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Tools for Assessing the Labor Market Impacts of Infrastructure Investment

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The American Recovery and Reinvestment Act (ARRA) helped to kick off a renewed debate over the state of the nation's infrastructure. For years, advocates for increased infrastructure spending had argued that the deterioration of the nation's public capital stock was harming prospects for durable economic growth. When an ambitious fiscal policy response was necessitated by the steep recession beginning in 2008, the Obama administration used the opportunity to fund substantial infrastructure investments as part of its economic recovery package.[1]

Advocates for increased infrastructure investment often stress its job-creation potential. In the debate over ARRA, for example, advocates often pointed to the short-run macroeconomic benefits that these investments would spur by creating jobs and lowering the overall unemployment rate. These advocates have also stressed that new jobs created by infrastructure investment over the longer-term could be a particular boon for communities traditionally disadvantaged in the U.S. labor market—including minorities, those working in areas like central cities or rural communities from where good-paying blue-collar jobs have moved, and workers who have not attended college.

These possible labor-market benefits stemming from infrastructure investment are, of course, just one (and probably not the most important) facet of their overall effect on the economy. For example, recent proposals to reduce both greenhouse gas emissions and reliance on external sources of energy could provide both climate and energy security. A modern transportation infrastructure could reduce transportation costs, fuel usage, and increase economic opportunities for many. In both cases, substantial infrastructure investments would be required, and the size of these investments would have clearly visible impacts on the U.S. labor market. Given this, it would be useful to know what these likely impacts would be. This paper suggests some tools that could be used to make these assessments. Forthcoming papers in what will be an ongoing research project at the Economic Policy Institute (EPI) draw on this methodology to "score" the job-market effects of various proposals for infrastructure investments.

Labor market impacts of public investment: Stability and structure

Assessing the labor market outcomes of infrastructure investments requires examining two largely separate components: the short-run impacts (or, economic *stabilization*) and the long-run impacts (*structural* change).

Stabilization refers to the effect of such spending on the business cycle. When an economy is booming and labor markets are tight (characterized by low unemployment and rapid rates of job-creation relative to the underlying growth in the working-age population), infrastructure spending (particularly if deficit-financed) could theoretically be inflationary, and the jobs supported by it could be largely just pulled from already-employed resources in the economy. Conversely, when an economy is shrinking and labor markets are loose, such spending can have a palliative effect on the labor market and can play a key role in beating back (or at least shortening) the recession by increasing the net number of jobs economy-wide; jobs supported by the new spending are much more likely to put previously idle resources back to work.

To assess the stabilization impacts of infrastructure spending relative to other measures billed as economic stimulus, we rely mostly on "off-the-shelf" estimates of macroeconomic multipliers compiled by a range of forecasters. These multipliers measure how much additional economic output is generated for each dollar added to the deficit from these tax cuts and/or spending increases.

The *structural* impacts of such spending depend on both the number and *types* of jobs created through infrastructure investments. Over the long-run the hope is that the economy will approach something close to full-employment. When (if) this happens, the labor market effects of infrastructure spending will hinge crucially on the *types* of jobs it creates and how the pattern of job-creation will affect the relative demands for different sub-populations in the labor market. Assessing these structural impacts requires some original research and the creation of an economic model. Describing the methodology behind this model is a main focus of this paper.

Stabilization

Recessions happen when an economy experiences a self-reinforcing reduction in demand—that is, economic weaknesses lead to a decline in consumer and business spending, which further contributes to the overall declines. In this regard, the current recession is like all others. However, the dual crashes in housing and financial markets has made this recession frighteningly severe relative to others. In short, these crashes led to a sharp reduction in household wealth and limited access to credit, which led to a pull-back in consumer spending, especially on new homes and durable manufactured goods (autos, in particular).

Even worse, the generally most-reliable tool in policy-makers' kit for fighting recessions—the Federal Reserve cutting short-term interest rates—has failed to spark any recovery. Short-term rates have been essentially zero for months while job losses have accelerated. One reason for the ineffectiveness of monetary policy is that the housing sector is plagued by record levels of inventory. Traditionally, increased home sales were a key "transmission mechanism" through which interest rate cuts sparked economic recovery. Today, as record inventories puts relentless downward pressure on home prices, prospective buyers remain on the sideline waiting for prices to bottom out, and not even low interest rates should be expected to bring them back into the market anytime soon.

