputs.

Alternatively, researchers could combine measures of input prices with a markup index. The Bureau of Labor Statistics reports a markup index for non-residential building construction, and this measure has grown sharply in recent years (Wasilewski, 2023).

In the United States, firms bid for transportation projects of all types and bids are public at the conclusion of the bidding. Currier (2026) uses these data and concludes that markups have increased over the past decade, accounting for much of the rise in costs over this period. Interestingly, these data may in fact understate the true markup, since the amount of the winning bid need not be the final price paid by the government. Currier argues that competitive pressures fail to drive markups down because of the large fixed cost that complying with procurement requirements places on firms (Bagley, 2019; Trebbi et al., 2026).[6] This is consistent with work showing very few bids—and sometimes only one bid—for US federal information technology contracting (Kang and Miller, 2021).

2.3. Administrative apparatus

The price changes for labor or capital that I discuss above may be materially impacted by choices of the administrative state, as well as by policies dictated to the administrative branch by the legislature or judiciary. I refer to these entire set of constraints as the "administrative apparatus". These choices and policies of the administrative apparatus can increase or decrease costs.

Put differently, the government also has a production function. Like a private firm, it takes inputs — funding and rules from the legislature, prices that are sometimes market determined and sometimes not, combined with frequently inflexible human capital — and translates these inputs into infrastructure. It may well be the case, as Dabla-Norris et al. (2012) write, that "in many countries only a fraction [...] of the actual accounting cost of investment passes into the value of capital". This is problematic for cost estimates and their kin as "this obvious point is routinely ignored and cross-national estimates of physical capital are based on the assumption of full efficiency of public investment" (p. 236). Thus, just as firms may impose a markup that puts a wedge between the cost of production and the price at which they sell to the government, the government may add a wedge between the cost at which it purchases from the private firm and the cost to the taxpayer.

Many studies now suggest that government behavior is integral to long-run cost increases (Dunkelman, 2025; Klein and Thompson, 2025; Rosenthal, 2017; Barro, 2019; Goldwyn et al., 2023). It is therefore important to structure an index so as to include these costs. Notably, producer prices are unlikely to fully include these costs of government policy. For example, while the price a highway builder pays for asphalt likely reflects the regulatory environment for asphalt production and for trucks, it does not include the costs associated with protecting citizens from harmful asphalt components as mandated by the legislature. In contrast, measures of total expenditure must, by definition, include these costs. We discuss these issues in greater detail below.

Broadly, think of the administrative apparatus as having two parts: the rules of the game as given, and the behavior of bureaucrats conditional on these rules. In democracies, the rules of the game are largely determined by the legislature, but with sometimes important influence from the judiciary. When North and Weingast (1989) discuss executive-limiting institutions as a means of creating economic growth in their seminal examination of why England grew and Continental powers stagnated, they focus on limits on the seizure of private property. These rules were dictated to the king by a proto-legislature.

Conditional on the rules established by legislature or judiciary, the state appoints or hires bureaucrats and these bureaucrats make decisions. Decisions about rules and decisions conditional on rules may increase or decrease costs.

Rules of the game, as related to the production of infrastructure, include the rules of the procurement process, the extent of proceduralism, the extent and strength of veto points, the extent of contract enforcement, limits on pollution or noise, the mechanisms for participation in government, and myriad other forms. Not all rules of the game implicate increased costs. For example, Bolotnyy and Vasserman (2023) study the rules of the procurement process and find that the most commonly used form of procurement auction, a "scaling" auction that is usually mandated by state law, generates lower costs for governments than the alternative of a lump sum auction. However, Bagley (2019) argues that rules themselves — any one of them well-meaning and justified — deliver diseconomies of scale when combined. Or, more simply, if government requires a laborious permitting process, this increases the quantity of labor required for a given project. In my work, I have argued that if policy allows for veto points from many actors (Brooks and Liscow, 2023), these vetoes may raise the cost of planning and therefore the cost of the final output. Liscow and I term the features that largely arise from the 1970s onward that give citizens greater input into government "citizen voice". We argue that the rise of citizen voice helps explain cost increases.

Many of these rules work to increase costs, and it may be helpful to consider them as an internal government markup. But not all government rules need to work to increase costs. As North and Weingast (1989) remind us, if the government acts to make contract enforcement habitual and transparent, this decreases the cost of doing business and lowers prices (Nunn, 2007; Besley and Ghatak, 2010). Similarly, if government acts to coordinate where markets cannot, it can lower the costs of production. For example, Michaels et al. (2021) show that zoning in advance of urban development raises home values and eases later market transactions. In the present case, if the federal government regulates a nationally applicable standard for construction, this can lower firms' costs of producing infrastructure. For example, Goldwyn et al. (2023) suggest that were government to standardize the type of escalator requested across all subways stops in a line, this could meaningfully decrease costs.

Even given the rules of the game, governments still have scope for decisions that impact costs. How well government can undertake these tasks, either due to staffing or skill, is a measure of what some call "state capacity" (Liscow et al., 2025; Pahlka, 2023). Like firms, some governments are better managed than others, and are able to

[6] Kroft et al. (2025) also find substantial markups in government procurement auctions.

produce more outputs given the labor at hand. Corruption also impedes the translation of money into physical output. This is greater concern in the developing world, but the issue is certainly not absent in the developed world.[7] For example, Collier et al. (2015) document that across countries, weaker institutional environments, including those with greater corruption, have higher road construction costs.

Just as an ideal price index should hold quality constant and should include private sector markups, an ideal cost index should not remove or hold constant government-driven price changes. Although an index should not remove these costs, it would be useful to segregate the costs of the administrative apparatus. This would give policymakers a dollar value impact of their choices. I know of no research that does this for public infrastructure, and this may be a fruitful path for future work.

