So You Want to Do an Infrastructure Package

Alon Levy

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Alon Levy is a Fellow with the NYU Marron Institute and founder of the urban transit blog pedestrianobservations.com. Alon's work focuses on public transportation and how to apply best practices from cities around the world. Alon Levy grew up in Tel Aviv and Singapore and has lived in the French Riviera, New York, Providence, Vancouver, and Stockholm, and is currently based in Berlin. While earning a Ph.D. in math at Columbia, Alon picked up an interest in public transportation networks, starting from the New York City Subway, and has been investigating how to apply best industry practices from a variety of cities around the world. Alon's perspective is comparative, with interests including network design, integrated planning of transportation and development, and cost control.

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Introduction

"Work it harder, make it better
Do it faster, makes us stronger"

Daft Punk
Harder, Better, Faster, Stronger

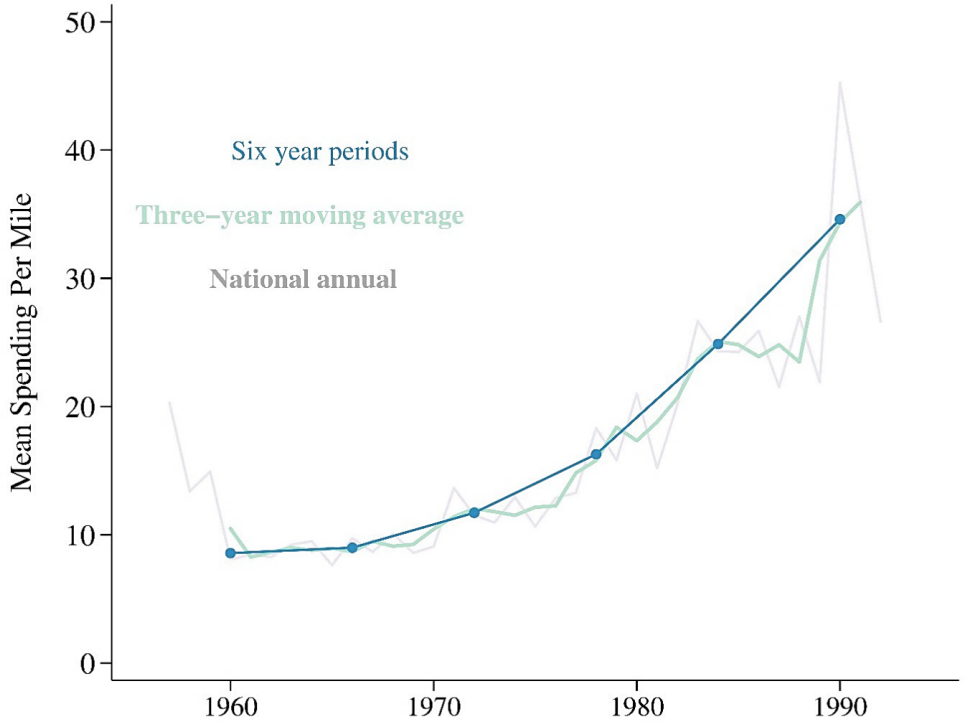
It's infrastructure week again! For real this time. With the economy still recovering from the largest recession since the Great Depression, and a Congress that is unlikely to reach agreement on much else, the Biden Administration's desire to focus on infrastructure is only natural. The U.S. has many genuine and urgent infrastructure needs, while the language of "job creation" is one that Republicans and Democrats both speak fluently.

Good infrastructure is of course a jobs program. Much of the New Deal investment was specifically about employing people who would otherwise be out of work, and this has informed public works in the generations since. But it is not solely or even mostly a jobs program. Infrastructure is capital-intensive, which means it creates fewer jobs per dollar spent than many other kinds of spending. More importantly, it produces durable, long-term benefits: those bridges, tunnels, power plants, and similar kinds of tangible investment all last for a long time, creating more productive potential for the economy and society. The longer-term boost to productivity and living standards is why there are plans for infrastructure. If it were just about job creation, make-work projects or cash aid would suffice.

