The National and Regional Macroeconomic Effects of Transportation Policies in the American Recovery and Reinvestment Act

Authors:

Frederick R. Treyz, Ph.D.†‡
Fred@remi.com

Evan Braun†
EvanB@remi.com

Tomer Radbil†
Tomer@remi.com

Vivian Kan†
VivianK@remi.com

Rod Motamedi†
Rod@remi.com

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†Regional Economic Models, Inc. (REMI)
433 West Street
Amherst, MA 01002
T: 413-549-1169
F: 413-549-1038
fred@remi.com

‡ Corresponding Author

ABSTRACT

We use a dynamic eight-region model (REMI TranSight) to evaluate the overall economic effects of the Department of Transportation components of the American Recovery and Reinvestment Act (ARRA). We show the respective macroeconomic impacts on these eight regions for seven major programs: highway infrastructure investment; public transit; Amtrak; high-speed rail; aviation; shipyards and merchant marine; and discretionary funding. The macroeconomic benefits of these initiatives are primarily realized as short-term job creation.

However, our program-level simulations allow us to compare macroeconomic outcomes for projects with differing rates of return, observed as changes in transportation costs for final goods, commuting costs, and access costs for factors of production and intermediate inputs. We find that long-term effects are highly responsive to these dynamic network changes, introducing significant policy implications. Given more detailed travel demand and consumer behavior data, state and local governments and Metropolitan Planning Organizations (MPOs) can use dynamic macroeconomic models to estimate the long-term benefits of potential projects, realized as efficiency and transportation cost savings. Thus informed, policymakers will be able to distinguish between “bridges to nowhere” and “bridges to somewhere” and subsequently invest their stimulus dollars in projects that will yield the greatest long-run benefits, minimizing wasteful spending.

INTRODUCTION

In response to the greatest economic crisis since the Great Depression, President Obama signed the American Reinvestment and Recovery Act (ARRA) on February 17, 2009. The objectives of the stimulus package are twofold: to stimulate output and increase employment in the short-term, and to invest in long-term projects that are crucial for sustained economic prosperity. In this analysis, we utilize the REMI TranSight model to evaluate the Department of Transportation components of the ARRA, totaling $48.1 billion, through 2030. This model allows our study to show the total economic effects of infrastructure spending, including a dynamic component that incorporates increases in labor and factor mobility and decreases in transportation, access, and commuting costs. Policymakers would be wise to make use of such modeling; by evaluating and comparing the economic impacts of different projects, local governments, state Departments of Transportation, and Metropolitan Planning Organizations (MPO's) can steer their stimulus dollars to the most productive projects, bypassing those with minimal long-term macroeconomic benefits.

Many of the long-term effects of the transportation initiatives appear as the aforementioned changes in mobility and costs. The immediate response, however, is that of a traditional Keynesian stimulus, designed to increase employment over the baseline forecast for the next two to three years. The Federal Open Market Committee has held the target federal funds rate at 0-0.25% since their December 18, 2008 meeting (1) and traditional monetary policy is thus insufficient to foster economic recovery. In our analysis we assume a Keynesian policy model in which monetary policy is constant. Our findings are presented as the differences relative to REMI's standard baseline forecast, which is estimated based on historical trends, the REMI model's underlying equations, and a macroeconomic forecast acquired in October 2008 from the University of Michigan's Research Seminar on Quantitative Economics.

With this aggregate study, we evaluate three separate dimensions of these transportation initiatives: 1) the temporal effect; 2) geographical effects and their variations; and 3) the respective impacts of the various scenarios. Since project-level data is often unavailable, many of our simulations required us to make significant assumptions. Despite the administration's emphasis on "shovel-ready" projects, only $20.5 billion (42% of the total transportation component of the ARRA) has been allocated at the time of publication, and less than $500 million has been paid out thus far (2). These projects should be evaluated more rigorously upon the release of more precise data.