2.4. Implementation

Thus, an ideal index is a weighted average of all input prices for capital and labor, where weights are each component's share of total cost. For example, if pre-construction engineering becomes relatively more important over time, the constant-quality price for government engineering should receive a larger weight over time. Or if permitting compliance costs become a larger portion of the government labor cost, these labor costs should receive a greater weight.

The ideal measure we have outlined is both rhetorically useful and likely virtually impossible to faithfully implement. That said, working toward such a measure is crucial for making policy decisions, since a valid measure of the cost of construction infrastructure over time is one-half of the crux of any cost–benefit analysis. Problems here are indeed thorny. For example, how might one calculate a constant quality measure of legal services? In the next section, I compare the existing measures of infrastructure costs against the baseline of this ideal measure.

3. What we actually measure and what conclusions these measures yield

I now turn to comparing existing price or cost measures in the literature with our ideal baseline. This measurement choice is consequential. In Fig. 1, I show the major indices for which I can establish a common temporal comparison. The figure clearly shows that increases in the expenditure-based measure in red far outpace changes in the price and cost measures in blue and green. In this section, I discuss the underlying drivers of these discrepancies. I first consider measures based on prices and costs and then move to measures based on expenditures. Properly measured, all three types of indices should generate the same costs.

3.1. Price and cost indices

The government produces multiple measures that aim to track infrastructure costs via measured prices or costs. Here I discuss the three most prominent of these indices: the Department of Transportation's National Highway Construction Cost Index, the Bureau of Labor Statistics's measure of street and highway input costs, and the Bureau of Reclamation's Construction Cost Trends. For each measure, I summarize how the government calculates it, and evaluate it against the baseline of the ideal index I motivated above.[8]

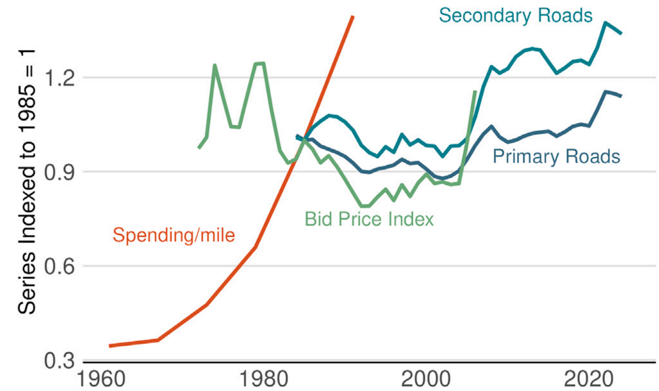

Fig. 1. Expenditure based measure shows far more growth than cost or price measures.
Notes: This figure shows spending per mile from Brooks and Liscow (2023), the Bid Price Index from the Department of Transportation and the Primary and Second Road Construction Cost Trends from the Bureau of Reclamation. I deflate all series to 2016 values using the Consumer Price Index, and index all series to 1 in 1985.

3.1.1. Department of transportation measures: Bid Price Index and National Highway Construction Cost Index

I begin with the Department of Transportation's construction cost index, probably the most widely used of the three indices I discuss. Since the early 1970s, the Department of Transportation's Federal Highway Administration has created an index based on contractor bids for federal projects. The first index based on these data was the Bid Price Index, which Federal Highway Administration produced from 1972 to 2006 (U.S. Department of Transportation, Federal Highway Administration, Office of Infrastructure, Office of Program Administration, 2007). In 2003, Federal Highway Administration created the National Highway Construction Cost Index (NHCCI), which it continues to produce today.[9]

The prices upon which the index is built come from the winning bids submitted by contractors for transportation projects. These bid documents include line items for each component of the bid. For example, the Oregon Department of Transportation's contract 15530 awarded the lowest bidder the right to repave a segment of Interstate 5. Fig. 2 reports one page of this 19 page bid document, and shows the bids from the three bidders (Carter and Co. is the lowest bidder) for component parts including excavation and laying aggregate base. For each line item, contractors report the number of units that they provide as well as a total price. Interestingly, rules prohibit labor as an explicit line item. Instead, contracts bake labor costs into each component. From Fig. 2 example, "General Excavation" includes both capital and labor costs. Therefore, these bids give the Federal Highway Administration measures of component prices ($c_{i,t}$ above) for all key highway inputs, including labor.[10]

The Federal Highway Administration then uses weights ($w_{i,t}$ above) to combine these prices in any given period. The Federal Highway Administration calculates these weights as the component's share of

[7] Alexeeva et al. (2008) provide advice on how to look at reported costs to detect corruption, and Alexeeva et al. (2011) present an interesting analysis of the government's role in road contracting in World Bank client countries in Europe and Central Asia.

[8] Focusing on recent years, the Eno Center for Transportation released a helpful overview of these indices and an analysis of potential drivers (Truslow, 2025).

[9] The Federal Highway Administration has an excellent overview of its methodology in Federal Highway Administration (2021a). In 2007, Congress was sufficiently concerned to ask the Federal Highway Administration to consider the scope and causes of cost increases. In a responding report, the Department of Transportation's Office of the Inspector General concluded that commodity price increases were the likely culprit for the increases over the pre-Financial Crisis price run-up U.S. Department of Transportation Office of Inspector General (2007).

[10] The Federal Highway Administration uses a Fischer Ideal index formula for calculations Federal Highway Administration (2021a).