With this in mind, it is important to ensure the US actually builds back *better*, which means doing so efficiently. Over the last few generations, American infrastructure construction costs have exploded, to the point that it is no longer affordable to do much, even as many peer countries spend a fraction of what the US does on the same bridge or tunnel or high-speed rail line. The difference in

Interstate construction spending per mile (2016 US Dollars)

Source: Figure 1, Brooks, Leah and Liscow, Zach, 2019. "Infrastructure Costs." Hutchins Center Working Paper



Notes: This figure reports national spending per mile as the sum of total spending in a given year divided by miles completed in that year. We calculate the 3-year moving average from this figure. The line with the blue dots shows the miles-weighted average of state data grouped in six-year periods as discussed in the text. For purposes of presentation, we omit 1993, which is a very high outlier and has very few miles.

costs often boils down to domestic state capacity: bureaucracies in East Asia and Continental Europe tend to be better-staffed and more empowered to make professional decisions. The details are naturally more complicated, but the pattern is nonetheless clear: the countries with the lowest infrastructure costs are also the countries where the state acts swiftly, with mechanisms that limit the lag between financing and construction.

If infrastructure is truly on the agenda, we must not be afraid to draw lessons from how other countries maximize their bang for their buck, and thus to avoid repeating the mistakes made in our own recent history. In what follows, I lay out precisely what those lessons are, and explain what needs to be done — ideally, as soon as possible — to ensure we don't just build back better, but also **quickly**, **affordably**, and **flexibly**.

Building back, quickly

When the Obama administration passed the American Recovery and Reinvestment Act (ARRA) in 2009, the overarching goal was to limit unemployment. The bill therefore included many different kinds of spending as well as some tax cuts, while infrastructure accounted for a relatively small proportion of spending: just $8 billion for intercity rail nationwide, for example, where California alone had been hoping for $10 billion in federal funding for its high-speed rail project. The infrastructure portion of the bill was also delayed because of lead time, often by years.

In a recent report written with Eric Goldwyn and Elif Ensari, my coauthors and I show how many of the problems confronting the Green Line Extension (GLX) in Boston, among many other problems with that project, are connected to stimulus-related deadlines.[1] The ARRA reasonably wanted the money spent quickly; the goal was to stimulate the economy in 2009-10, not in 2017. Hence, there were deadlines. This led to backward planning: the project was expected to open by the end of 2014, so the design was rushed. Even though design began even before the stimulus, the planners had to cut corners and hope for the best, and when the worst came, the schedule slipped.

"Such long lead times illustrate why it is difficult to use infrastructure as stimulus."

Something similar happened with the California High-Speed Rail project. In 2008, when Proposition 1A passed (also known as the High-Speed Rail Act), the state promised that it would open the line from Los Angeles to San Francisco around 2020. The project mostly failed because it only rounded up a fraction of the intended budget, but it also suffered from cost overruns and schedule slips, and by the early 2010s could only promise a 2027 opening.

Such long lead times illustrate why it is difficult to use infrastructure as stimulus. Attempting to results in not just ineffective stimulus, but subpar infrastructure to boot. Nonetheless, there may still be benefits to moving infrastructure during an economic downturn, including lower wage and interest costs. Yet time is of the essence. As one of the consultants we spoke with when we studied Boston's GLX told us, while the ARRA may have passed in 2009, most GLX construction has only happened in recent years. As a result, wages and materials costs have been substantially higher than expected, since the money that was allocated under recession conditions was now being spent at the peak of the economic boom.