Temporal Effects

As shown in Figure 1, the immediate effect of the disbursement of stimulus dollars is a rapid increase in employment over the baseline forecast, peaking in 2010. Employment drops quickly thereafter, and the stimulus effect is largely exhausted within four years. In 2014 employment actually drops below the baseline and then gradually increases, reaching the baseline by 2030. This is contrary to our expectation that efficiency gains from the transportation projects would result in employment remaining above the baseline in the long term. Although the transportation component of the ARRA increases employment during the recession by roughly 375 thousand jobs nationwide, the dynamic impact is insufficient to offset the "flooding" of the labor market by construction workers and employees in intermediate demand industries upon completion of the intensive construction phase of the projects. This observation that employment does not significantly increase above the baseline forecast in the long run has substantial policy implications. The REMI forecast assumes that the economy begins to improve in 2010,

evidenced by increasing employment and GDP; however, the lackluster long-term effects imply that if the economy does not improve, a second stimulus may indeed be needed to stimulate growth.

There are several possible explanations for this development. In the first place, many of the initiatives will render concrete benefits that are not readily modeled. For example, Amtrak improvements and the Federal Aviation Administration's programs provide the funding for construction projects that will result in taxpayer cost savings from improved safety, logistics, and maintenance; however, such savings are difficult to quantify and model. Secondly, some of the likely efficiency gains, such as those from transit initiatives, were not modeled due to insufficient data. Lastly, long-term programs such as high-speed rail are unlikely to provide significant efficiency gains during the time frame of our analysis.

It is important to emphasize that the drop in employment change below zero, observed beginning in 2014, is a fall below the baseline forecast and not an absolute decrease in employment. The REMI forecast assumes that total employment increases at least 0.5% yearly from 2011, and increases more than 0.8% by 2030.

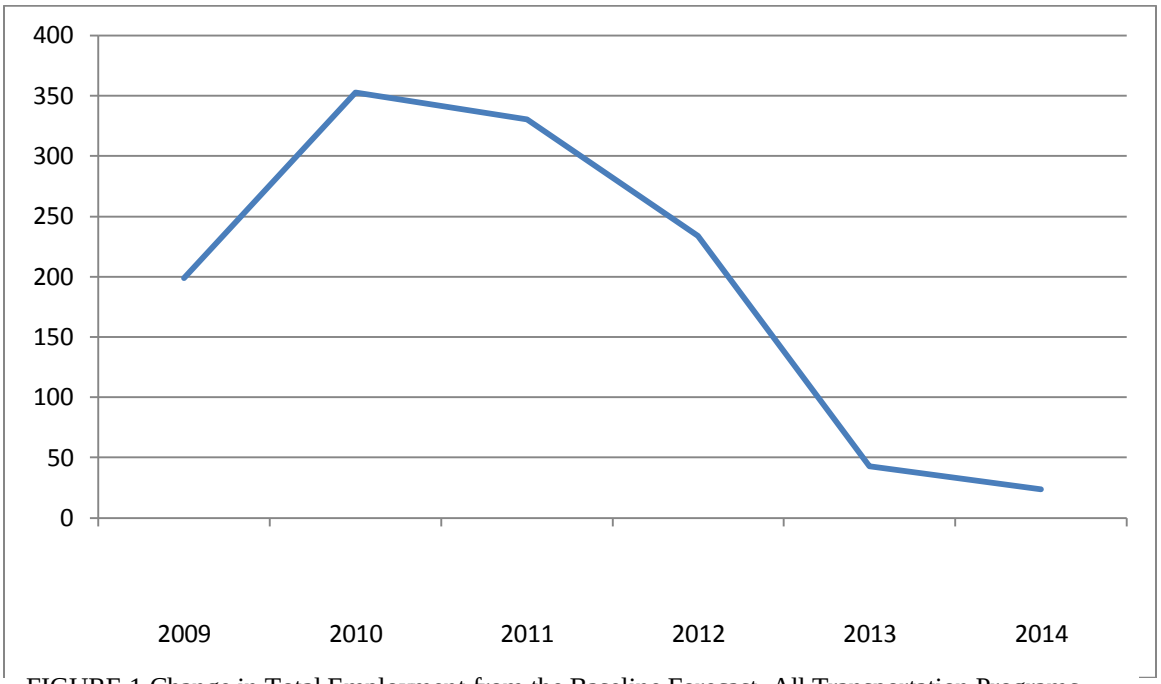

FIGURE 1 Change in Total Employment from the Baseline Forecast, All Transportation Programs

Geographic Effects

Figure 2 on the next page shows the percentage change in unemployment in 2010, the peak year, over the baseline forecast incorporated into the REMI model. The model configuration used for our simulations groups the states into the following eight regions: New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountain, and Far West.

