The Obama Economic Recovery Plan: National and Regional Macroeconomic Effect of Energy and Environmental Policies

Authors:

Frederick R. Treyz, Ph.D., Regional Economic Models, Inc.

Rod Motamedi, Regional Economic Models, Inc.

Mario S. DePillis, Jr, Ph.D., MAR&R Economics

Billy Leung, Regional Economic Models, Inc

Dr. Frederick R. Treyz, Ph.D. CEO
Regional Economic Models, Inc.
433 West Street
Amherst, MA 01002
t: 413-549-1169
f: 413-549-1038

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Introduction

With America in the worst economic crisis in a generation, President Obama signed the America Reinvestment and Recovery Act (Recovery Act) in February 2009. The spending package is designed not only to create short-term jobs, but also to invest in long-term goals such as energy independence, an upgraded infrastructure, and an educated workforce. In this paper, we evaluate the regional and national economic impacts of the Department of Energy components of the stimulus package using the REMI PI+ model. We show annual economic effects through 2030, and account for economic changes brought about by energy savings and productivity improvements, as well as the ripple effects of direct spending and employment changes.

The short-term effect of the Recovery Act is a Keynesian-type stimulus, while the long-term effects of the Act result from changes in energy efficiency and costs. The economy is in recession resulting in a high rate of unemployment. The Federal Reserve maintains interest rates at virtually zero, and has exhausted the ability of monetary policy to bring the economy back to full employment. Thus, the Obama economic team designed a fiscal stimulus to increase the rate of employment, and create jobs through the Keynesian multiplier effect. The goal is twofold: first, to create jobs for roughly the first year, and second, to avoid the risk of a downward economic spiral into a protracted recession. In our economic analysis we assume that monetary policy is constant. Thus the overall policy modeled is Keynesian.

The results in this paper are presented in terms of differences relative to REMI's standard baseline forecast. Our baseline forecast follows a general path determined by the historical data in the model, the model's equations, and a macroeconomic forecast acquired in October 2008 from the University of Michigan's Research Seminar on Quantitative Economics (RSQE).

Our analysis focuses on describing three dimensions of the stimulus: 1) the effect over time; 2) the geographical effect; and 3) the impact of the individual programs. These policies are modeled on a high level because actual programs receiving stimulus funds are still being determined. Further study will be needed once policy implementation details and actual programs are known.

The Effect over Time

The overall result is a large increase in employment over the baseline forecast, but the stimulus effect is largely exhausted within the first two to three years. Thereafter employment quickly drops but remains over the baseline due to the long-term benefits produced through greater efficiency and cost savings. This is shown in Figure 1 below.