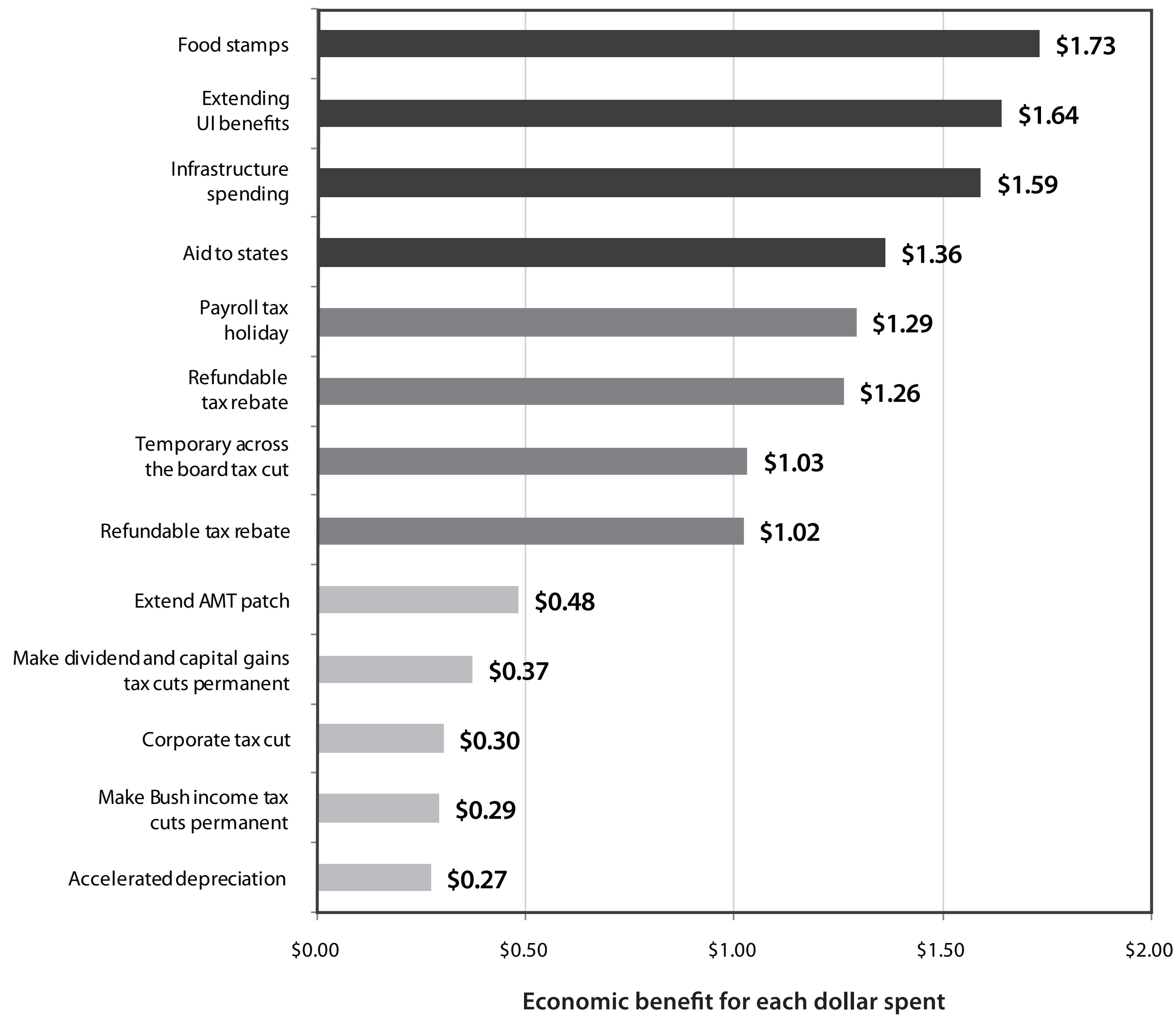
The traditional solution for an economy mired in recession when interest rate cuts are having no effect is to have government directly boost demand so that dangerous cycle of contractionary layoffs $\rightarrow$ depressed demand $\rightarrow$ layoffs is broken.

This governmental boost to demand can be accomplished either through tax cuts or government purchases—that is, either the government boosts after-tax incomes to spur consumer and business spending or spends the money itself.[2] **Figure A** provides an assessment by one of the country's leading macro-modelers as to the relative effectiveness of different forms of economic stimulus. It shows clearly that after transfer programs aimed at the most cash-strapped U.S. households (unemployment insurance and food stamps), infrastructure investment yields the greatest bang-for-the-buck, spurring extra output and employment for every one dollar of increase in the federal budget deficit. In terms of relative effectiveness, this general ranking of economic stimulus proposal has near-unanimous support among macroeconomists.[3]

Tax cuts tend to be less effective than government spending because (especially during recessions) households may save a large portion of any tax cut. Further, a non-trivial portion of any consumer spending induced through tax cuts will "leak" out of the American economy by being spent on imports, which do not spur domestic production and employment. With households now

FIGURE A

Economic benefits of various stimulus provisions



SOURCE: Mark Zandi from Moody's Economy.com.

swimming in debt and facing huge losses in the housing equity that supported their consumption spending for years, one imagines that the tax cuts are even more likely to be saved rather than spent than is even usually the case during recessions.

On the other hand, public investment in infrastructure is guaranteed to be spent back into the economy and boost demand and a much smaller share of this spending "leaks" away via imports. The first-round effect of these investment dollars is to hire construction workers, planners, architects, engineers, project managers, and foremen who then turn around and use their new income to boost their own spending.

Further, the new hires are not only constrained to the industry *directly* receiving investment funds; jobs are also indirectly created in supplier industries, such as accounting, office supplies, and construction capital manufacturing (such as Caterpillar, which recently laid off 20,000 workers).

Lastly, even more jobs are created as these workers in direct and supplying industries respend their income back into the economy. That is, construction workers newly hired by money from ARRA will patronize diners and restaurants around the worksite, spurring demand for cooks and waitresses. Of course, a portion of all these new hires will pull already-employed resources out of other sectors and industries. However, a portion of these new hires will instead put currently idle resources to work. The multipliers above give the *net* addition to employed resources resulting from various measures of economic stimulus.

Structural change

Advocates have long noted that ambitious proposals to modernize and maintain American infrastructure offer the opportunity to provide good, family-sustaining jobs to groups traditionally disadvantaged in the American labor market.[4]

Clearly, maximizing the synergy between the twin goals of modernizing the American public capital stock and providing new opportunities to disadvantaged groups requires an affirmative effort—there is no guarantee that these goals will go hand-in-hand always and everywhere. That said, it is worth examining how we might expect the purely *mechanical* outcomes of increased infrastructure investment to impact the labor demand for various groups within the U.S. labor market. This examination will provide researchers and advocates a baseline expectation as well as early warning signals about possible inequities in job-creation that policy makers should seek to redress.