Oregon Department of Transportation

Tabulation of Bids

Line No / Item ID Item Description		Quantity and Units	(1) CARTER & COMPANY INC		(2) HP CIVIL INC		(3) WILDISH STANDARD PAVING	
			Unit Price	Ext Amount	Unit Price	Ext Amount	Unit Price	Ext Amount
SECTION: 0002	ROADWORK							
0230	0330-0105000K	126.000	51.96000	6,546.96	100.00000	12,600.00	200.00000	25,200.00
GENERAL EXCAVATION		CUYD						
0240	0350-0105000J	865.000	2.25000	1,946.25	1.00000	865.00	7.00000	6,055.00
SUBGRADE GEOTEXTILE		SQYD						
	Section Totals:			$54,713.21		$37,465.00		$58,255.00
SECTION: 0003	BASES							
0250	0640-0100000M	370.000	66.50000	24,605.00	70.00000	25,900.00	90.00000	33,300.00
AGGREGATE BASE		TON						
	Section Totals:			$24,605.00		$25,900.00		$33,300.00

Fig. 2. Indices based on price.
Notes: This figure presents an example of a bid, here a portion of items bid in a contract to repave part of Interstate 5 in Oregon. This example comes from page 5 (of 19) from this bid document: https://www.oregon.gov/odot/Business/Procurement/SiteAssets/Lists/Project/EditForm/C15530_BT.pdf. Carter and Company is the winning bidder, and HP Civil and Wildish Standard Paving are the two other bidders.

value in the total cost. For example, if asphalt accounts for one-quarter of the cost of construction at time t, the price of asphalt receives a weight of 25 percent in the price index at time t. Because components vary over time in their contribution to total costs, these weights also vary over time. Unfortunately, these weights are not public, so I cannot present them or evaluate their change over time. The Federal Highway Administration computes the weights based on bids.

The Federal Highway Administration index does not aim to measure the price of producing a constant quality unit over time. Instead, this index measures private contractor's costs for producing the cost-weighted average state project in a given period. Thus, the NHCCI and its predecessor are cost indices. Because it is the price at which the private contractor sells to the government, it includes markups taken by the private sector contractor (Federal Highway Administration, 2021b).[11]

Though in general one should be concerned about the impact of changes in labor productivity on index measures, I do not believe that these changes impact this index. Contractors report the amount of labor included with each line item in a way already determined by productivity changes. Put differently, changes in labor productivity affect costs and are baked in.

While the NHCCI is best understood as a measure of average cost, it is important to note that it does not include all costs of construction. Bid prices are neither the contractor's final price for producing work, nor the government's total cost of producing output. The prices the contractor bids are for the purposes of winning a bid are the "bid price". This may differ from the final price that the contractor charges the government (Liscow et al., 2025; Brooks and Liscow, 2023). Differences could stem from the government changing what it wants to build, or from some unforeseen difficulty in construction. While many projects may come in at the cost bid by the contractor (Liscow et al., 2025), the very small share of contracts that come in over bid meaningfully impact average cost. Flyvbjerg et al. (2003) finds that both politicians and contractors prefer under-cost initial bids to make a project get started, and pair these with later cost increases.

Additionally, governments incur costs above and beyond those incurred by private contractors. For each project put out to bid, the government must do preliminary work to prepare the bid and detail what it wants. It may also purchase land or consult with citizens about what the best project might be. Governments also face litigation risk, and costs to protect against litigation risk, that are beyond those costs reflected in the bid.

Therefore, the NHCCI and its predecessors are best understood as useful lower-bound measures of private sector contractor cost in the production of infrastructure. Fig. 3 shows the Federal Highway Administration's two price indices over time. Both increase, and by this measure costs are about three times as high in 2025 as they were in 2000. In comparison, using a CPI adjustment, $1 in 2000 is now worth $1.91.

3.1.2. Bureau of labor statistics: Producer price index for streets and highways

Another prominent construction cost measure is the Bureau of Labor Statistics's producer price index for the production of infrastructure, specifically roads and highways. Producer price indices are designed to measure "the selling prices received by domestic producers for their output" (U.S. Bureau of Labor Statistics, 2025b). In the case of roads and highways, the "producer" is somewhat ambiguous: is it the private contractor, or the government? In practice, the Bureau of Labor Statistics measures the producer price index for roads and highways for private contractors, not the government.

Producer price indices are particularly difficult to measure in industries where output is not sold in the market. This is surely the case for streets and highways, which have publicly available bids, but not market prices. In this case, the Bureau of Labor Statistics writes that "Although PPI cannot develop output price indexes for industries that produce no marketable output, it can develop input indexes for them" (Hoglund et al., 2015). While the Bureau of Labor Statistics gives the example of "membership associations and organizations", the definition of an industry with non-marketed output equally well fits the production of roads and highways by government (Hoglund et al.,

[11] Onayev et al. (2022) create their own price index based on bid prices from 2005 to 2017. They examine the impact of quality, productivity and markup determinants of cost increase. They do not explore the role of the administrative apparatus.

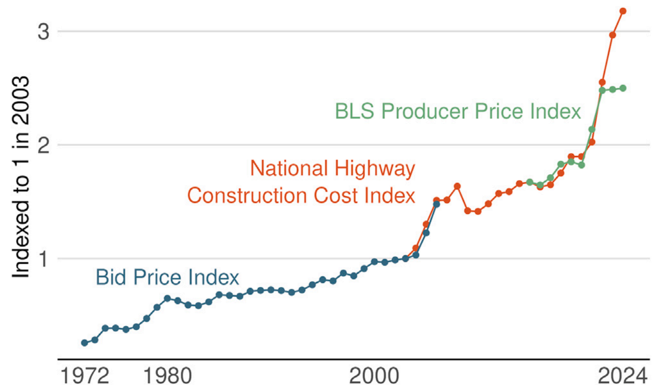

Fig. 3. Indices based on price.
Notes: This figure shows the three most prevalent highway construction price indices. I report the Federal Highway Administrations's Bid Price Index, and the index that supersedes it, the National Highway Construction Cost Index. I index both of these series to 1 in 2003. I also show the price index the Bureau of Economic Analysis uses to value infrastructure. This index is the Bureau of Labor Statistics series WPUIP231231. I set this Bureau of Labor Statistics series equal to the NHCCI in 2015.