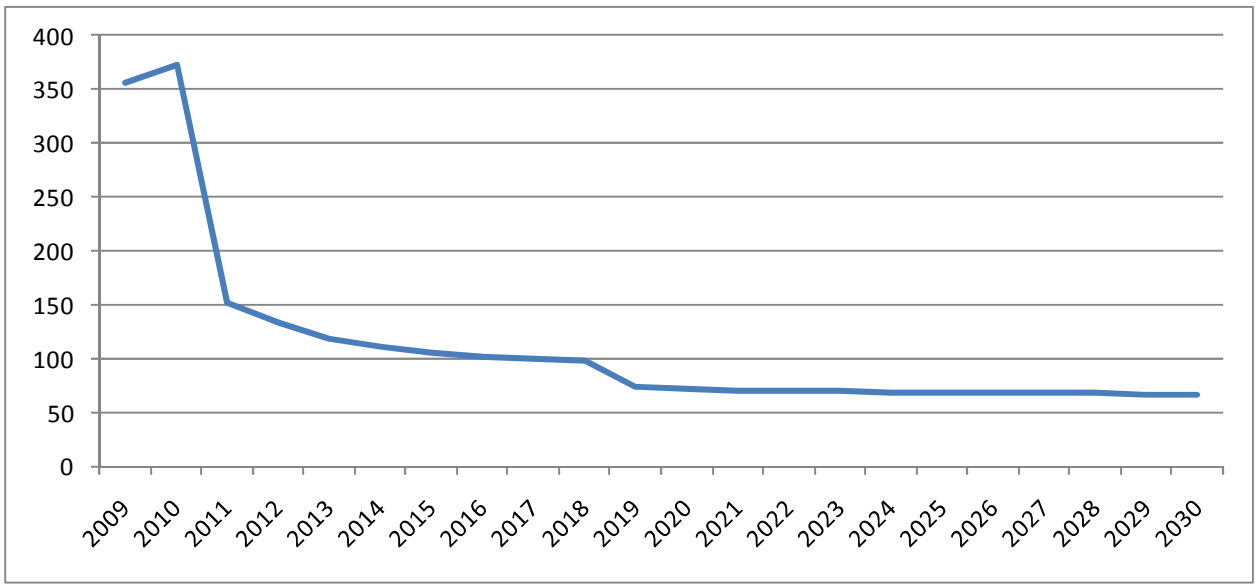

Figure 1: Change in Total Employment from Baseline Forecast, All Energy Programs

The Geographic Effects

Figure 2 shows the relative percentage change in employment in 2010 (the peak year) across the regions used in the model. The darker the region is, the larger its difference is relative to the other regions. The model configuration we used for this simulation groups the states into eight large regions: New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountain, and Far West.

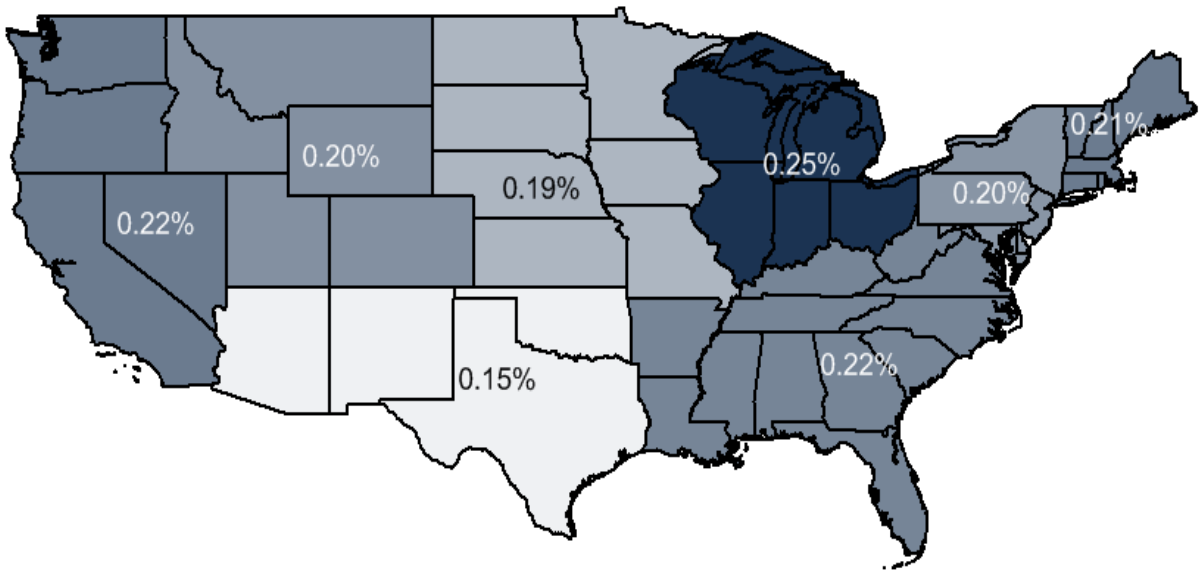

Figure 2: Percentage Change in Employment in 2010 – Relative Difference (Darker is Larger), All Energy Programs

This graphic shows that the Great Lakes region sees the largest percentage growth in employment while the Southwest region is the smallest. The coloring also shows that each of the other six regions marginally differ in

percentage growth. Some differences can be explained by the inputs themselves, e.g. the Great Lakes region will receive funding through the investments in the National Labs whereas the Southwest region will not. For the most part the differences reflect the different economic base in each region. The Great Lakes region boasted the highest percentage increase in jobs supported by intermediate and investment demand while the Southwest region has the lowest. The major industries in the Great Lakes, relative to their size, provide the greatest amount of inputs to other industries and are well-supported by the investment spending contained in these simulations. The manufacturing industries that see the largest percentage growth are Nonmetallic Mineral Product Manufacturing, Furniture and Related Product Manufacturing, and Wood Product Manufacturing.