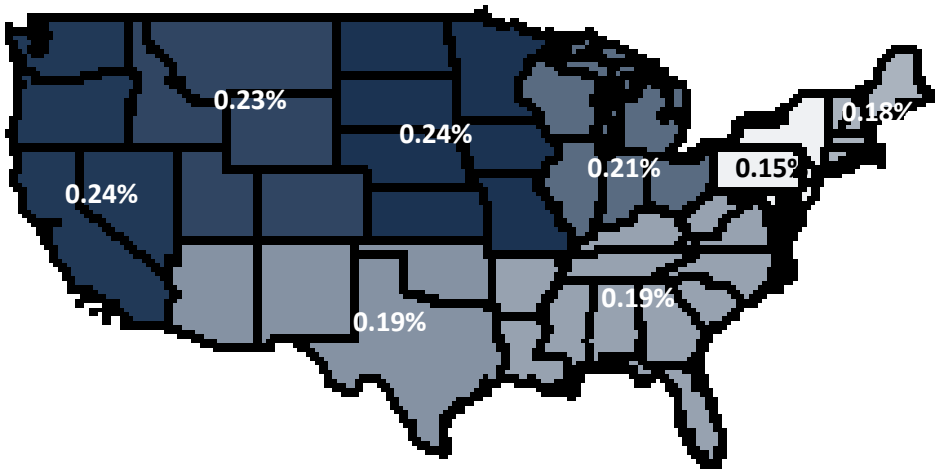

FIGURE 2 Percent change in total employment from the baseline forecast by region (darker regions see larger changes)

This data shows that the Far West, Plains, and Rocky Mountain Regions experienced the highest rates of growth and the Mideast region the lowest; the Northeast, Great Lakes, Southeast, and Southwest regions experienced marginally differing rates of growth. Some of these differences can be explained by differences in the inputs. For example, the Southeast, Great Lakes, Plains, and Far West regions are modeled as receiving funds for high-speed rail programs, while the Northeast, Mideast, Southwest, and Rocky Mountain regions are not. However, much of the changes reflected the differing economic bases in the regions; for example, although the Plains region was third from the bottom in expenditure within the region, it had one of the highest percentage increases in jobs caused by intermediate demand and investment demand. Also, the Northeast and Mideast regions may have seen such small increases because their economies are heavily service-based.

Program Summary

The eleven transportation initiatives of the stimulus package fall under the following major categories: Highway infrastructure ($27.5 billion), public transit ($8.4 billion), Amtrak ($1.3 billion), high-speed rail ($8 billion, with an additional $5 billion in the federal budget for the next five years), aviation ($1.3 billion), shipyards/merchant marine ($100 million, although the amount of money actually spent is larger because the federal share for this program is only 75%), and discretionary funding ($1.5 billion) (3). Note that the expenditure in Table 1 is not always equal to that stated by the DOT because we have excluded internal administrative costs and projects in US territories from our simulations. In addition, the three-year multipliers in the table below are not always the same as we would see by dividing the three-year cumulative effect by the total expenditure for the program; some program expenditures are allocated over more than three years, and we only count the expenditure and output gains within those three years when calculating the three-year multipliers.

Program	Stimulus ($, billions)	Cumulative Effect After Third Year	Cumulative Effect After Tenth Year	GDP Multiplier – 3 Year	GDP Multiplier – 10 Year
Highway Infrastructure	27.210	31.046	33.895	1.426	1.246
Public Transit	8.146	6.004	9.025	1.201	1.108
Amtrak	1.294	1.686	1.414	1.303	1.093
High-Speed Rail	13.000	9.112	17.287	1.425	1.330
Aviation	1.267	1.785	1.506	1.409	1.189
Shipyards/ Merchant Marine	0.131	0.154	0.134	1.179	1.026
Discretionary Funding	1.500	1.977	1.693	1.318	1.129

TABLE 1 Summary Statistics for all programs

HIGHWAY INFRASTRUCTURE

Of the $27.5 billion allocated to highway infrastructure spending, $26.66 billion was allocated directly to the states for "shovel-ready" highway projects, with preference given to those that can be completed within three years (4). An additional $550 million was stipulated for highway projects on federal lands (4). $310 million of these funds are to be spent on Indian Reservation Roads, with the remaining $240 million for Park Roads and Parkways, Forest Highways, and Refuge Roads (4). The rest of the funds administered by the Federal Highway Administration, totaling $290 million, are allocated to projects in U.S. territories (with a small amount set aside for administrative costs) (4) and are excluded from our simulations. Thus, the total spending modeled is $27.21 billion.