1 Eric Goldwyn, Alon Levy, and Elif Ensari, "The Boston Case: The Story of the Green Line Extension," Marron Institute of Urban Management, December 9, 2020. https://marroninstitute.nyu.edu/papers/the-boston-case-the-story-of-the-green-line-extension

Long lead times are largely a problem of red tape. In addition to the many layers of review, infrastructure projects in the U.S. constantly face the threat of potential lawsuits — a problem shared with other countries with laws that favor litigation, like Germany, even if their costs are lower overall. Take the 1970 National Environmental Policy Act (NEPA), which requires "environmental impact statements" for "major federal actions" that could "significantly affect" the environment. As the Niskanen Center's Brink Lindsey and Samuel Hammond note in their 2020 report Faster Growth, Fairer Growth:

> In the early days, NEPA's procedural requirements were modest: An EIS could be as short as 10 pages, and the legislation didn't provide for a private right of action. Courts soon declared a private right of action, though, and under the pressure of litigation the law's demands grew ever more onerous: Today the average EIS runs more than 600 pages, plus appendices that typically exceed 1,000 pages. The average EIS now takes 4.5 years to complete; between 2010 and 2017, four such statements were completed after delays of 17 years or more. And remember, no ground can be broken on a project until the EIS has made it through the legal gauntlet – and this includes both federal projects and private projects that require a federal permit. Meanwhile, the far more numerous environmental assessments (the federal government performs more than 12,000 of them a year, compared to 20-something Environmental Impact Statements) have likewise become much lengthier and more time-consuming to complete.

The red tape created by environmental review and our adversarial legal system harm U.S. state capacity, and thus our ability to act swiftly. But even without those constraints, state governments also suffer from limited in-house design capacity. They have enough people to supervise small projects, such as building a handful of suburban commuter rail stations, but not big ones like the Green Line Extension. In some cases, states don't have long-term planning staff to speak of, and only begin to hire after they are sure they will get federal funding. This leads to a measure-once, cut-twice problem, which delays implementation down the line.

The past year has generated considerable discussion about America's declining state capacity, even before the coronavirus crisis made the coordinating role of the state more prominent.[2] State capacity — the ability for the government to effectively implement decisions — is particularly important when it comes to infrastructure, where acting swiftly can make all the difference. This means the state should be able to make decisions quickly — a key measure of efficiency that's often neglected in favor of merely minimizing all-in costs.

In addition to quick decisions, it is ideal if construction can be done quickly, too.

2 See, for example: Tyler Cowen, "What libertarianism has become and will become — State Capacity Libertarianism," Marginal Revolution, January 1, 2020. https://marginalrevolution.com/marginalrevolution/2020/01/what-libertarianism-has-become-and-will-become-state-capacity-libertarianism.html

This does not mean rushing the planning: it is important to measure twice and cut once. Speeding up planning means hiring larger capital construction management agencies to avoid bottlenecks, and not cutting corners. But there are ways to speed up construction, especially in the world's lowest-construction cost countries, such as Spain, Italy, and Turkey. They prefer to do construction 24/7 rather than in limited work windows during the day, and Spain and Italy also often award contracts in part based on how fast the contractor expects to finish the job.

Passengers board trains at Santa Justa Station in Seville, Spain, the nation's third busiest station with an estimated 8 million passengers annually. Spain's construction costs average $14 million per station, compared to $120 million per station in Los Angeles, California.

The preference for speed is particular to the lowest-cost countries. One hears from the United States that a project can be good, cheap, or fast, pick two out of three. French planning follows the same maxim, and tries to spend time to avoid spending money on, say, land acquisition deals for high-speed rail. But France is at best a medium-cost country; in the low-cost world, planners believe that time is money, and therefore emphasize swift planning. They thus do environmental and historical reviews in-house, without lawsuit enforcement. For example, Italy has strict laws for protection of historical and archeological monuments, but there is an administrative bureaucracy that checks that they are followed, rather than any judicial process.

It is especially important to have a swift state for the purpose of counter-cyclical Keynesian stimulus. It may not be possible to spend a lot of money on infrastructure now to create jobs in 2021-2, but it should be possible to reform institutions to ensure that in the next recession the federal government will be

able to spend money on useful infrastructure with minimal delay, creating jobs at 10% unemployment rather than competing with the private sector for jobs at 3% unemployment.