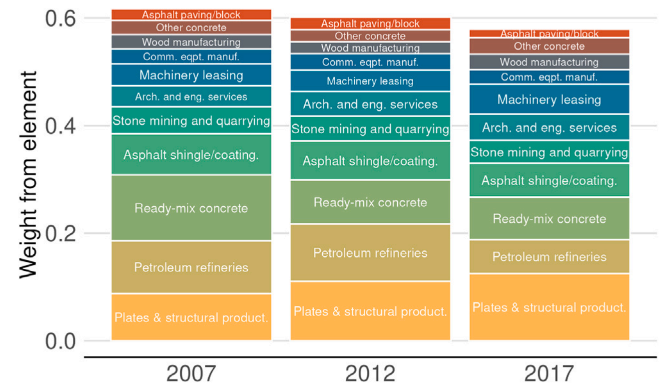

Fig. 4. Weights for Bureau of Labor Statistics Price Index.
Notes: This figure shows weights $w_{i,t}$ for the Bureau of Labor Statistics producer price index. Bureau of Labor Statistics and BEA adjusts weights every five years in line with the economic census. I show the components that rank in the top ten of the component share in any of the three years. Weights are the relative share of all intermediate inputs. Bureau of Labor Statistics excludes compensation of employees, taxes, and gross operating surplus from these calculations. Data come from the sheet "The Use of Commodities by Industries, After Redefinitions (Purchasers' Prices) - Detail" (`IOUse_After_Redefinitions_PUR_Detail.xls`), which I download from the BEA here. I shortened some category names to fit the graphic. Full names are "Comm. eqpt. manuf." = "Other communications equipmen manufacturing." ; "Wood manufacturing" is "Veneer, plywood, and engineered wood product manufacturing"; "Asphalt paving/block" is "Asphalt paving mixture and block manufacturing"; "Asphalt shingle/coating." is "Asphalt shingle and coating materials manufacturing"; "Ready-mix concrete" is "Ready-mix concrete manufacturing"; "Other concrete" is "Other concrete product manufacturing"; "Plates & structural product." is "Plate work and fabricated structural product manufacturing"; "Machinery leasing" is "Commercial and industrial machinery and equipment rental and leasing"; "Arch. and eng. services" is "Architectural, engineering, and related services.".

2015). Indeed, the Bureau of Labor Statistics suggests that these input indices may be the best practicable choice for such industries, writing that "[these] input indexes could potentially be used in deflating non-marketable output" (Hoglund et al., 2015). Even on the limited set of roads that do toll — the closest analogue to a marketable output — tolls are probably less likely to reflect costs than input prices, so the input index may very well be the best practicable solution from Bureau of Labor Statistics's tool box. As I detail below, these input price indices do not include markups and account for some but not all changes in productivity.

Over time, the Bureau of Labor Statistics has produced two series for road and highway input costs. The first ran from 1986 to 2010 (Bureau of Transportation Statistics, 2002). In the 2010s, the Bureau of Labor Statistics undertook a major measurement revision and created the new "Inputs to highways and streets, excluding capital investment, labor, and imports", (code WPUIP231231) beginning in 2015 and continuing through the present. I concentrate on this second index here.

Like all price indices, the Bureau of Labor Statistics's index is a weighted average of commodity input prices. These input prices (my c_t) are constrained to be the same across all industries. That is, by construction, highway contractors, residential developers, and power plant producers face the same commodity price for asphalt. If for some reason the price of asphalt or concrete used in roads and highways differs in price from the overall average price, the PPI for roads and highways will fail to capture this difference.

Because the Bureau of Labor Statistics PPI uses a Laspeyres price index, weights for commodities (my $w_{i,t}$) are the quantities consumed by the highways and streets sector in the initial period. The Bureau of Labor Statistics takes the total value of commodities from Economic Census data on industry output. It then attributes these outputs to industries that use these inputs based on data from the Bureau of Economic Analysis that link inputs to outputs by industry. In practice, Bureau of Labor Statistics generally updates weights as new information from the Economic Census becomes available (U.S. Bureau of Labor Statistics, 2011, footnote 7).

These weights are public, and I present the commodities that account for the largest portion of costs in Fig. 4. Each bar shows the weight associated with the Economic Census year denoted at the bottom. All items but "architectural and engineering services" are goods, rather than commodities.[12] Steel products, concrete, asphalt and oil are the largest categories in Economic Census years 2007, 2012 and 2017, together accounting for about one-third of the total costs in each year. Interestingly, it is difficult to separate out the role of construction equipment, as many categories are manufacturing, which mixes the costs of raw inputs and machinery.

The Bureau of Labor Statistics says that their PPI series aims to measure prices for producing a constant quality unit, writing that "... when changes in physical characteristics of a product cause product cost differences, the Bureau of Labor Statistics attempts to make an accurate assessment of real price change by systematically taking account of differences in quality. The explicit quality adjustment method is especially important with automobiles, machinery, and other types of goods that undergo periodic changes in their model. The usual method of quality adjustment involves the collection of data from companies in the PPI sample reporting on the costs they incurred in connection with the quality change" (U.S. Bureau of Labor Statistics, 2011, p. 3). Put succinctly, while the PPI for highways and streets does not adjust for output quality directly, the Bureau of Labor Statistics does quality adjust the commodity indices upon which the PPI is based (Weinhagen, 2025). Thus, I classify this as an index that, at the very least, tries to adjust for quality.

The Bureau of Labor Statistics's PPI includes labor to the extent that labor appears in purchased services or commodity prices. As Fig. 4 shows, the only service that gets appreciable weight is "architecture

[12] When the Bureau of Economic Analysis calculates the value of infrastructure stocks, it uses a combination of this PPI and the Employment Cost Index to make data real.

and engineering services''. This input cost should account for changes in labor productivity, if the price for the commodity measures the price of purchasing a constant quality unit of engineering services.