While the Great Lakes region was only at the top in absolute numbers in one simulation (Weatherization), in relation to its size, this region outperformed all the others. Much of the boost to the Great Lakes region comes from the Weatherization program. The states in this region receive more funding and thus reap the most benefits from direct employment and lower utility bills than any other region.

In terms of absolute numbers, the Southeast region of the US is the clear winner. This region factors in or around the top in many of the simulations. Whereas a few regions do not receive any funding from some of the programs outlined herein, the Southeast region is a beneficiary of all eight. The Southeast region receives the most funding from the Environmental Management, Advanced Batteries, Smart Grid, and the State Energy Programs and Renewables. The reasons for the geographical variance can be found in the Results sections below.

Program Impacts

The major energy components of the Recovery Act are Energy Efficiency and Renewable Energy ($16.8 billion), Environmental Management ($6.0 billion), Smart Grid and Related Programs ($4.5 billion), Fossil Energy ($3.4 billion), Science through the national energy labs ($1.6 billion), and ARPA-E ($400 million). Within Energy Efficiency and Renewable Energy, the package allocates $5.0 billion to weatherization, $3.1 billion to state energy programs, $2.0 billion to advanced battery manufacturing, and $6.7 billion to energy efficiency and renewable energy.

Table 1: Program Summaries

Program	**Stimulus ($, billions)**	**Cumulative Effect After Third Year**	**Cumulative Effect After Tenth Year**	**GDP Multiplier – 3 Year**	**GDP Multiplier – 10 Year**
Weatherization	$5	$8.5	$12.2	1.70	2.44
State Energy Programs and Energy Efficiency and Renewables	$9.8	$31.7	$66.3	3.23	6.77
Advanced Batteries	$2	$3.4	$2.8	1.69	1.38
Environmental Management	$6	$3.7	$12.1	0.61	2.01

Fossil Fuels	$3.4	$2.2	$7.0	0.64	2.05
Science	$1.2	$2.7	$5.6	2.28	4.66
ARPA-E	$0.4	$1.0	$1.2	2.39	$2.92
Smart Grid	$4.5	$9.6	$12.7	2.12	2.81

Weatherization

Residential weatherization improves energy efficiency through the installation of insulation for homes and water heaters, and measures such as caulking and weather stripping on windows. Home weatherization is relatively labor intensive and uses insulating materials that are produced in every region of the country. Projects of this type are not new to the Recovery Act and to certain extent are part of regular maintenance of buildings and structures. However, the Recovery Act places particular emphasis on weatherizing low income housing.

Government funding for these weatherization projects increases demand for a labor-intensive industry (construction) while also increasing the disposable income of a population with a high marginal propensity to consume (MPC). As such, weatherization expenditures create a large number of jobs per dollar of spending during the installation phase. Over the longer term, the improvement in residential heating and cooling efficiency results in reduced expenditures for electricity, natural gas, and fuel oil. Since weatherization is targeted towards low-income households, energy savings will be spent on other consumer goods. Since the general basket of consumer goods and services are more domestically supplied and labor intensive, the diversion of consumer spending away from energy towards other goods and services results in a net increase in employment.