Building back, affordably

The United State has a severe construction cost problem for infrastructure. Together with Eric Goldwyn and Elif Ensari, with the assistance of Marco Chitti, Abdirashid Dahir, Yinan Yao, and Anan Maalouf, I have constructed a database of subway projects around the world with their costs.[3] Subways are amenable to analysis from a 30,000' altitude, since they are such big projects that they are amply covered in mass media and trade media, and costs across countries tend to be comparable.

Out of several hundred subway lines in our database, the five that are in New York are the five most expensive — all well above $1 billion per kilometer where the global median is about $250 million; other American subways range between $400 and $800 million per kilometer. This is not about our wealth: there is no correlation between a country's GDP per capita and its subway construction costs. Nor is it about geological factors: the biggest factor behind a project's cost is what country it is in, and costs are fairly consistent even across different geologies. Some specific cases have unusually difficult local geography, like Shanghai and Amsterdam's alluvial soil, but the American cases are not among those. This is purely institutional.

Worse, this is not just a problem for public transportation. To the extent we have any data for road tunnels, the same problem is seen there, too: the Alaskan Way Viaduct Replacement in Seattle cost around $1 billion per kilometer, for example, while the A86 beltway tunnel in Paris and the M-30 tunnel in Madrid cost about $300 and $130 million per kilometer. respectively.[4]

A full accounting of the causes behind America's abysmally expensive infrastructure remains to be done. However, the following problems loom large from both quantitative analysis of the large dataset and some ongoing case studies:

- **Overdesign:** American infrastructure is often overbuilt, not out of higher quality but out of agency turf battles, obsolete standards like NFPA 130 that have better foreign replacements, or scope creep.[5]

3 See: https://transitcosts.com/

4 Alon Levy, "Los Angeles Should Ignore Elon Musk and Build Subway Tunnels to Relieve Traffic," Urbanize: Los Angeles, July 20, 2017. https://urbanize.city/la/post/los-angeles-should-ignore-elon-musk-and-build-subway-tunnels-relieve-traffic

5 As international transit authorities have noted, "NFPA 130 is one of the strictest standards and it could not be often applied for the old metro which was constructed before NFPA 130, which was established in 1983. If this standard is applied strictly, the structure of the tunnel and station tends to be bigger and the cost of the construction also

- **Poor procurement practices:** there is improper supervision of private contractors, and things are getting worse as public agencies offload more risk to the private sector, which responds by bidding higher to hedge against the risk; there are also some one-bid contracts, for example the 7 extension in New York, leading to even higher costs.
- **Poor project management:** design review teams are usually understaffed and cannot respond to contractors fast, so there is little institutional capacity to build big projects. Wages for office workers are below market rate and hiring is difficult.
- **Labor:** in New York, the productivity of construction labor seems unusually low and wages high.
- **NIMBYism:** the United States makes it easy to sue, for example NEPA is enforced by lawsuit, whereas its Italian equivalent is enforced by the administrative state. Lawsuits in the US and other lawsuit-happy countries like Germany rarely win, but do delay projects, so there is defensive design, including unnecessary scope in order to buy off political support. Leah Brooks and Zachary Liscow have a paper on the growth in Interstate construction costs over the decades, blaming citizen voice lawsuits for the increase.[6]
- **Politicization of projects:** the civil service is weak compared with both elected politicians and their unelected political appointees, and there is not much continuity in design.

Building back, flexibly

Unfortunately, past American attempts at regulating the interface between the public and private sectors have involved excessive red tape. The issue is not that there is too little oversight of private contractors or too much, but that the focus of the oversight, coming from 100-year-old Progressive Era reforms, is wrong. It is rigid, where what is needed is flexibility and empowerment of public-sector engineers.