Although the index may not suffer from large issues due to changes in labor productivity, the Bureau of Labor Statistics's measure does not include contractor markups. The Bureau of Labor Statistics's price measure is so far upstream from production — measuring the prices producers of streets and highways pay to purchase inputs for construction — that it cannot capture the markup by the contractor on prices charged to the government.

The Bureau of Labor Statistics PPI certainly does not include any costs additionally incurred by the government, or any of the costs of the administrative apparatus I discuss above. To the extent that features of the administrative state serve to make markets more functional, these should be reflected to some extent in the input prices that contractors pay.

Fig. 3 shows the Bureau of Labor Statistics PPI alongside the NHCCI. These indices run largely in parallel until 2022. At this point, the NHCCI increases and the PPI does not.[13] Increased markups can explain a divergence between these two series. The timing of the divergence is coincident with the aftermath of the passage of the Inflation Reduction Act in 2022. This legislation increased demand for the production of infrastructure, and it may be the case that supply was slow to respond. Such a situation could cause the Bureau of Labor Statistics producer prices, which do not include markups, to grow markedly less rapidly than the NHCCI "consumer" prices, which do include markups. Indeed, the Bureau of Labor Statistics's measure of markups in the related industry of non-residential building construction grew sharply starting in 2022 (Wasilewski, 2023).

3.1.3. Bureau of Reclamation Construction Cost Trends

The Bureau of Reclamation produces the last of the three major price indices, and has data available from 1984 to the present. It produces separate construction cost indices for many types of infrastructure projects, including pipelines, powerplants, and dams. Relevant to this paper, the Bureau of Reclamation also measures costs for primary and secondary roads. Their website says that their index contains both labor and capital costs (U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, 2025). According to the Bureau of Reclamation website, in the past the Bureau of Reclamation calculated indices from their own internal project costs. Over time, the Bureau of Reclamation has done substantially less building, and now bases its calculations on three component parts: the Bureau of Labor Statistics PPI I discuss above, the Department of Agriculture's Land and Rental Prices data, and construction cost estimates from *Engineering News-Record*.[14]

Without further detail, it is difficult to understand whether this index controls for changes in quality, though it seems likely it does not. The issue of whether the index contains markups is more nuanced. Data from the PPI do not include markups. If the *Engineering News-Record* data are based on estimates from private contractors from the prices they charge for outputs, those data do contain markups. Therefore, these data likely partially include markups.

Finally, whether from the PPI or *Engineering News-Record*, these measures include costs due to the administrative apparatus only to the extent that government decisions lead to more security or predictability of contracting. They do not include any costs to the government for route preparation and engineering, nor do they include costs of litigation or citizen voice.

Though the Construction Cost Trends (CCT) indices use different inputs, they largely parallel the NHCCI, as Fig. 5 shows. Like the Bureau of Labor Statistics PPI, the CCT indices remain flat in recent years while the NHCCI — the only index that includes markups — has increased.

[13] Interestingly, even changes in this PPI exceed the overall rate of inflation (Van Nostrand et al., 2023).

[14] See https://www.enr.com/economics.

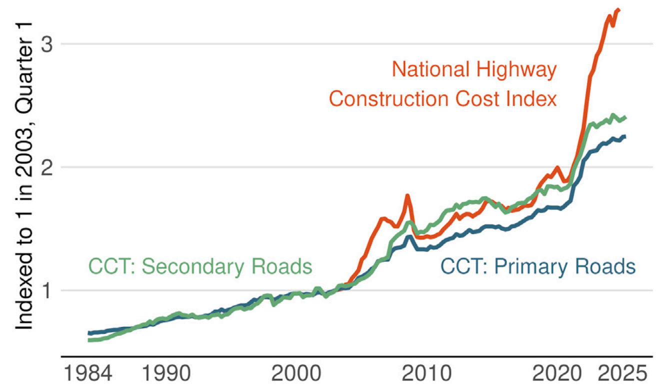

Fig. 5. Bureau of Reclamation Construction Cost Trends.
Notes: This figure presents construction cost indices by quarter from the Bureau of Reclamation's Construction Cost Trends, as described in Section 3.1.3, for primary and second roads. I set the indices to one in 2003 Q1. For comparison, the figure also includes the National Highway Construction Cost index, as described in 3. I normalize this series to 1 in the first quarter of 2003 as well.

3.1.4. Prices and costs, in sum

In sum, these price and cost indices include some, but not all, ideal features. Table 1 presents a summary of the three key features by index. Some of the price measures deal with quality issues. The more we believe we should measure quality to citizens at large and not just to road consumers, the more inadequate current quality controls are. Some of the indices at least partially include markups. And none of the indices include costs to government beyond those paid by private contractors. This is particularly concerning, as many sources suggest that these are potentially the category of costs that have seen the largest uptick in recent decades.

3.2. Expenditure based measures

While price indices are one useful way of aggregating measures of cost, we show that, as implemented, they may fail to include important cost drivers. One alternative is to measure expenditures. In this method, researchers observe total government expenditures, $P * Q$, and divide total expenditures by units of output, Q, to arrive at a measure of per unit cost P per unit Q. If a researcher observes both P and Q, this index is easy to calculate and conceptually simple to explain to policymakers.

However, observing P and Q is not a given. Even for recent years, comprehensive US data do not exist to measure the most common type of highway cost—road repaving. While researchers may be able to measure total costs by states, they cannot tie costs for an individual project to project-specific outcomes, limiting researcher ability to be precise about costs.

Even beyond these data limitations, dividing expenditures by quantity is not a panacea. Relative to other measures, it too has benefits and costs. A crucial benefit of the expenditure based method is that it gives a comprehensive measure of cost to the government. By definition, measures of total expenditures include all expenses incurred by the government. Therefore, this method surely avoids the problems inherent in trying to completely survey all possible categories of cost inputs. Unlike measures of input prices, it measures total production costs borne by the government.