Methodology

There were three components to the weatherization. First, the weatherization aid was modeled as increased demand for construction. To address the free rider problem, we assumed that 1/3 of the weatherization would have happened anyway, and hence only the demand for construction was reduced by this amount. Second, the effect of weatherization was modeled as an on-going savings on natural gas, other fuels, and electricity costs. The savings were assumed to be constant for the first ten years and then decrease in a straight line to zero savings in the last 12 years from 2019 to 2030. This was on the assumption that physical deterioration would be negligible for weatherization such as insulation, but that eventually remodeling and new technology would depreciate the value of weatherization. Finally, the annual savings on fuel were spent instead on other items in the consumer's basket of goods. This assumed that the low-income consumer spends all of the benefits of weatherization and does not divert some of the dollars into savings.

To calculate the total energy savings we first divided the regional weatherization spending by the average amount of money spent on each home, $6,500 to arrive at the number of homes. We then derived the average per household expenditure on natural gas, fuel, and electricity costs from the Energy Information Administration. The household expenditures were then decreased by 32%, which is the average amount of

savings for each home after weatherization takes place. The 32% savings rate was taken from a press release given by the Obama administration as a national average savings after weatherization occurs.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg
Total Employment	Thousands (Jobs)	63.344	64.813	19.203	17.719	16.047	13.885
Total GDP	Billions of Fixed (2000) Dollars	$3.012	$3.185	$0.646	$0.570	$0.476	$0.500
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$1.592	$1.558	$0.193	$0.223	$0.184	$0.229

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	18.963	Great Lakes	2010
Total GDP	Billions of Fixed (2000) Dollars	$0.881	Great Lakes	2010
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.525	Great Lakes	2010

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	-1.322	Southwest	2016
Total GDP	Billions of Fixed (2000) Dollars	-$0.164	Southwest	2016
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.135	Southwest	2016

The fuel savings preserve a positive effect long after the initial investment, extending the economic impact. This differs from the programs without returns on the investment, such as the clean-up of toxic waste sites under the Environmental Management program. The GDP multiplier after three years is 1.77, a 77% increase. After ten years the multiplier is 2.44, a 144% increase.

Weatherization has the largest effects in regions with high heating costs such as the Great Lakes and the New England. As those areas become more competitive due to lower energy costs, the other areas become less competitive on a relative basis.

State Energy Programs and Energy Efficiency and Renewables

In the Economic Recovery Act, state energy programs differ from general weatherization primarily in that they have state involvement or funding. They consist of both energy efficiency programs similar to weatherization and also renewable energy programs. The state energy programs also differ in that the spending is done annually over a ten year period rather than in the first two years.

For this paper, we used a simplified representation of the programs. The category of energy efficiency and renewables is very broad and includes a wide range of technologies and energy sources. At the time this paper was written few details were available on what types of state programs would be acceptable under the federal plan. Individual energy efficiency and renewable projects are more accurately evaluated using specific data and assumptions appropriate to the specific project. The range of energy efficiency and renewable programs is well-illustrated on the California-specific pages of the EERE web site. Programs include energy efficiency measures such as building energy codes, industrial plant assessments, and industrial technologies. Renewable energy programs include biomass, wind, geothermal, and solar.

The REMI model has been used for similar studies. Treyz and Motamedi evaluated regulations requiring that all new homes in New Mexico (Treyz and Motamedi, 2007) meet energy star guidelines. Treyz et al. studied the economic impacts of a feebate program in Connecticut (Treyz, Leung, and Clarke 2007). The feebates program places a tax on gas-guzzling cars and subsidized fuel efficient automobiles. As a result, Connecticut residents spend less on fuel and motor vehicles and more on the general basket of consumer goods and services. As consumer spending shifts from relatively out-of-state to within-state production, net jobs are created within Connecticut.