Methodology

The immediate disbursement of the highway funds was modeled as an increased demand for highway construction. The Federal Highway Administration has released state- and urban area-level data on the direct apportionment of funds to state Departments of Transportation (4). The $310 million for Indian Reservation Roads was split equally among the Far West, Rocky Mountain, Southwest, and Plains regions (the regions with the majority of, and largest, Indian reservations (5)), while the remaining $240 million for park roads was allocated among all eight regions, weighted by the percentage of other funds allocated to the region. Given the timeframe for the project-specific allocation of funds (June 2009 - September 2010) and the stated preference for projects to be completed within three years (4) (as well as the lag between disbursement and construction), 20% of the funding was allocated in 2009, 30% in both 2010 and 2011, and 20% in 2012.

The TranSight transportation cost matrix is the interface for modeling cost savings and changes in "effective distance" due to improvements in the transportation network. This feature includes separate matrices for transportation costs, accessibility costs, and commuting costs (see descriptions given in the above summary of the highway infrastructure components). The default values for these three costs between and within all regions are 1; thus, any cost savings are modeled as a value less than 1, while any cost increase results in an input greater than 1.

To calculate the transportation cost savings, we assumed a return of 5% on our investment, less the $550 million apportioned for Indian Reservations and Federal Lands (as these are more likely to be used for recreational and personal use than in transporting goods and services). We multiplied our expenditure, $27.21 billion, by 5%, resulting in a total cost savings of $1.3605 billion. This number was divided by the total output of trucking (derived from the baseline forecast) for each year from 2009 until 2030, giving us the percentage decrease in transportation cost for each year. This percentage decrease was subtracted from the baseline value of 1 within the model's transportation cost matrix to calculate the new effective distance. For the sake of simplicity, the transportation cost savings were assumed to be equal within and between all regions. The accessibility cost savings were assumed to be equal to half of the transportation cost savings, with the commuting cost savings equal to 10% of the transportation cost savings. Commuting cost savings are only applied within regions, as most commutes do not transcend regions.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	134.438	203.531	202.281	133.547	-1.859	24.759
Total GDP	Billions of Fixed (2000) Dollars	7.547	11.651	11.848	8.016	-0.057	1.345
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	4.018	5.934	5.886	3.852	-0.361	0.696

TABLE 2 Summary Statistics for Highway Infrastructure, 5% return on investment

The immediate impact of the direct spending on road construction results in more than 200,000 jobs saved or created above the baseline forecast; however, the dynamic results are less impressive. Once all money is disbursed in 2012, total employment actually drops below the baseline and remains there for the duration of the study. It increases gradually but, in 2030, total employment for the country as a whole remains 500 jobs below the baseline. This is certainly a very small decrease, trivial in comparison to the forecasted employment growth.

In order to illustrate the importance of project selection in maximizing the return on investment, we ran simulations with identical construction inputs and a 10% return on investment. Table 3 reports the outputs from this simulation and the percentage changes from the 5% simulation.

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	134.578	203.813	202.734	134.094	-1.172	25.450
Total GDP	Billions of Fixed (2000) Dollars	7.559	11.675	11.889	8.067	0.009	1.434
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	4.038	5.966	5.932	3.904	-0.292	0.768
Total Employment - % Change from 5%	Thousands (Jobs)	0.104%	0.139%	0.224%	0.410%	36.955%	2.788%
Total GDP - % Change from 5%	Billions of Fixed (2000) Dollars	0.159%	0.206%	0.346%	0.636%	115.789%	6.638%
Real Disposable Personal Income - % Change from 5%	Billions of Fixed (2000) Dollars	0.498%	0.539%	0.782%	1.350%	19.114%	10.242%

TABLE 3 Summary Statistics for Highway Infrastructure, 10% return on investment

Although we still observe a drop in employment below the baseline forecast, this drop is significantly smaller than in our first simulation; in addition, GDP remains above the baseline in 2013, delaying the drop in output by one year. Because the construction inputs were identical to those in the 5% simulation, these significant benefits are thus solely due to the dynamic network and transportation cost benefits. Given detailed localized travel demand data, state and local policymakers can calculate project-specific transportation cost changes and apply this method of analysis to allocate their stimulus funding to the most useful projects with the greatest macroeconomic impacts, thus avoiding wasteful spending on projects that do not yield significant benefits.