Furthermore, comprehensive expenditure measures necessarily include the costs of government policy choices. Therefore, expenditure based measures capture soft costs, such as litigation costs, internal planning costs, or citizen voice costs that price indices omit and would struggle to capture even if they attempted to measure them.

Whether or not total expenditures is really a comprehensive measure is a data question, which researchers should contemplate carefully.

Table 1
Measures of infrastructure cost.

Index	Years available	Does it hold quality constant?	Does it include markups?	Does it include costs of the administrative apparatus?
Price Measures				
NHCCI/Bid Price Index	1972–200X, 2003 to present	no	partially	no
Bureau of Labor Statistics PPI	2015-present	possibly, unclear how	no	no
Bureau of Reclamation Construction Cost Trends	1984-present	no	partially	no
Expenditure Measures				
Brooks and Liscow (2023)	1956–1993, six year intervals	no	yes	yes

Notes: This table summarizes the major sources that describe highway costs over time, including the years those sources are available, and notable features about each index. See text for greater detail.

In the case of Interstate highway expenditures in Brooks and Liscow (2023), we capture the total cost of the Interstate highway as reported by states to the federal government. This includes the administrative apparatus of the state's Interstate highway building system, including supervision and planning.[15] It likely does not capture the time spent by the state's Secretary of Transportation and his or her staff on Interstate issues, but these costs are likely quite small relative to the total cost.

For other types of transportation expenditures, researchers should be conscientious when looking for a comprehensive measure of costs. For example, if a local transit agency builds a new rail line, total expenditure on the construction contract is not a good measure of total cost. This measure surely fails to cover the cost of the in-house staff from the local transit agency over the many years preceding the contract and in the years monitoring while construction occurs. In practice, it may be quite difficult to separate these pre-planning costs of contract supervision from a transit agency's overall budget.

An expenditure method expresses costs relative to an intuitively understandable unit of Q. This is easier to understand than a hedonic compilation of attributes. For example, recent papers have used a highway mile (Brooks and Liscow, 2023) and the relative roughness of roadways (Currier et al., 2023). Expenditure per highway mile constructed is a clear measure of cost per unit. Expenditure per roughness requires more nuance. If we are interested in expenditure per new unit constructed, then we are interested in expenditure per roughness as of construction. Alternatively, expenditure in year t per roughness in year $t+10$ seems quite interesting—but combines demand for the roads (the amount of driving) and the initial quality of construction. While one could divide expenditure in year t by average road roughness in year t, this denominator uncomfortably combines both the new flow of roads and the quality of the existing stock.

Even supposing that a plausible denominator by which to normalize expenditures exists, expenditure methods still have a fundamental drawback. If the unit Q changes quality over time, and the index does not change the denominator to reflect this, the index is not reporting a cost for a unit of constant quality. Changes in quality limit the ability to draw precise conclusions from comparisons over time. For short periods of time, quality change can be small, and unlikely to materially bias comparisons over time. However, over longer periods, quality changes may be substantial, and it may become more difficult to interpret these measures absent additional information about quality change.

Our empirical example, Interstate highway miles, has surely changed quality over time. To give one example, concert goers at the Hollywood Bowl were sufficiently angered by freeway noise intruding on their music idyll to spur a 1958 UCLA engineering study for solutions. This study suggested noise walls to mute the sonic disruption from the Interstate traffic. California's Department of Transportation did not implement this suggestion until 1968, and noise walls did not appear on Interstate highways broadly until the 1970s, gaining ground after the Noise Control Act of 1972 (Wagner, 2016). The reduction in noise that these walls generate yield an improvement in quality: noise decreases capitalize into property values (Moretti and Wheeler, 2025) and make concerts at the Hollywood Bowl more enjoyable. Interstates have also become smoother over time (Mehrotra et al., 2024, see Figure 1(c)). Quality increases have surely occurred elsewhere on Interstates and in other forms of transportation infrastructure. Thus, unadjusted expenditure based cost measures combine both quality and price changes.

In Brooks and Liscow (2023), we show that the cost of building a mile of Interstate highway increases over three times in real terms from the dawn of the Interstate era to the close of its large-scale construction in the early 1990s. In that paper, we divide federal highway expenditures in a given year—90 percent of the cost of the Interstate system—by the number of miles constructed in that year (in practice, we do some adjustments to make spending with construction year). While we do many regression adjustments for the difficulty of physical construction (elevation, ruggedness, pre-existing population density), we do not adjust for changes in the quality of the highway constructed. Thus, our estimates combine quality and price changes.

Fig. 6 compares the cost increase we measure in Brooks and Liscow (2023) with the Bureau of Labor Statistics PPI, measures of construction wages and compensation over time, and the Bureau of Labor Statistics construction equipment price series. The increase in per unit expenditure we measure dwarfs changes in these other measures. In my view, while the expenditure measure we document is likely upward biased due to unmeasured quality improvements, those improvements are not large enough to account for a more than three-fold increase in expenditure per mile.[16] As I discussed in Section 2.3, we posit

[15] The 1970 volume of *Highway Statistics* writes "In the use of Federal aid for highway construction, the States initiate the improvements to be made. They make the surveys and the plans, let the contracts, and supervise the construction" (Federal Highway Administration, 1970, p. 65).

[16] Uribe (2024) extends measures of expenditures on the Interstate system after Brooks and Liscow (2023) closes in 1993. I attempted to continue the series from Brooks and Liscow (2023) with their data, but was unable to generate estimates that lined up for years that overlap. My best guess is that this is due to our use of different measures of expenditures, as Mehrotra et al. (2024) document in their paper. Researchers wishing to resolve this issue should look at the expenditure source totals as a starting place.