Eric Goldwyn and I have talked to a number of contractors and cost estimators. They have said that doing business with the public sector is difficult. One used the expression "the T factor" or "the Sound Transit factor" for taking construction contracts with public transit agencies and raising costs by about 10% relative to private-sector work. In New York this is worse, with Brian Rosenthal's New York

tends to be higher." JICA Preparatory Survey On Greater Cairo Metro Line No.4, 2010. https://openjicareport.jica.go.jp/pdf/12001715_03.pdf

6 Brooks, Leah and Liscow, Zach. 2019. "Infrastructure Costs." Hutchins Center Working Paper. https://www.brookings.edu/wp-content/uploads/2019/08/WP54_Brooks-Liscow_updated.pdf

Times article about Second Avenue Subway costs suggesting the public sector premium is nearer to 30%.[7]

The current problem is that civil service reforms made American government inflexible. Even when flexibility is legal, state agencies are reluctant to do any of it. Contracts are done on a lowest-bid basis, which means that in principle a dishonest or incompetent contractor could lowball the bid and then do shoddy work; in practice, this happens in California frequently with change order litigation. To prevent this from happening, New York overspecifies the contracts to the point of micromanaging what material the contractors are allowed to use.

"Building back flexibily requires empowering low- and mid-level civil servants to work flexibly and at arms-length with private contractors."

There is a better way to do the procurement required for major infrastructure projects. In short, building back flexibily requires empowering low- and mid-level civil servants to work flexibly and at arms-length with private contractors. In Italy, this process is called alta sorveglianza, or "high surveillance," and consists of a team of in-house, public sector engineers who can communicate with the contractors and respond rapidly to requests for changes, avoiding the need for contentious litigation ex post. In Turin, population 886,837, the in-house team is made up of 10 to 15 people. In contrast, in Boston, a much larger city, the analagous team was 5 to 6 people throughout the 2000s, which was enough capacity to oversee small projects such as reconstructing individual stations but not large ones like the Green Line Extension.

With a design review team that can oversee contracts more carefully, the bidding can be more flexible. Lowest-bid contracts are uncommon in Europe. Italy awards contracts by a weighted formula in which costs are only 30% of the total, and the rest is either a technical score or a combination of 50% technical score and 20% how fast the contractors expect to finish; Spain awards contracts by the latter method. France awards contracts by 60% technical, 40% price. American agencies in contrast use lowest-bid procurement, and in the few cases when they don't, such as in California, the technical score is only 30%, so the differences in price dominate the overall decision.

Another way to make public procurement more flexible is to demand that public agencies itemize contracts. This means that instead of one big lump sum contract covering an entire project or big segment, each segment must be divided into pieces saying how much labor and materials are required. If there is a problem, the extras

7 Rosenthal, Brian M., "The Most Expensive Mile of Subway Track on Earth," *The New York Times*, December 28, 2017. https://www.nytimes.com/2017/12/28/nyregion/new-york-subway-construction-costs.html

are already priced in. Madrid works this way, and avoids change order disputes. When there is a mix of lump sum and itemized auctions in the same place, itemized ones are cheaper: Valentin Bolotnyy and Shoshana Vassermann study this for Boston highway maintenance, finding that scaling auctions reduce costs by 10%.[8] Nicholas Ryan likewise finds that itemized contracts for coal power plants in India lead to lower overall prices, first because itemizing reduces private-sector risk, and second because contractors do not bank on renegotiation.[9]

The public planning team responsible for such oversight cannot be political. The appointments must remain professional and insulated from politics, with people staying in regardless of changes in federal or state control. This also includes oversight groups such as historical preservation and environmental protection. Giving politicians the power of flexibility means that they will direct funds to cronies; giving this power to civil servants, who have no political ability to beat corruption charges in court, means that they will use it judiciously.