Because the employment effect of highway spending is very responsive to direct expenditure, the regions with the highest expenditure (Southeast, Far West, and Great lakes) see the highest absolute increase in employment, while those with the lowest expenditure (New England, Rocky Mountain, and Plains) see the lowest absolute increases. The percentage change increases in the peak year, however, are more mixed, ranging from 0.9% in the Mideast region to 0.15% in the Rocky Mountain region.

PUBLIC TRANSIT

Public transit is a particularly attractive component of our transportation infrastructure because it improves the mobility (and thus employment opportunities) of those who cannot afford cars, reduces traffic congestion, and reduces greenhouse gas emissions and demand for oil. The ARRA contains $8.4 billion in total funding to be administered by the Federal Transit Administration, spread among three separate programs (6). The allocation for Transit Capital Assistance is $6.9 billion, to be used for planning, engineering, and design of transit projects and capital investments in buses and security equipment (6). Fixed Guideway Infrastructure Investment (FGII) and Capital Investment Grants/New Starts each receive $750 million (6). FGII funds may be used for any project that involves the construction, maintenance, or improvement of a fixed guideway transit system, while the New Starts program supports similar initiatives whose construction is already underway (7).

Methodology

Lacking project-specific data (the information provided by the FTA is only state- and program-level specific) (8), our modeling of the public transit initiatives of the ARRA has required us to make some significant assumptions. For Transit Capital Assistance, 80% was allocated to investment and 20% to construction; construction spending is defined as the erecting and repair of new buildings and infrastructure, while investment is the purchase of final goods (buses, trains, safety equipment, etc.) that are incorporated into these projects. The FTA stipulates that 50% of funds are to be obligated by September 2009, with the rest by March 2010 (7); funds are required to be disbursed by September of 2015 (7). Thus, we assume that 10% of funds are spent in 2009, 20% in 2010, 30% in 2011, 20% in 2012, 10% in 2013, and 5% each in 2014 and 2015. Fixed Guideway Infrastructure Investment is modeled as 30% investment and 70% construction. Again, funds are to be disbursed by September 2015 (7), and we model the spending according to the following distribution: 5% in 2009, 10% in 2010, 20% in 2011, 30% in 2012, 20% in 2013, 10% in 2014, and 5% in 2015. Lastly, New Starts are also modeled as 30% investment and 70% construction and, as funds are to be disbursed by 2010 for projects already underway (7), funds are allocated equally between 2009 and 2010.

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	19.156	31.359	35.484	25.969	13.125	4.991
Total GDP	Billions of Fixed (2000) Dollars	1.258	2.159	2.587	1.934	1.012	0.356
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	0.605	0.973	1.107	0.801	0.393	0.144

TABLE 4 Summary Statistics for Public Transit

Much like the results for our highway infrastructure analysis, the regions that received the most funding (Mideast, Far West, Southwest, and Great Lakes) saw the largest absolute changes in employment above the baseline, with the Mideast seeing an employment increase of 7500 in the peak year of 2011; on the other hand, the Plains region saw the smallest increase at just under 2000. The relative changes, on the other hand, are not as easily predicted. The Northeast region, which ranked 6th in funds allocated and 7th in total employment increase, had the highest percent increase in employment (followed closely by the Mideast); total percentage changes ranged from over 0.025% in these regions to less than 0.015% in the Plains.

HIGH-SPEED RAIL

Despite our status as the world's leading economic and technological power, America lacks a comprehensive high-speed railway system. The ARRA includes a "down payment" on such a system by funding the early stages of development. Accordingly, we model the early-stage planning and construction but no efficiency changes or cost savings.