Policy impulse

The first question that arises in this sort of modeling exercise is how to characterize the *policy impulse* for the model to analyze. That is, we need to know how federal, state, and local policies will change spending levels overall and across industries. In the current case, these inputs are simply the level and the industrial composition of investment flows that result from a policy decision to increase infrastructure investments. For example, when assessing the impact of ARRA's infrastructure components one would try to match up appropriated spending with industrial classifications that are represented in the jobs model. In this case, ARRA appropriated $13 billion that could be used for school construction and renovation. This $13 billion would be inputted into our jobs model by assigning all of it to the construction sector. For other ARRA provisions that call for providing information technology investments for health care providers and schools, we would input the appropriated money into the information technology producing sector in our jobs model. Essentially, "scoring" legislation or a policy proposal using our jobs model requires making judgments both on *how much* spending is being called for and *into which industries* the spending flows.

In the series of forthcoming research reports that will make use of the methodology discussed in this paper, we examine various scenarios that advocates of expanded infrastructure investments have sketched out as plausible solutions to a particular problem—say, expanding transit investment as a means of curbing greenhouse gas emissions from the overall transportation sector.

For example, one transit scenario calls simply for fully funding the pent-up demand for transit projects that currently exists—essentially it puts a dollar value on all of the backlogged projects that have been approved by state and local governments but that currently lack dedicated funding. This scenario is taken directly from the report "Jump-Starting the Transit Space Race" from Reconnecting America (RA). RA claims in this report that roughly 400 new rail, streetcar, and bus rapid transit projects have been proposed across the United States yet remain unfunded. Meeting this need would require roughly $250 billion in new funding. Assuming that this investment could occur within a decade if funding were secured, this report uses the figure of $25 billion per year for 10 years.

Given the levels of investment specified in a given scenario, we then rely on research reports, interviews with experts, and other sources to get a sense of how the overall spending package will be allocated to the different industrial sectors identified in our model. In the RA "Jump-Starting" scenario, we follow the recommendations of the American Public Transport Association (APTA) in allocating a breakdown of roughly 60/40 in new investments versus increased operating costs. The new investments further breakdown into roughly on-third new manufactured rail and auto parts equipment and two-thirds new construction.

In the appendix to this report, we will update all the various scenarios scored through our jobs model in this research project. For the rest of the body of this paper, we will illustrate how the model works by simply assuming a $200 billion investment in the construction sector.

Jobs model

Once inputs have been specified, we useexperience gained in previous research merging industrial data on input-output relationships with household-level data on demographic and labor market variables to characterize the job outcomes that would result from the change in industrial mix accompanying increased infrastructure investment.

The jobs model allows us to identify both the (relative) *number* and *type* of jobs created for a given amount of spending in a particular industry. It should be noted that these results do *not* include the re-spending effects that stem from the increased incomes of workers hired as a result of spending. That is, we include (say) the workers *directly* hired in the construction industry as well as the workers newly hired by industries that *supply* construction (heavy equipment, for example) but we do *not* include the effect of construction and heavy equipment workers subsequently spending their wage income. New wait-staff hired at a diner near a construction site to handle increased demand from the site's workers, for example, are not captured in this structural analysis. Their re-spending effects are generally better captured in the short-run macroeconomic multiplier estimates presented previously.

It is important to note that these estimates are based on currently existing patterns of employment across sectors. As such the final results tell us how many and what kinds of jobs would be created with our current economy. However, to the extent that the new investments are aimed at transforming the economy or labor market, our results are not precisely indicative of the true impact. For example, policy restrictions on the kinds or quality of jobs created, and specific policy targeting of job creation would lead to different outcomes than estimated here. However, the numbers presented here compose an estimated baseline for policy makers to consider.

How many jobs?

Calculating the total number of jobs supported by a given stream of infrastructure investment takes two steps. First, we translate a given amount of infrastructure spending into the number of *jobs* directly supported in the receiving industries. Second, we then calculate how many jobs are needed to produce the output in *supplier* industries that expand to support the output generated by the industries directly receiving the investment flows. The construction industry (for example) is a purchaser of cement, steel, heavy equipment, as well as less obvious supplies – such as accounting and legal services. These supplier industries will need to expand to support final output of the construction industry when it expands.

Both the direct and indirect jobs associated with a given amount of spending are derived from the employment requirements matrix (ERM) compiled by the Bureau of Labor Statistics (BLS). The ERM is a 201x201 matrix that uses data on the input-output relationships between industries and industrial employment figures to estimate how many jobs in an industry are supported by a given amount of spending—both *direct* jobs as well as jobs supported by expanding output of supplier industries.

In the language of matrix algebra, the total number of jobs created through a given vector of spending can be represented as follows. Let **I** be the 201x1 vector made up of a single column that shows the amount of spending directly allocated to each industry as infrastructure investment. The vector has 201 rows (one for each industry) and only one column, which indicates how much new infrastructure spending has been earmarked for each industry. Obviously, many (most, in fact) of the entries in this vector will be zeroes—as very few industries will receive money directly (retail trade, for example, is not generally a sector that people think of supporting directly in the name of improving the nation's infrastructure).

Let **E** be the 201x201 ERM. Each of the 201 columns and rows corresponds to a single industry. A given *column* (say the one representing the construction industry) represents $1 million in final demand. Each of the 201 *rows* in this column displays how many *jobs* are supported in every industry by this $1 million in final demand for construction spending. While the single-largest share of total jobs supported by \$1 million in construction spending is in the construction sector itself (and generally on the diagonal of the matrix), roughly 40% of the total jobs supported are spread throughout the rest of the economy.