Recommendations

It is possible to avoid the problems of high costs, slow projects, and excessive red tape. Our construction costs project is still in-progress, so we only have partial recommendations. And yet, even what we have found is likely to lead to drastically less expensive and higher-quality infrastructure in high-cost countries like the United States. Any of the following changes seems politically plausible for the incoming administration:

- **Federally-funded subway tunnels should use the cut-and-cover technique for stations wherever possible.** In this method, the street is opened up, disrupting traffic for about two years, and then tracks are put inside and the tunnel is covered. Past generations built entire subway systems this way. Today, the standard best practice used in most countries is to bore tunnels between the stations, which is more expensive but less disruptive, and then use cut-and-cover for the stations.[10] Some American projects refuse to use cut-and-cover stations at all, including Second Avenue Subway, in large part due to political fear of opposition to street closures. In San Jose, the local transit agency, VTA, is about to seek expedited FTA approval for a $6.9 billion BART subway to Downtown San Jose, using a large-bore technique designed

8 Bolotnyy, Valentin and Shoshana Vasserman. 2019. "Scaling Auctions as Insurance: A Case Study in Infrastructure Procurement." NBER Working Paper, January 8. https://www.nber.org/conf_papers/f116929/f116929.pdf.

9 Ryan, Nicholas. 2019. "Contract Enforcement and Productive Efficiency: Evidence from the Bidding and Renegotiation of Power Contracts in India," NBER Working Paper, February 2019. https://www.nber.org/papers/w25547

10 Levy, Alon, "Why American Costs Are So High (Work-in-Progress)," *Pedestrian Observations*, March 3, 2019. https://pedestrianobservations.com/2019/03/03/why-american-costs-are-so-high-work-in-progress/

for constrained city centers with older subways in which cut-and-cover is often too difficult.[11] No such subways exist in San Jose, and the FTA should reject the application on cost grounds unless VTA goes back to the typical method of twin-bore tunnels and cut-and-cover stations — an option that cleared the EIR process but was rejected for political reasons.

- **The FTA should require transit agencies that wish to build subways to maintain up-to-date databases or maps of the urban geology, showing what is underneath the street, to make tunneling easier.** New York had such maps 20 years ago but has lost them and made no effort to remake them, and each of the city's utilities does roadwork without informing the others. There is no reason why it should cost as much to dig a subway station in an American urban neighborhood that was built around the turn of the century as to dig one in Rome near the Colosseum, where the rules forbid any ground shifting to prevent damage to fragile 2,000-year-old archaeology.[12]
- **Congress and the executive branch should add escape clauses from regulations that increase costs, especially Davis-Bacon on prevailing wages and "Buy America" rules.** There already is an escape clause in Buy America for cases where it costs 25% more to procure domestic equipment than to import it, however it requires FTA approval which is rarely given, and which was not given at all for public transit projects throughout the Trump administration. FTA approval should resume and be frequent and streamlined.
- **A similar escape clause should be instituted for prevailing wage laws.** It is unclear to what extent union labor is a problem outside New York, but within New York it has contributed to rampant overstaffing and wages in the building trades that are well above market rates. Prevailing wage laws should be used to ensure local workers earn a fair and competitive wage, not to reward special interest groups and other political insiders.
- **Funding for state projects should forbid states from requiring vendors to set up in-state plants to encourage the formation of a US-wide market, rather than separate markets for separate states.** The situation today is so dire that 40-70% premiums on rolling stock are routine, and the premium works out to about $1 million per $20/hour job created; jobs which would only last a few years.[13]
- **Transit agencies should staff-up in-house, preferably well in advance of**

11 "VTA's BART Silicon Valley Phase II," Valley Transportation Authority. https://www.vta.org/projects/bart-sv/phase-ii

12 Levy, Alon, "Regional Rail: Best Practice Versus New York Practice," November 9, 2017. Slide deck: https://pedestrianobservations.files.wordpress.com/2017/11/nyupresentation2.pdf

13 Levy, Alon, "Why Free Trade in Rolling Stock is Good," Pedestrian Observations, May 27, 2018. https://pedestrianobservations.com/2018/05/27/why-free-trade-in-rolling-stock-is-good/

when funds and projects begin to flow. The federal government can nudge state and local transit agencies in this direction by, for example, requiring an agency to demonstrate it already has the capacity to oversee a big infrastructure project before releasing funds for it. A good test for whether an agency's institutional capacity is sufficient is to require contractor selection to be judged predominantly on a technical score. In many of the low-cost countries we have researched, contracts are selected based on technical scores rather than on a lowest bid basis, which then requires agencies to maintain in-house staff with the skills and experience required to competently score proposals.