Methodology

There are ten potential corridors identified in the strategic plan for high speed rail (9). We selected four corridors that are most likely to receive the $8 billion federal funding, which is awarded on a competitive basis; our selections are based on the criteria set forth by the High Speed Intercity Passenger Rail (HSIPR) Guidance published in June (10). The four chosen corridors are: California Corridor, Pacific Northwest Corridor, Chicago Hub Network, and Florida Corridor. Although there are four different funding tracks, only Track 1 and Track 2 are included in this simulation because Tracks 3 and 4 are not funded by the ARRA. Track 1 is aimed at providing support for "ready-to-go" projects and the money can be used toward construction such as infrastructure, facilities, and equipments; Track 2 is intended to fund the development of entire segments or phases of corridor programs and the projects do not necessarily need to be "ready-to-go" (10). In addition, President Obama has submitted a budget request for an additional $5 billion for the next five years in high speed rail investment.

We assume that more than half of the total $13 billion will be spent within the next three years because Track 1 has a project completion deadline of September 30, 2012; thus, our assumption is that 70% of funding will be directed to Track 1. Track 2, to which we allocate the remaining 30% of funds, has a project completion deadline of September 30, 2017. The Far West region is the main recipient of the federal funding since it includes both the California and Pacific Northwest Corridors. The Chicago Hub Network is spread throughout the Great Lakes, Plains, and Southeast regions. The Florida Corridor will provide funding to the Southeast region. Northeast, Mideast, Southwest, and Rocky Mountain regions do not receive any funding. We assumed that for both tracks, 70% of the funding will be directed toward construction, 25% will be used for professional and technical services (i.e. planning), and the remaining 5% will be allocated for investment (producers' durable equipment).

The Chicago Hub Network is the most extensive and complex high speed rail project within the selection (9), so it was allocated 37.5% of the original $8 billion. California and the Pacific Northwest Corridors are each awarded 25% of the funding, while Florida receives the last 12.5% because it is the shortest project out of the four. We assume that the additional $5 billion will be distributed evenly among the four corridors in five years.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	15.047	65.281	65.406	66.547	30.016	10.854
Total GDP	Billions of Fixed (2000) Dollars	0.922	4.036	4.154	4.332	1.985	0.666
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	0.469	2.000	1.963	2.047	0.855	0.315

TABLE 5 Summary Statistics for High-Speed Rail

The high-speed rail program has the largest multiplier among all initiatives modeled in our simulations. Because of its longer time horizon, it will keep construction workers, engineers, and planners employed for longer and encounters the drop in employment and output below the baseline much later than other programs. In the long-term, the development of a sophisticated

high-speed railway system is likely to result in a decrease in demand for fuel and air travel for long-distance trips, as people who were previously forced to drive would be able to take the more economical and environmentally-friendly train for long-distance trips.

Once again, regions receiving the most funding see the greatest increase in employment, with the Far West receiving a net gain of 23,000 jobs in the peak year of 2012. The Great Lakes benefits by nearly 14,000 jobs, the Southeast by over 13,000 jobs, and employment in the Plains is nearly 8,000 above the baseline. In addition, this component allows us to examine the economic interactions between the different regions in this national model. Even the regions that do not receive funding for high-speed railway projects (Northeast, Mideast, Southwest, and Rocky Mountain) see employment increase by 1-3 thousand due to increased demand for intermediate inputs and professional and technical services produced within the region.

Further study is needed as this network develops and more project-specific construction data (as well as information on consumer and traveler behavior) are available, allowing us to improve on our significant assumptions about the geographical distribution of funds and include the dynamic effects of changes in consumer behavior.

AMTRAK

The Federal Railroad Administration has also been charged with allocating $1.3 billion to improve America's largest existing passenger rail network, the National Railroad Passenger Corporation (Amtrak). Amtrak is required to spend $850 million to rebuild and modernize infrastructure and equipment, with the remaining $450 million to be allocated specifically for projects to upgrade security and life safety systems (11). After evaluating a list of potential projects totaling over $20 billion, Amtrak has chosen to fund $1.294 billion worth of projects (12).

Methodology

Amtrak provides a detailed project summary that includes the time frame and funding allocated for each project (12). All projects are expected to be completed by February 17, 2011. Some of the money is given to specific Amtrak stations for upgrades and repairs and some is distributed to specific regions for general upgrades and replacements. We determined the amount of funding allocated for each region and assumed that 80% will be used for construction projects, with the remaining 20% going toward investment. Because of the nature of the projects, i.e. mainly security and station improvements, we do not model any transportation, efficiency or cost savings. Based on Amtrak's project-specific data, roughly 13% of the funds will be spent in 2009, 60% in 2010, and the remaining 27% in 2011.