To estimate this number of jobs supported by infrastructure investment, **J**, simply perform the following matrix operation:

J = I*E

This operation yields a 201x1 vector, with 201 rows again corresponding to each industry in the model. The single column summarizes how many jobs in each industry are supported by the \$200 billion in construction spending. Perhaps counterintuitively, even though direct spending only occurred in a single row of our initial 201x1 spending vector, there will be almost no zeroes in the rows of the 201x1 jobs vector. Construction, like almost all other kinds of production, requires a huge array of inputs. Most of the jobs created in supplier industries through this amount of construction spending will be very small relative to the jobs directly created in construction, but non-zero job support will be widespread.

It is important to note that the number of jobs supported by infrastructure spending that is output from the jobs model is a measure of gross, not net, job creation. That is, if a given amount of infrastructure spending supports 1 million jobs in total, this does not mean that the economy as a whole will see a net increase in employment of 1 million. Rather, a portion of these 1 million jobs may be pulled from currently employed sectors of the economy. Again, the macroeconomic multipliers identified in the previous section are far superior in assessing the net job-creation impacts of infrastructure spending.

That said, the gross jobs numbers identified in our model do convey important information. For one, they give a good *relative* ranking of the labor intensity of different kinds of spending and can, by themselves, allow judgments to be made about the best place to engage in investment spending if the goal is to increase the greatest number of job-opportunities in the economy. And, even more importantly, it is the gross number of jobs created that must be combined with the types of jobs created that will allow researchers to judge how relative labor demand for different sub-populations in the labor market will fare. This point will be made plain in the section below where we examine how the number and type of jobs created through infrastructure spending result in changing demands for workers with different educational attainments.

What kinds of jobs?

To estimate the characteristics of jobs created through infrastructure spending, we use data from the Current Population Survey (CPS) to calculate the *share* of each industry's employment by relevant categories (gender, race, ethnicity, wage levels, etc.). To insure we have a large enough sample size, we pool together data from 2005 to 2007.

To match up the CPS data on demographic and labor market variables with the BLS data on industry input-output relationships, we needed to construct a crosswalk between the industry coding schemes used in the respective datasets. This crosswalk was easy to construct as it essentially matches up both the CPS and the BLS industry codes to a third classification system (the North American Industrial Classification System, or NAICS) that maps cleanly onto both the CPS and BLS data. This crosswalk is available from the authors upon request.

Next, we simply multiply the number of jobs created in each industry (either through direct spending or through supplier effects) by the industry demographic shares and then sum these up across industries to get the total number of *jobs in each category* (both direct and supplier jobs) that are created through a given amount of infrastructure spending.

Again, in the language of matrix algebra, this can be expressed as follows. Let **D** be the 201x36 vector of demographic characteristics by industry (these 36 demographic categories are those listed in Table 1 of this paper). Define **F** as the 1x36 vector of jobs supported in each demographic category through a package of infrastructure investment and compute it as:

F=J*D

Model outputs: Number and types of jobs supported

For illustration, we assume that \$200 billion in new construction spending is the sole policy impulse. Again, more realistic scenarios that we will score as an ongoing research project are specified in an appendix (updated on a rolling basis) to this paper.

Plugging this simple $200 billion construction investment into our labor-market model results in the finding 2.2 million direct and supplier jobs would be supported. Of those, 1.4 million jobs are supported directly through the initial investment flows and another 845,000 are supported in industries that provide inputs into the receiving industries. **Table 1** provides details on the number and types of jobs that would be created through this spending by

TABLE 1

Types of jobs supported by $200 billion in construction spending

	Direct	Indirect	Total	Direct	Indirect	Total
		(thousands)			*(% of total)*	
Totals	1,384,237	845,184	2,229,421	64%	36%	100%
Gender						
Male	1,249,340	535,342	1,784,683	90%	63%	80%
Female	134,896	309,842	444,738	10	37	20
Race						
White	865,962	590,740	1,456,702	63%	70%	65%
Black	71,732	86,000	157,732	5	10	7
Hispanic	404,510	121,295	525,805	29	14	24
Asian	17,840	32,944	50,783	1	4	2
Other	24,193	14,313	38,506	2	2	2
Union status						
Covered	187,163	67,336	254,499	14%	8%	11%
Non-covered	1,197,074	777,878	1,974,952	86	92	89
Education						
Less than high school	351,847	97,202	449,050	25%	12%	20%
High school only	573,468	282,370	855,838	41	33	38
Some college	326,973	247,073	574,046	24	29	26
BA or greater	131,948	544,356	350,487	10	64	16
Wage quintiles						
First (lowest)	180,090	166,058	346,148	13%	20%	16%
Second	325,192	174,975	500,168	23	21	22
Third	336,156	173,683	509,840	24	21	23
Fourth	315,630	169,190	484,820	23	20	22
Fifth (highest)	227,167	161,325	388,492	16	19	17
Region						
Northeast	202,988	144,879	347,868	15%	17%	16%
Midwest	251,318	206,289	457,607	18%	24%	21%
South	570,292	305,604	875,896	41%	36%	39%
West	359,638	188,412	548,050	26%	22%	25%

cont. on page 8

TABLE 1 (cont.)