Methodology

As noted above, we used a simplified representation of the programs for this study because at the time this paper was written few details were available on what types of state programs would be acceptable under the federal plan. The modeling was similar to the weatherization program. The program expenditures were modeled as direct spending on construction projects. All of the annual savings on fuel were spent on other items in the consumer's basket of goods. Unlike the weatherization simulation, the savings did not reduce over time as insufficient program detail was available.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg - 2030
Total Employment	Thousands (Jobs)	174.797	181.813	84.953	79.781	74.219	76.737
Total GDP	Billions of Fixed (2000) Dollars	$10.006	$10.785	$4.729	$4.489	$4.202	$4.923
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$4.660	$4.659	$1.635	$1.654	$1.529	$1.986

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	43.762	Southeast	2010
Total GDP	Billions of Fixed (2000) Dollars	$2.387	Far West	2010
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$1.036	Far West	2010

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	-1.277	Southwest	2016
Total GDP	Billions of Fixed (2000) Dollars	-$0.423	Southwest	2016
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.418	Southwest	2016

This program has the largest multiplier. By 2018, each dollar of spending is generating $6.77 of real GDP. The large multiplier is due to the nature of the spending and benefits of the State Programs. Firstly, there is two years of heavy investment in construction and equipment that is then followed by years of cost savings for various fuels. This pattern causes the three-year multiplier to be quite large at 3.23 and causes its continuing increase due to the creation of efficiencies in the economy.

Advanced Batteries

The Advanced Batteries program strives to improve the state of the art in plug-in hybrid electric vehicles (PHEV) and their batteries. Currently the size, weight, cost, and lifetime of batteries is a major bottleneck in the widespread adoption o f PHEVs. By providing financial support for firms engaged in the effort to develop new batteries, the federal government is increasing the risk tolerance and hopefully imagination the battery entrepreneurs.

The funding will be distributed between US manufactures that produce the batteries and their components; manufactures producing other parts for the PHEVs; and the remainder will go toward evaluation of PHEVs and infrastructure projects (EERE). Over time these projects aim to change the input fuel for road transportation to domestically-produced electricity from foreign-imported fossil fuels.

Methodology

It was assumed that the government support in this category would behave much like seed money to enable future productive enterprise. Based on this initial assumption the total $2 billion was assumed to be spent on construction of facilities and was to be spent over two years. However, no assumptions were made as to the success of this financing effort in the ultimate creation of feasible and marketable battery technologies. Thus, there are no future sales numbers or other impacts resulting from advanced batteries. In order to allocate the lump spending across the model regions, the total was shared out using each region's share of existing electrical equipment and appliance manufacturing output taken from the model's baseline forecast.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg - 2030
Total Employment	Thousands (Jobs)	24.000	24.156	0.172	-0.375	-0.953	1.731
Total GDP	Billions of Fixed (2000) Dollars	$1.332	$1.370	$0.021	-$0.025	-$0.067	$0.089
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.704	$0.678	-$0.045	-$0.027	-$0.043	$0.040

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	6.602	Southeast	2010
Total GDP	Billions of Fixed (2000) Dollars	$0.333	Southeast	2010
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.174	Great Lakes	2010

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	-0.270	Southeast	2014
Total GDP	Billions of Fixed (2000) Dollars	-$0.019	Far West	2015
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.015	Mideast	2011

The simulation results reflect the distribution of electrical equipment and appliance manufacturing around the country. With their existing clusters and proximity to the automobile manufacturing centers of the nation, the Southeast and Great Lakes regions are able to best leverage the improvements in this area. For example, two companies already have plans to invest roughly $1.2 billion in establishing advanced battery manufacturing facilities in Michigan. KD Advanced Battery Group, LLC, and A123 Systems each plan on manufacturing lithium ion batteries for the PHEV makers.

The ten-year GDP multiplier of this simulation is 1.38, which is lower than the short-term multiplier of 1.69. This disparity is due to cessation of funding from this program after 2010. When the investment in the manufacturing facilities stops, the regional economies drop below the baseline while they wind down after the conclusion of the investment period. Over time the economies return back toward the baseline as suggested in the Minima table. The simulation was run through 2030 but the lowest figures occur much closer to the end of the funding as opposed to the end of the simulation.

Environmental Management

This portion of the DOE spending is directed toward the risk reduction and cleanup of the environmental legacy of the nation's nuclear weapons program. During the latter parts of World War 2 and for the duration of the

Cold War, the United States maintained a vast and complex nuclear weapons program. One of the legacies of that program is a number of contaminated sites that were host to the processing of uranium, the testing of nuclear weapons, or the storage of radioactive materials.