Results

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	3.563	16.563	7.375	-0.078	-0.391	0.953
Total GDP	Billions of Fixed (2000) Dollars	0.211	1.011	0.464	-0.001	-0.025	0.055
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	0.107	0.504	0.197	-0.025	-0.022	0.018

TABLE 6 Summary Statistics for Amtrak

Following the pattern evident in our simulations thus far, the ten-year multiplier for the Amtrak component is lower than the three-year multiplier. Output and employment drop below the baseline as the regional economies "unwind" following the completion of construction and investment expenditures, although it is again important to remember that this decrease is relative to a national employment increase of over 0.8% in 2012 (1.5 million jobs). The Northeast and Mideast regions receive the most funding and thus see the largest increases in employment and GDP growth above the baseline; this is unsurprising considering the predominance of the Northeast Corridor (NEC) running between Boston, New York, Philadelphia, Baltimore and Washington within the Amtrak network as a whole (in terms of ridership and total service frequency).

AVIATION

The ARRA stipulates that $1.3 billion is to be set aside for improvements to America's aviation facilities and infrastructure. These initiatives do not comprise a drastic structural realignment of our aviation system. Instead, they provide the necessary capital for much-needed upgrades and new construction to assure the continued functioning of the backbone of air travel in the United States: airports themselves and Federal Aviation Administration (FAA)-controlled navigation, radar, and air traffic control facilities.

Methodology

Of the $1.3 billion in recovery funds administered by the Federal Aviation Administration (FAA), $200 million is to be appropriated within the FAA's existing Facilities and Equipment (F&E) program, which finances capital projects and modernization efforts for the FAA's air traffic control, navigation, and airway facilities and systems. The FAA has released project-specific data for the F&E program: $50 million is used to upgrade power systems, another $50 million for air route traffic control centers, $80 million for air traffic control towers and radar facilities, and $20 million for navigation and landing equipment (13). Power system upgrades were modeled as investment spending (producers' durable equipment), while the combined $180 million for navigation and landing equipment, air traffic control towers and air route traffic control centers are exclusively construction projects. The FAA has released data on the individual cost of each project, as well as the agency-wide expenditure per year for each program (14) with all expenditure occurring in 2009 and 2010; the expenditure for each project in a given year is weighted by the percentage of total program expenditure for that year.

The remaining $1.1 billion is disbursed through the ARRA-specific Grants-in-Aid for Airports program. Excluding funds appropriated for U.S. territories, the total amount disbursed is $1,067,548,630 (15). Grants-in-Aid projects are modeled exclusively as construction expenditure. While total state expenditure data is available (15), the temporal allocation is not; thus, the expenditure is divided equally between 2009 and 2010.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	13.297	15.953	0.438	-0.031	-0.484	1.074
Total GDP	Billions of Fixed (2000) Dollars	$0.786	$0.966	$0.033	$0.000	-$0.032	$0.062
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.404	$0.470	-$0.012	-$0.003	-$0.016	$0.034

TABLE 7 Summary Statistics for Aviation

Because of the predominance of construction and other "one-time" expenditures without any apparent direct cost or efficiency savings, employment increases by nearly 16,000 jobs over the baseline. Employment peaks in 2010 and again drops shortly thereafter, actually falling below the baseline by 2012 and not reaching the baseline forecast by 2029. Once again, the total regional increase in jobs for each region corresponds closely to the raw expenditure on these programs.

SHIPYARDS/MERCHANT MARINE

The $100 million administered by the Maritime Administration (MARAD) for "Supplemental Grants for Assistance to Small Shipyards" is intended for capital and infrastructure improvements to encourage greater efficiency, quality, and competition within the shipbuilding industry. (16).