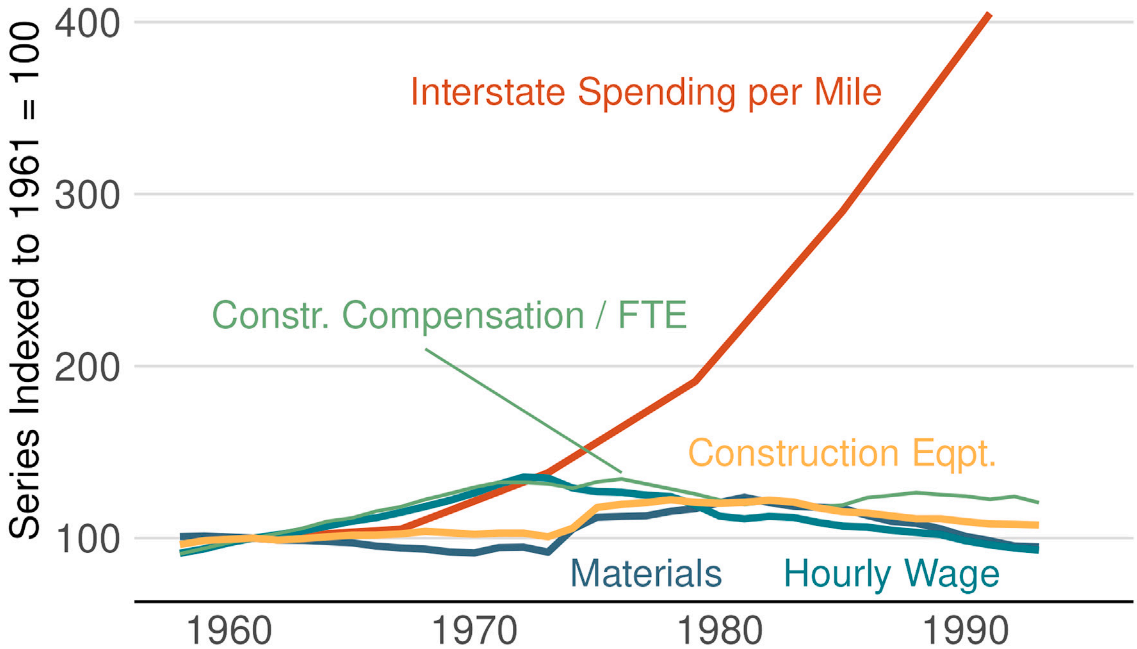

Fig. 6. Brooks-Liscow Interstate Expenditure Estimates.
Notes: This figure reproduces Figure 5 from Brooks and Liscow (2023). Interstate spending per mile is from the six-year periods in Brooks and Liscow (2023) with the addition of an index for construction equipment. Construction hourly wage is from the Bureau of Labor Statistics; construction compensation per full-time employee from the Bureau of Economic Analysis; and materials and construction equipment prices are from the Bureau of Labor Statistics. I adjust all series with 2016 values with the Consumer Price Index, and index all values to 100 in 1961.
Source: Reproduced with permission from Brooks and Liscow (2023).

that change in statute and in judicial decisions gave rise to greater citizen voice, and this greater input into government decision making increased costs.

3.3. Related but distinct cost measures

In addition to the measures I have discussed above, the literature is enriched by alternative measures of cost and quality. I do not attempt a complete review here, but highlight two recent papers. Mehrotra et al. (2024) use offer an alternative method for measuring the cost of the Interstate highway over time, focusing on what they call the "user cost", which they define as the marginal cost of vehicle miles traveled to the public. Because the authors use expenditures, this measure includes the administrative apparatus cost elements discussed here and also considers the cost of capital. This yields an interesting and conceptually quite different measure than the ones I consider here, marrying both the cost of construction and the cost of capital to the government. The cost of capital should appear in the prices indices above, but only inasmuch as it impacts the behavior of private contractors. To the extent that lawmakers make choices about expenditures based on the cost of capital, this cost may appear.

Turning the focus to quality, Currier et al. (2023) evaluate road quality using cross-sectional data from Uber. They find wide variation in road quality across the United States, with poorer and more minority areas more likely to have lower quality roads. While these estimates are not costs, they may provide the basis for data that researchers or governments can use to potentially adjust for quality. This is most useful to the extent to which researchers have separated out the quality of existing roads from the quality of newly constructed roads.

4. Comparison to housing cost literature

Before discussing paths forward to better measurement, I shift to make comparisons to the literature on housing costs, which has also been very concerned both about the measurement of costs and about the increase in construction costs. In addition, both the infrastructure and housing literature identify government costs by looking at a wedge. In housing, this is the difference between the cost of production and the sales price. For infrastructure, it is the difference between the price as measured by inputs or bids and the government's total expenditure. Are there insights from the housing cost literature that could help us improve on the measurement of costs in infrastructure? And are the issues I describe in this paper important in the measurement of housing costs, too?

Fig. 1's comparison of the expenditure based measures of cost to the price based measures shows that expenditure-based measures report substantially greater cost increases than input-based measures. The two most likely omitted culprits in bridging this divide are markups and costs due to the administrative apparatus. A similar bifurcation in measurement appears in analysis of drivers of the large run-up in house prices in recent decades. Specifically, since at least the mid-1970s, researchers and pundits have expressed consternation about increasing housing prices, as well as potentially flat or decreasing construction labor productivity.

Analysis for this industry has a parallel to the two types of measures I discuss above. Early influential work by Glaeser, Gyourko and Saks looked at home prices—the correlate of expenditure measures above—and compare those prices to measures of construction cost, akin to the PPI measures from the Bureau of Labor Statistics (Glaeser et al., 2005a,b). They argue that the wedge between the price at which housing sells and the marginal cost of physical construction gives an estimate of the regulatory barriers to building. These regulatory barriers are a close parallel to the administrative apparatus that I describe above, and in fact many share some direct behaviors, such as permitting and litigation costs.