A number of these sites are no longer needed by the DOE but due to the contamination cannot be used for any other purpose. Now, in a situation where there are many underutilized resources in the economy especially in the labor market is a good time to undertake these cleanup programs. When the economy rebounds, these laborers and resources can be used for more immediate productive purposes. By hastening the remediation of these sites, the DOE hopes to make the land available for future productive uses and to save money by early closings of the sites (US DOE).

Methodology

The key assumption in this simulation is that the DOE will spend the cleanup budget over ten years: the total amount was shared equally from 2009 through 2018 in Waste Management and Remediation Services. The amount of spending per region was proportional to the state-by-state expenditures provided by the DOE.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg - 2030
Total Employment	Thousands (Jobs)	14.125	14.594	14.641	14.422	14.031	5.183
Total GDP	Billions of Fixed (2000) Dollars	$0.944	$0.992	$1.014	$1.016	$1.005	$0.362
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.446	$0.443	$0.447	$0.451	$0.448	$0.158

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	5.078	Southeast	2011
Total GDP	Billions of Fixed (2000) Dollars	$0.316	Southeast	2011
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.157	Southeast	2018

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	-0.590	Southeast	2021
Total GDP	Billions of Fixed (2000) Dollars	-$0.049	Mideast	2022
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.031	Great Lakes	2019

The results of this simulation are largely determined by the inputs. Because we obtained projected spending by state, the money was allocated accordingly. For example, New England and the Plains region are not expected to receive any funding as part of this program. The Southeast region is expected to receive the largest allotment of environmental management dollars. A particularly large project in the Southeast region is the cleanup of the Savannah River Site, a major Cold War facility. The REMI model was used to analyze a restructuring of the Savannah River Site (Gunther) and the impacts of reduced activity at the Yucca Mountain Site (Carroll). The closure of these sites and other like them will in some cases be offset by the return of the land to productive uses. The simulation here only measures the impacts of the remediation efforts.

The three year multiplier of Environmental Management is below one due to the modeling assumptions. The spending for this program was spread over ten years under the assumption that at least some of the sites would take numerous years to fully remediate. Thus, we do not see a full multiplier until 2018 with the ten-year figure of 2.01.

Fossil Fuels

The Office of Fossil Energy received $3.4 billion from the Recovery Act. Initiatives will focus on research, development and deployment of technologies to use coal cleanly and efficiently. Investments will go toward finding and testing new ways to produce energy from coal - such as gasification - and improving techniques to clean or capture and store the emissions from coal-fired power plants.

The United States has some of the largest coal deposits in the world. Even though it generates some fifty percent of its electricity through burning coal, the United States has enough coal to last many decades. Coal has the benefit of being plentiful, cheap, and domestic. However, coal has distinct disadvantage of being one of the most polluting fuels available for power generation. From the mining of it to its burning, coal generates many tons of carbon dioxide, soot, and acid-rain-causing pollutants. Cleaning up coal has become a central goal of effectively reducing the nation's reliance on foreign fuels and combating climate change. The Fossil Fuels program strives to fund the research that will enable the clean and efficient use of coal.

Methodology

The fossil fuels program is a research effort with the goal of better utilizing the nation's fossil fuel supply. In the absence of expected allocations, we assumed that the money will distributed around the country based on the current distribution of professional, technical, and scientific services and that the benefits, realized in terms of electricity costs savings, would follow the spending. While the distribution of coal mining is very uneven around the country, the distribution of coal-fired power plants, especially at our level of regional aggregation, is relatively even. However, because our regions are not equal in size, we retained the allocation of benefits in line with the research spending.