Types of jobs supported by $200 billion in construction spending

	Direct	Indirect	Total	Direct	Indirect	Total
		(thousands)			*(% of total)*	
Totals	1,384,237	845,184	2,229,421	64%	36%	100%
Occupations						
Mgt., business, and finance	138,749	123,352	262,102	10%	15%	12%
Professional	23,318	120,809	144,126	2	14	6
Service	7,854	64,161	72,015	1	8	3
Sales & related	15,114	120,320	135,434	1	14	6
Office & admin. support	83,888	132,322	216,210	6	16	10
Farm, fish, forest	0	0	0	0	0	0
Construction & extraction	973,661	21,841	995,502	70	3	45
Install, maintain., and repair	74,471	41,842	116,314	5	5	5
Production	27,009	117,402	144,411	2	14	6
Transport	39,485	96,092	135,577	3	11	6
Central city status						
In central city of MSA	369,166	218,372	587,538	27%	26%	26%
In MSA, not central city	625,548	372,973	998,521	45	44	45
Not in MSA	190,575	129,571	320,147	14	15	14
Not identified	198,947	124,268	323,215	14	15	14

SOURCE: Authors' analysis as described in text.

direct, indirect, and total effect. It also provides an overview of the different demographic and labor market categories that we track in this research project. **Figure B** gives a quick visual breakdown of what types of jobs would be created through transit investments.

Gender

The jobs supported by construction skews heavily male—80%. This is largely due to the overwhelmingly male character of the direct jobs created in this sector, where current jobs are over 90% male. Further, the largest bloc of supplier industries for construction output is the manufacturing sector, which is also predominantly male (70%) and partly as a result even supplier jobs from this spending skew male—63% to 37%.

Race and ethnicity

The jobs supported by construction investments also skew heavily toward Hispanics and slightly away from African Americans, relative to each group's share in the overall labor market. Hispanics make up 24% of the jobs supported through construction spending, relative to 15% of the overall labor force. African Americans make up 7% of the jobs supported through construction spending, compared to 11% of the overall labor force.

Union status

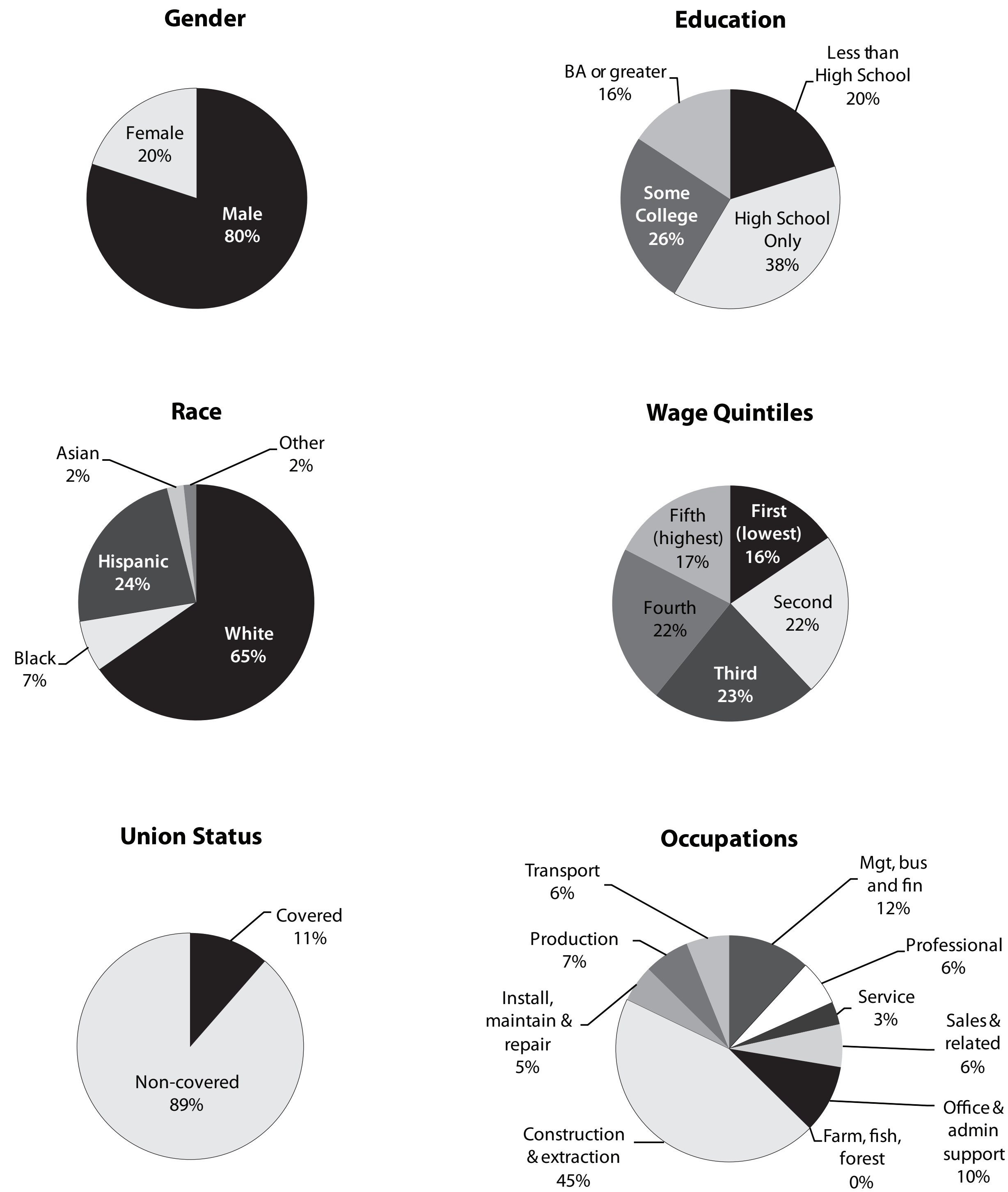
The jobs supported by construction spending would employ more union members than the average that prevails in the private sector—11.5% compared to just under 8%. This is largely driven by the 13.5% unionization rate in the construction sector itself.

Wage level

The jobs supported through $200 billion in transit investments bunch in the middle of the wage distribution, with relatively few low- and high-wage jobs (defined as the bottom and the top 20% of the overall wage distribution).

FIGURE B

Demographic and labor market variable shares of jobs supported by construction spending



SOURCE: Authors' analysis as described in text.