However, it is not clear that the wedge between market transactions and producer prices is a full measure of the cost of the administrative apparatus at work. Recent work suggests that even the production cost portion of housing production — that is, the cost of construction itself, and not the cost of compliance — is either rising or failing to decrease in the presence of obvious technological improvements. D'Amico et al. (2024) show that homes built per construction worker increased after the end of World War II, but decreased dramatically from 1970 onward. These authors argue that construction has failed to be able to take advantage of economies of scale, due to land use regulations — the administrative apparatus, here — that have limited the size of new home development.

Goolsbee and Syverson (2023) and Garcia and Molloy (2025) both agree that construction productivity has fallen precipitously in the US since the 1970s. Goolsbee and Syverson (2023) grapple with whether this is a true decline or an artifact of deflators used in this work. They find, using a physical measure of output, that productivity declines. Garcia and Molloy (2025) further investigate issues of quality, parallel to those I discuss above. Perhaps the precipitous decline in construction productivity is a mirage, and the quality of housing is actually sufficiently increasing to explain the decline in construction productivity. However, even with rigorous controls for quality, Garcia and Molloy (2025) conclude that construction productivity is still declining. Further, Garcia and Molloy offer suggestive evidence that long permitting timelines — features of the administrative apparatus — are associated with failure of productivity to grow.

While there has been a recent burst of interest in construction productivity, concerns about its absence date back more than fifty years. A 1985 paper discusses the absence of productivity gains in construction, and attributes it to both smaller projects, as in D'Amico et al. (2024), and to an inappropriate deflator that overstates productivity declines (Allen, 1985). A 1965 paper suggests that no appreciable productivity decline had occurred, popular consternation aside; this may well have been correct in 1965 (Dacy, 1965). The Bureau of Labor Statistics convened a panel of experts to discuss measurement in 2016, and produced an overview (Sveikauskas et al., 2016).

While these parallels provide interesting food for thought, important differences exist between how the US produces housing and how it produces infrastructure. In the housing case, almost all costs — even those driven by the administrative apparatus — are borne by private actors. Except perhaps for affordable housing, developers bear much of the costs of compliance with local land use regulation. Private developers and the government hold meetings to interact with citizens, and developers must modify projects to suit local demands as expressed by and through the government. Even with affordable housing, these costs are shared, and not borne entirely by government. In contrast, when private highway contractors build for the government, these private contractors have less responsibility for convincing the public that the proposed project is worthwhile. If they interact with the public, their responsibilities are more often limited to convincing the public that a particular construction method or closure is required. Thus, private contractor costs should not be a complete measure of the costs of the administrative apparatus.

5. Looking forward: Where can we improve?

Having considered all of these measures, my view is that no current index or estimate meaningfully captures the full cost of producing a constant-quality unit of infrastructure. The absence of such a measure substantively impedes our understanding of the magnitude and drivers of cost increases.

However, data and methods exist to make improvements. Chief among feasible improvements is the ability to more closely approach a constant quality measurement. Recent data advances make this very promising. For example, Swei et al. (2021) suggest a method for normalizing by "lane miles of service", where the quality of service is measured by road roughness. This type of approach may be even more feasible if index makers are able to access the very granular type of data that Currier et al. (2023) use to measure road roughness. Such data would allow us to separate out the quality of new and existing roads, or to consider the long-run quality or durability of roads, ideally, conditional on the traffic that the road receives. Similarly, Liscow et al. (2025) also use measures of road quality to adjust toward a constant quality measure of prices. It is unclear how we could extend these measures of quality backward in time—a job for a very clever researcher!

Beyond roughness, we may be able to push on other dimensions of road quality, such as directness in routing, or the noise volume they induce, as in Moretti and Wheeler (2025).

When we have managed to create a constant quality index, the next logical step is to attempt to understand what drives movement in this index. Here we are interested in changes in input prices, in markups, and in the impact of the administrative apparatus. Most of the current indices allow researchers to potentially discriminate between these first two, as at least some input price measures — and some output price measures — include markups. Understanding the role of markups on prices has a long, storied history in economics. Some of this expertise could surely be well used in this domain, extending Currier et al. (2023)'s recent work.

In my opinion, the least directly studied of the features that may drive costs are those of the administrative apparatus. Usually researchers are forced to measure the costs of the administrative apparatus as a residual difference between explained measures of cost and actual measures of cost. This is what both Brooks and Liscow (2023) and Glaeser et al. (2005b) do.[17] This is empirically unsatisfying, as some omitted feature could always possibly explain the difference between actual and explained cost measures. Furthermore, it is difficult to translate the residual measure into policy prescription, as the residual does not point to specific policy practices that increase or decrease costs.

As a profession, we continue to struggle with direct measures of the administrative apparatus, regardless of whether those features increase or decrease cost. It may be that new methods of text analysis will allow us to better hone in on exactly what it is that government does that impacts cost. Or perhaps transparency in state and local budgets, such that wage expenditures on approval and oversight are visible, may yield gains. Additionally, the large private sector of consultants, whose business is built entirely on helping the public and private sector follow legislative or judicially driven compliance rules has grown up since the 1960s. A better understanding of the birth and growth of this sector may be an additional way to illuminate cost drivers.

Finally, this paper focuses exclusively on the United States. We know that other developed countries have increasing housing prices, but much less steeply growing infrastructure costs. Can we glean any insight from measurements in other countries or from this important divergence?

I look forward to progress on all these fronts — and ones that I have yet to envisage — in the years ahead.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author used Gemini and Claude to help fact check, edit and code. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: I was paid to consult with public relations company Eckel and Vaugh on this topic in March 2024.

Data availability

Data will be made available on request.

[17] I am equally guilty in Brooks and Lutz (2016).

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