The research effort is assumed to last ten years and has a tenth of a percent rate of return, i.e. one tenth of the money spent on research will equal the amount of electricity cost savings in the economy under the assumption that the research effort will reduce future emissions fees and other generation costs. The total savings was shared out by consumer class: 25% to industrial customers, 25% to commercial, and 50% to households. The last year's (2018) research amount is assumed to determine the cost savings for the remainder of the simulation

period (through 2030). In other words, one tenth of a percent of the research spending in 2018 is assumed to be the offset for every year from 2019 through 2030.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg - 2030
Total Employment	Thousands (Jobs)	8.688	8.813	8.719	8.516	8.234	3.073
Total GDP	Billions of Fixed (2000) Dollars	$0.567	$0.584	$0.589	$0.584	$0.577	$0.209
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.298	$0.286	$0.286	$0.284	$0.286	$0.109

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	1.949	Mideast	2009
Total GDP	Billions of Fixed (2000) Dollars	$0.153	Mideast	2011
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.082	Mideast	2018

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	-0.301	Southeast	2021
Total GDP	Billions of Fixed (2000) Dollars	-$0.028	Mideast	2021
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.016	Southwest	2021

Because the total program amount was shared by the national distribution of profession, technical, and scientific services, the Mideast region, which contains New York, New Jersey, Pennsylvania, and Washington, DC among other states, sees the largest impacts. This region is the home to the greatest concentration of professional, technical, and scientific services in the nation. As such the region also sees the largest benefits from the cost savings. An example of a project occurring outside of this area is a gas cleaning technology for IGCC being developed by TDA Research in Colorado which will remove trace metals from coal-derived syngas.

Much like the Environmental Management simulation, the short-term multiplier of the Fossil Fuels program is less than one (0.64). Here again the program spending is allocated over ten years to capture the time required to develop and implement the technologies under consideration. After the conclusion of the ten year period, the multiplier rises to 2.05.

Science

The DOE Office of Science administers the National Labs. The Science program stimulus spending is focused on many required updates and upgrades to our National Labs. These improvements include repair and maintenance of structures and the construction and upgrades to the equipment used by the scientists of the National Labs.

Methodology

The allocation of money for some of the programs has been determined by the DOE. The state-by-state spending was first scaled up to the program total ($1.2 billion) and then divided into construction and research spending according to the proportions laid out by the DOE ($830 million on construction and the rest on research). The construction and additional research was assumed to last three years with the construction beginning in 2009 and the research beginning in 2010. This program is assumed to create a 10 percent return that was modeled as a reduction in production costs across the nation.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg - 2030
Total Employment	Thousands (Jobs)	6.656	13.469	13.688	7.250	3.859	4.124
Total GDP	Billions of Fixed (2000) Dollars	$0.401	$0.881	$0.925	$0.542	$0.313	$0.369
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.206	$0.528	$0.525	$0.323	$0.211	$0.243

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	5.051	Far West	2011
Total GDP	Billions of Fixed (2000) Dollars	$0.357	Far West	2011
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.214	Far West	2011

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	-0.133	Southwest	2030
Total GDP	Billions of Fixed (2000) Dollars	-$0.009	Southwest	2030
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.013	Southwest	2030

Because not every region has a National Lab, nor is every National Lab the recipient of funding through this program, regional benefits are not evenly distributed. The DOE already lists of projects to be funded through this

allocation. The Labs in the Far West region, such as the Lawrence Berkeley National Laboratory and the Lawrence Livermore National Laboratory, are large recipients of funding. These Labs require both routine maintenance and upgrades to bring them in line with earthquake standards.

Although it is home to important labs such the Los Alamos and Sandia National Laboratories, the Southwest region does not receive any funding. However, the Southwest is not the only region that does not receive any funding: New England and the Rocky Mountains do not either. Even with the highly uneven distribution of funds across the nation this program still manages to create a long-term multiplier of 4.66. This large number is due to the efficiencies and increased competitiveness caused by the production cost savings. As the research at the National Labs is moved to market, it will create improvements in economy that will allow it to grow by much more than just the direct spending would suggest.

ARPA-E

Congress created the Advanced Research Projects Agency for Energy with the goal of funding cutting edge research in energy and climate. However, until receiving an allocation of money in the Recovery Act, ARPA-E had not received any funding at all nor had an office been created for the program. The goal of ARPA-E, an organization purposely modeled after Defense Advanced Research Projects Agency (DARPA), is to engage in high risk, high payoff research concepts.