Education

The jobs supported by construction spending would skew heavily away from workers with a four-year college degree with only 15.4% of the jobs requiring a college degree or greater, compared to roughly 29% in the overall economy. These jobs also skew heavily toward those without a high school degree or those workers with a degree but who have not attended college.

Relative educational differentials

Perhaps the most important outcome of the jobs model is the impact of infrastructure spending on the relative demands of workers with different educational attainments. Many trends in the overall economy have reduced wages for workers without a college degree in recent decades. In coming years, a key factor in affecting the demand for that 70% of the American workforce without a four-year college degree will be the industrial mix of the U.S. economy.

Public investment in industries where non-college labor is abundant can increase demand for these non-college workers and lean *against* the long-run trend of rising inequality along educational lines. If this public investment has spillover effects—e.g., higher productivity—and this in turn spurs competitiveness and a more general revival of U.S. manufacturing, then the equity benefits could be large.

In each stage of this research project, the impact of increased infrastructure spending on the relative labor demands generated for college and non-college labor will be examined. It should be noted that such an examination can only give the "all-else-equal" effect of this investment on relative labor demands, and, little in the economy actually happens all-else-equal. That said, anything that changes the industrial mix of the American economy in a direction that increases demand for non-college labor will have salutary effects on American inequality.

At this point, it should be getting clearer why both gross job creation and the types of jobs created are crucial to know in assessing the labor market impacts of spending.

Some rough arithmetic based on our construction example demonstrated this point. The $200 billion in construction spending yielded 2.2 million total jobs supported, and 15% of these required a four-year college degree. The 333,000 college-jobs supported by construction spending (15% times 2.2 million) is roughly 1% of the entire U.S. college workforce (roughly 29% of U.S. workers have a four-year college degree, and, this workforce is just over 130 million at present, so, roughly 38 million American workers have a four-year college degree). The 1.9 million non-college jobs supported by construction spending (85% times 2.2 million) is roughly 2% of the entire non-college labor force in the United States (70% of the workforce of 130 million, or just over 90 million).

The difference in these respective shares (2% of non-college labor versus 1% of college labor) gives us an estimate of how much *relative* demand for non-college labor increases with infrastructure spending—around 1 percentage point (2% - 1%). Note that this difference will increase whenever: (a) the difference in college-intensity between the overall economy and those jobs created through infrastructure spending increases, or, (b) the total *number* of jobs created through infrastructure spending increases.

Conclusion

While the justification for an increase in infrastructure investment is ample without even bringing up its job-market impacts, it is useful to know what to expect from such spending in this regard. In the short-run, infrastructure spending is unambiguously effective economic stimulus at a time when the U.S. labor market desperately needs it. In the longer-run, such spending may lean with or against the forces driving inequality in the United States. Knowing which way such spending breaks in terms of its expected effect on inequality gives policy makers the chance to try to correct any expected inequities and to encourage aspects that seem promising in lifting demand for those workers who have seen their wages lag behind overall productivity for a number of years. The methodology spelled out in this paper will allow us to make such an assessment.

Appendix A: Scoring Transit Investment Increases

This appendix describes the model inputs we used to generate the results reported in EPI Issue Brief #252, *Transportaion Investments and Jobs.*

Stabilization impacts

For the short-run macroeconomic impacts of this spending, we relied extensively on multipliers generated by Mark Zandi of Moody's Economy.com. We note that using these multipliers probably *understates* the positive job-creation impact of investments called for by many advocates of expanded transit investments, for a number of reasons.[5]

Zandi's infrastructure multiplier measures general infrastructure investment, but makes no differentiation between types of investment. Yet, transportation infrastructure investments are not all created equally—for example, highway and mass transit projects produce job outputs that differ from each other in quantity of jobs, types of jobs, and location of jobs created. While this paper does not quantify the difference between different types of transportation investments, other research efforts have taken steps to detail the relative job creation effects of these specific investments. This research suggests that two types of investments—maintenance and repair and public transportation—provide the maximum job creation bang for each investment buck.

Fix-it-first

An investment strategy of "fix-it-first"—that is, one that concentrates on the maintenance and repair of existing transportation capacity—would create 8% to 17% more jobs than one that concentrated on building new capacity (Mattera and LeRoy 2003; Surface Transportation Policy Project 2004, Appendix 1). There are two reasons for this.

First, for each dollar spent on new capacity, a larger proportion is spent on capital, and thus a smaller portion is spent on labor. A new overpass, for example, requires huge amounts of steel beams, rebar, and concrete, along with heavy machinery. By contrast, a larger portion of the money spent on maintenance and repair, such as repaving or resurfacing, goes to labor cost because the capital costs are relatively minor.

Second, land costs can also crowd out labor costs, leading to fewer jobs created per dollar. New capacity projects often require either land purchase or, at the very least, rights-of-way acquisition. A study by Good Jobs First (Mattera and LeRoy 2003) estimates that on average, land costs constitute 10% of the total cost of a new capacity project.

A fix-it-first strategy also has the benefit of speed, a key advantage in a recession economy. New capacity projects must first go through a lengthy planning process, often including cost analysis, environmental impact assessments (as mandated by the National Environmental Policy Act and, in a few cases, stricter state statutes), engineering, and land acquisition. By contrast, the lead time for maintenance and repair projects is much shorter, often a highly truncated version of the above process (and also involving much less land acquisition). This speed is important because an economy in a recession can deteriorate quickly, and often exponentially, and the faster that government can act to create jobs and boost aggregate demand, the better.