Methodologies

MARAD received over 500 applications, requesting a combined $1.25 billion, and project-specific allocations do not need to be released until August 17, 2009. Of the $100 million allocated, $2 million is reserved for program administration, so only $98 million is modeled (16). Unlike the other programs within the stimulus package, these funds are not allocated with a 100% federal share; instead, the federal government covers a maximum of 75% of each project (16). Therefore, to determine the total amount spent on shipyard projects, we multiplied $98 million by 1.34, determining that $130.67 is to be allocated. Because the remaining 25% is paid by the private shipyards themselves instead of the state or local government (16), we do not model any reallocation of government spending. Project-specific data is not available; thus, funds are disbursed by region weighted by the number of existing shipyards in the region, as determined by the Economic Census of 2002 (17). We model 70% of the spending as investment and 30% as demand for construction. Because the deadline for MARAD to announce accepted applications is August 17th, 2009, we assume that only 20% of the funds will be disbursed in 2009, with 50% in 2010 and the remaining 30% in 2011.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	0.438	1.141	0.703	0.016	-0.016	0.091
Total GDP	Billions of Fixed (2000) Dollars	0.028	0.078	0.048	0.002	-0.001	0.006
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	0.014	0.035	0.019	-0.002	-0.004	-0.003
Population	Thousands	-0.031	0.000	0.000	0.000	-0.031	-0.001

TABLE 8 Summary Statistics for Small Shipyards

Due to its small size, the overall economic impact of the Small Shipyards program is relatively weak. In total, it is expected to create just over 1100 jobs in its peak year of 2010. Total employment again drops below the baseline by 2012 (although the decrease is very small). Benefits are unsurprisingly concentrated in areas with substantial access to water and maritime shipping lanes, as these areas have the most shipyards and receive the most funding. The Southeast, Far West, Great Lakes, Mideast, New England and Southwest regions benefitted, while the landlocked Plains and Rocky Mountain regions saw miniscule predicted employment increases.

TOTAL

The previous simulations were all run simultaneously to estimate the total impact of the transportation component of the stimulus package on the US economy. The remaining $1.5 billion stipulated for Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grants, providing funding for assorted multimodal surface projects, has been included in this simulation. Because such funds will be disbursed through many agencies, TIGER Grants do not comprise a coherent standalone program. Awarding of these grants will be determined directly by the Office of the Secretary of Transportation and funds are to be allocated especially to high-impact projects that will result in specific transportation benefits while rapidly increasing employment, particularly in economically distressed areas. Much like our above study of the Supplemental Grants for Assistance to Small Shipyards, the current uncertainty surrounding the allocation of these funds has required us to make significant assumptions in our modeling of these funds. The per-region allocation is weighted by all other existing funding, with 70 percent modeled as construction and the remaining 30 percent as investment. Given that funding will be announced in late 2009 at the earliest, the temporal distribution of the spending is as follows: 10% in 2009, 55% in 2010, 35% in 2011.

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg (Through 2030)
Total Employment	Thousands (Jobs)	198.625	352.844	330.469	234.047	42.594	25.6408
Total GDP	Billions of Fixed (2000) Dollars	11.507	21.008	20.251	14.73	2.997	1.496
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	6.014	10.517	9.753	6.917	0.882	0.8038
Population	Thousands	-0.031	0.031	0.063	0.063	0.063	0.2694

TABLE 9 Summary Statistics for All Programs

As is to be expected considering the results of our previous individual simulations, the employment effect of all transportation components is highly responsive to the magnitude of funds allocated. By 2015, when the construction and funding phases of almost all programs are complete, total employment in the US economy dips below the baseline. Employment remains a relatively minor 1000 jobs below the baseline in 2030, the final year of our simulation.

CONCLUSION

In structuring the ARRA, Congress and the Obama Administration aimed to fund projects that will provide jobs in the short term while yielding long-term benefits. Our analysis shows that the construction-heavy Department of Transportation initiatives are heavily biased towards short-term job creation, in contrast to our previous research that has shown substantial long-term economic benefits of the Department of Energy components of the ARRA.

There are several possible reasons for this surprising result. In the first place, the broad scope of our study has required us to make significant assumptions regarding the long-term cost savings and efficiency gains and, in the case of mass transit, possible savings in the future have not been modeled. Secondly, while high-speed rail projects are likely to result in significant savings and efficiency improvements, these dynamic components are unlikely to be realized within the twenty-one year timeframe of our study. Third, the $48.1 billion, while a significant sum, is a relatively small investment in America's massive transportation infrastructure. Lastly, a large proportion of the projects funded, such as security upgrades for Amtrak or a refurbished air traffic control center, may be necessary but are unlikely to result in substantial cost or efficiency changes.

Most importantly, this analysis exhibits the advantages of comprehensive macroeconomic modeling in the selection and implementation of transportation projects, allowing policymakers to determine the most beneficial projects before they are implemented and thus minimize waste.

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