- **The federal government should also expand the federal civil service in order to ensure infrastructure money is spent effectively.** The most direct option would be the creation of a expert federal office or agency whose sole purpose would be to act as a federal consultant to state and local governments. This would require a permanent increase in federal spending but not a big one. Urban rail planning in Rome is done by an agency with an €6-10 million annual budget, and in Milan by a bigger omnibus agency that also controls waterworks. To be effective such an agency must be permitted to pay competitive market wages, which can run up to $140,000 a year or even more for a project manager in a rich coastal city. Nonetheless, the cost of such an office would pay for itself many times over through the diffusion of infrastructure best practices across local governments nationwide.
- **Because the greatest innovation in high-quality, low-cost public works is not in the United States or really in any country where English is the primary language, American governments should maintain global curiosity.** State and local planning officials could take part in exchange programs for a few months at a time, for example. These already exist between the national railroads of Europe as well as between Europe and Japan. The United States should join such arrangements in order to stay up to date with global developments in infrastructure. If every big agency participated, including USDOT, Amtrak, and the bigger state and city agencies, within a few years most agencies would have a handful of professional staffers who have been through such a program — a French expert, a Spanish expert, a Japanese expert, an Italian expert, and so on.

Conclusion

Infrastructure programs create jobs, but are not solely or even mostly a jobs program. Public works are about long-term investments that raise our productivity and thus our national living standards. A new subway line, say, makes it easier for people to get to work and other destinations in a city and, with the right uptake, can last forever.

Governments can and should fund public investments that the private sector cannot easily invest in, but this requires efficiency. Spending $6 billion on a new subway line that Southern Europe, Scandinavia, and Korea would build for $400 million creates $400 million in investment and $5.6 billion in waste — even if that waste creates some extra jobs. If job creation is to be considered the end unto itself, we can use monetary stimulus, direct cash benefits, and many other forms of public spending to quickly create more and better jobs.

There are still valid reasons to favor enacting an infrastructure package during or shortly after a recession. These include lower financing and labor costs, and a reduced risk of private-sector crowd out. Yet capturing these benefits require governments to act swiftly. Following the 2009 ARRA, in contrast, long lead-times meant many projects weren't into full swing until the mid-to-late 2010s, when the U.S. economy was well into its expansion. Lawmakers attempted to enforce timeliness through artificial deadlines, but without addressing the root causes of our notorious slowness, schedules slipped and budgets overran nevertheless.

This paper has attempted to explicate both why American infrastructure is so expensive and what to do about it, drawing on the best practices of the lowest-cost countries, as well as my expertise as a public transit researcher. At a high level, the U.S. simply lacks the state capacity to move projects expeditiously. Environmental review laws, byzantine Buy America and prevailing wage regulations, and the constant threat of litigation all conspire to slow projects to a snail's pace while causing costs to soar. Meanwhile, the dearth of in-house planning capacity at the state and local level means agencies charged with overseeing projects are not merely unaware of international best practices, but would be unable to implement such practices even if they were. Rather than award contracts based on the lowest cost bid, for example, U.S. transit agencies would be better off selecting contracts on the basis of a technical score, and with budgets that are itemized — two approaches that are known to be superior but which require in-house engineering and project management staff to enact.

Unfortunately, the Federal government is often no better. The FTA routinely releases funds for state and local projects that use construction techniques that are known to be unnecessarily expensive. Methods to streamline funding, such as

waiver approvals for the worst forms of red-tape, go underutilized if not neglected altogether. Federal infrastructure funding can also interact perversely with the incentives of officials in state governments, whose natural preferences for in-state vendors contributes to market segmentation and diseconomies of scale.

The good news is that all these problems are eminently solvable. Indeed, given the political will, we can choose to not just build back better, but also quickly, affordably, and flexibly.

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