Public transportation

For many of the same reasons pointing to the superiority of fix-it-first projects, focusing investments in public transportation would also create more jobs per dollar than investments in the traditional mix of transportation modes. Research has found that investments in public transportation create 9% to 29% more jobs than those in the traditional road and bridge infrastructure (Surface Transportation Policy Project 2004; Heintz, Pollin, and Garrett-Peltier 2009). These public transportation investments produce more jobs per dollar because less money must be used to acquire land (or the rights-of-way) and capital, although this varies across types of investments; for example, investments in new rail systems tend to have higher land costs than bus systems.

Although most discussion regarding the recently passed stimulus package focused attention on capital investments, it should be noted that money spent on operating assistance for public transportation systems creates the most jobs per dollar of any type of transportation spending. While federal involvement in funding the operations of local public transit systems may or may not be advisable on a permanent basis, temporary federal operations aid would be an effective economic stimulus in a recession. Nearly every state must balance its budget, and as the downturn causes tax revenues to fall, states are forced to cut services such as public transportation. This leads to layoffs for transit workers and rising transportation costs for transit users, and both effects serve to depress demand and shrink the economy.

Perversely, reducing transit services also decreases labor force mobility, making it more difficult for many workers to get to their current jobs or find new jobs. Federal operating assistance to transit agencies would act as an immediate stimulus, preventing layoffs, increasing disposable income, and helping low-income households that are in the most need of support.

A capsule description of some of the research supporting the claim that fix-it-first and public transportation provide better job-creation outcomes is provided below.

Federal Highway Administration's JOBMOD/STPP

The most well-known job creation model, called JOBMOD (and, more recently, JOBMOD2), was developed for and maintained by the Federal Highway Administration (FHA). This model uses input/output analysis to determine the amount of jobs generated by a certain amount of investment.[6] The most recent JOBMOD analysis found that each billion dollars invested in highway (or transit) creates 27,823 jobs. This analysis also breaks down the investment by function, finding that spending on maintenance and repair produces about 5-8% more jobs than spending on new capacity. Most of this difference is due to the fact that investments in new capacity are more capital-intensive than maintenance and repair. The model actually overstates the amount of jobs created by new capacity investments because it does not take into account the cost of land acquisition, which is rarely necessary for repair and maintenance operations. The Surface Transportation Policy Project (2004) found that with land acquisition taken into account—using the average land acquisition cost found by Good Jobs First (below)—JOBMOD estimated that maintenance and repair creates 9% more jobs than new capacity projects.

CSI/APTA/STPP

Cambridge Symantics, Inc. (CSI), along with American Public Transportation Association (APTA), developed a dynamic, general equilibrium model (CSI/REMI), which estimates the effects of transportation infrastructure investments on, among other things, job growth. Unlike JOBMOD, this model was able to disaggregate investments by transportation mode. Although the study was completed in 1999, the Surface Transportation Policy Project (2004) updated the model in 2004 and found that investments in public transportation produce 41,040 jobs per billion, about 9% more jobs than road and bridge maintenance and repair projects and 19% more jobs than new road and bridge projects. Unlike JOBMOD, CSI/REMI does take into account the cost of land acquisition.

Good Jobs First

Good Jobs First also conducted an analysis of FHA data, with similar findings to the CSI/APTA/STPP report. Using JOBMOD, and then factoring in land acquisition costs (which, it estimates, constitutes about 10% of new capacity highway projects), it found that the weighted average for construction job creation of the four subgroups of fix-it-first projects (restoration/rehabilitation, resurfacing, and reconstruction with no added capacity) produces about 7% more construction jobs than that of new capacity projects (new route, relocation, major widening, and reconstruction).

PERI/AAM

The Political Economy Research Institute (PERI), along with the Allied Association of Manufacturers (AAM), recently released a report studying the economic benefits of infrastructure. Similar to JOBMOD and this report's own methodology, PERI/AAM used an input/output model, but they were able to disaggregate industries to determine the specific job creation effects of different types of infrastructure investments.

Its findings are listed below (direct and indirect jobs/respending jobs):

- Transportation (overall): 13,829/18,930
- Roads/Bridges: 13,714/18,894
- Roads/Bridges (new): 12,638/17,472

- Roads/Bridges (repair): 14,790/20,317
- Rail: 9,932/14,747
- Mass Transit: 17,784/22,849

The findings indicate that highway maintenance and repair projects produce 16-17% more jobs while mass transit projects produce 20-29% more jobs than general highway projects.

Structural impacts

For the structural impacts of this spending, we used a set of inputs drawn directly from three scenarios that advocates of expanded transit investments have recommended.

The most modest scenario (which still argues for much more aggressive funding of transit infrastructure than is currently undertaken) argues simply for fully funding the pent-up demand for transit projects that currently exists. This scenario is taken directly from the report *Jumpstarting the Transit Space Race* from Reconnecting America (RA 2008)). RA claims in this report that roughly 400 new rail, streetcar, and bus rapid transit projects have been proposed yet remain unfunded to date across the United States. Meeting this need would require roughly $250 billion in new funding. Assuming that this investment could occur within a decade if funding were secured, this report uses the figure of $25 billion per year for 10 years.

A more aggressive scenario is taken from a report prepared by Cambridge Systematics (CS) for the American Public Transport Association (APTA) and the American Association of State Highway and Transportation Officials (AASHTO). CS finds that improving (not just maintaining) physical conditions and service performance in the nation's public transportation infrastructure would require an investment of $75 billion each year, or $750 billion over the next decade.

The most aggressive scenario is taken from a January 2009 discussion paper from APTA titled *Changing the Way America Moves: Creating a More Robust Economy, a Smaller Carbon Footprint, and Energy Independence*. This paper argues that to replace oil imports on a scale equivalent to what the U.S. import from the Persian Gulf each year and to spur an 8% reduction in carbon emissions from the U.S. transportation sector, investments of 1.6% of total U.S. GDP would have to made annually. Over the decade, this translates into roughly $2.3 trillion.

Given the levels of investment required in each of these scenarios, we follow APTA in assuming a breakdown of roughly 60/40 in new investment versus operating costs. The new investments breakdown further into roughly one-third new manufactured rail and auto-parts equipment and two-thirds new construction. **Table A1** below provides a quick summary of the dollar flows by receiving industry in each of these three scenarios.

TABLE A1

Model inputs for receiving industry flows

		Three scenarios ($ billions)		
Industry	***Share***	***Scenario 1***	***Scenario 2***	***Scenario 3***
Construction	33%	$83	$248	$759
Manufacturing				
Railroad rolling stock	17%	43	128	391
Other transportation	17	43	128	391
Rail transportation	17	43	128	391
Transit/ground psgr transport	17	43	128	391
TOTAL	100%	$250	$750	$2,300

SOURCE: Authors' analysis of BLS and Census data. For more information on methodology, see Bivens, Irons, and Pollack (2009).

Appendix B: Scoring Green Investment

This appendix describes the model inputs we used to generate the results reported in EPI Issue Brief #253.

Stabilization impacts

For the short-run macroeconomic impacts of this spending, we relied extensively on multipliers generated by Mark Zandi. While these multipliers argue that generic infrastructure investments are excellent economic stimulus, there is even some reason to think that investments undertaken in the short-run in the name of energy conservation would actually be even more stimulative than the generic infrastructure numbers would indicate. Much of the construction spending undertaken in the name of conservation would be mostly directed towards retrofitting existing structures rather than building new ones from scratch. This sort of "fix-it-first" construction typically is more labor-intensive than average and hence would make better economic stimulus.

A new commercial building, for example, requires huge amounts of steel beams, rebar, and concrete, along with heavy machinery. New capacity also often involves land costs, either purchasing the rights-of-way or the land itself. By contrast, renovation and retrofitting do not have costly capital and land expenses, so a larger share of each fix-it-first dollar goes towards job creation. Recent studies have found that about 8% to 17% more jobs are created by fix-it-first investments than by investments in new capacity (Mattera and LeRoy 2003; Surface Transportation Policy Project 2004, Appendix 1).

A fix-it-first strategy also has the benefit of speed, a key advantage in a recession economy. New capacity projects must first go through a lengthy planning process, often including cost analysis, environmental impact assessments, engineering, and land acquisition. By contrast, the lead time for maintenance and repair projects is much shorter, often a highly truncated version of the above process and much less land acquisition. An economy in a recession can deteriorate quickly, and often exponentially, so the faster that government can create jobs and boost aggregate demand, the better.

Structural impacts

For the structural impacts of this spending, we used as our inputs the industry spending flows identified in the Green Recovery (GR, henceforth) report authored by the Political economy Research Institute (PERI) for the Center for American Progress (CAP). This report focuses mostly on short-term, macroeconomic stabilization impacts of green investments. They argue for spending $100 billion on green investments as a part of an economic stimulus package.

We also look at two scenarios with even larger spending flows, $200 billion and $300 billion, that correspond with the spending targets recommended in the GR report. We also look at the implications of continuing this level of spending for a decade. This total level of spending (less than 2.5% of GDP in even most ambitious case for a decade) still probably does not quite get the U.S. economy fully on the path to being a low-carbon economy, but, it would constitute a very significant down-payment in this regard.

The PERI report has the great virtue of being specific about where to profitably target green investment spending in terms of industries. We use their industry spending flows as inputs into our model. **Table B1** below provides an industrial breakdown of this spending.

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TABLE B1

Model inputs for receiving industry flows

		Three scenarios ($ billions)		
Industry	***Share***	***Scenario 1***	***Scenario 2***	***Scenario 3***
Construction	40%	$40	$80	$120
Rail transportation	10	10	20	30
Transit and ground psgr	10	10	20	30
Utilities	30	30	60	90
Biofuels	10	10	20	30
Crop production	3	3	7	10
Basic chemical manufacturing	3	3	7	10
Agricultural chemical manufacturing	3	3	7	10
TOTALS	100%	$100	$200	$300

SOURCE: Authors' analysis of BLS and Census data. For more information on methodology, see Bivens, Irons, and Pollack (2009).

Endnotes

1. It should be noted, however, that the role of infrastructure investments in the ARRA is often overstated. Overall, infrastructure investments accounted for roughly 10% of economic stimulus provided in the legislation.
2. Normally, expansion of monetary policy would be a third option, but with the federal funds rate at nearly zero, monetary policy options seem to have been exhausted.
3. There are some who would argue that infrastucture's high bang-for-the-buck comes with a cost of being slower to implement than other forms of stimulus. While there is a grain of truth to this argument, given that all forecasts show that even with ARRA, the U.S. unemployment rate will continue to rise well into 2010 argues that we will need effective stimulus for some time to come, so infrastructure spending that comes online later is in no danger of "missing" the recession.
4. See Jones, Van. 2008. *The Green Collar Economy: How One Solution Can Fix Our Two Biggest Problems*. New York: Harper One.
5. There is also a significant difference between advocates' estimates and the macroeconomic approach of using economy-wide multipliers, which, by design, measures the net new increase in production (and by extension employment). Most frequently cited job creation numbers are gross jobs (or FTE's) or job-years, and thus are not strictly comparable. Even ignoring this difference, there are reasons to believe that the multiplier-based approach understates the true impact.
6. Technically, the model measures jobs "supported" by the investment rather than "created" (essentially the difference between gross and net job creation), although in a loose labor market this distinction is much less signifigant.

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