Methodology

This simulation closely matches that of the fossil fuels simulations. The total budget was shared out by the nation's existing professional, technical, and scientific services output over a three year period beginning in 2009 under the assumption that the grants will be made and research will be conducted over this time frame.

Results

All Regions

Category	Units	2009	2010	2011	2012	2013	Annual Avg - 2030
Total Employment	Thousands (Jobs)	3.781	3.906	3.875	0.469	0.359	0.739
Total GDP	Billions of Fixed (2000) Dollars	$0.248	$0.260	$0.263	$0.036	$0.027	$0.059
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.140	$0.138	$0.139	$0.016	$0.021	$0.039

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	0.838	Mideast	2010
Total GDP	Billions of Fixed (2000) Dollars	$0.066	Mideast	2010
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.034	Mideast	2009

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	0.001	New England	2014
Total GDP	Billions of Fixed (2000) Dollars	$0.000	New England	2014
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.001	Plains	2025

This simulation looks at the pure allocation of research dollars across the country. Again the Mideast region, with its large concentration of professional, technical, and scientific services, sees the largest growth. The increases in competitiveness cause the ARPA-E programs to have high multipliers of 2.39 in the short- and 2.92 in the long-term.

Smart Grid

The funding for this program is allocated to the Office of Electricity Delivery and Energy Reliability. The mission of this office is to lead national efforts to modernize the electric grid; enhance security and reliability of the energy infrastructure; and facilitate recovery from disruptions to energy supply. Improving the transmission infrastructure is a key component of the Obama Administration's goal of increasing the use of renewable fuel sources in the generation of the nation's electricity and realizing efficiency gains.

REMI conducted an analysis on improving the reliability of electricity distribution for Connecticut Light and Power. It was shown that the productivity benefits gained from fewer outages outweighed the cost of implementing the necessary upgrades to the distribution system. It is fair to assume that if a regional project can produce a measurable benefit, then a national scale project could do the same.

Methodology

We assumed a two year construction effort representing upgrades to the transmission infrastructure. The spending for this program is shared out by each region's share of total consumption of electricity. The benefits of this investment are assumed to be a reduction in electricity costs equal to ten percent of the spending. The savings are modeled using the same methodology as in the Fossil Fuels simulation. The cost savings are assumed to be due to reliability improvements, less need to acquire reserves, and fewer transmission constraints.

Results

All Regions

Category	Units	2009	2014	2019	2024	2029	Annual Avg - 2030
Total Employment	Thousands (Jobs)	60.063	3.109	2.250	2.281	1.813	8.021
Total GDP	Billions of Fixed (2000) Dollars	$3.479	$0.340	$0.346	$0.414	$0.428	$0.684
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$2.043	$0.333	$0.348	$0.386	$0.384	$0.514

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	17.059	Southeast	2010
Total GDP	Billions of Fixed (2000) Dollars	$0.889	Southeast	2010
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.502	Southeast	2009

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	0.027	Rocky Mountain	2030
Total GDP	Billions of Fixed (2000) Dollars	$0.009	Rocky Mountain	2016
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$0.008	Rocky Mountain	2027

Based on the national data taken from the REMI model's baseline, in 2009 and 2010 the Southeast region uses the greatest amount of electricity and thus receives the greatest direct spending and long-term benefits. On the other hand, the Rocky Mountain region uses the least. Because of the large direct spending ($4.5 billion) and the electricity cost savings resulting from this investment, the Smart Grid program has short-term and long-term multiplier over two: 2.12 and 2.81, respectively.

Total

Methodology

All the previously discussed simulations were run concurrently to produce the results below. The individual results will not aggregate exactly to the total run due to the feedback and dynamic effects in the model.

Results

All Regions

Category	Units	2009	2014	2019	2024	2029	Annual Avg
Total Employment	Thousands (Jobs)	355.656	112.313	74.859	69.844	67.781	113.364
Total GDP	Billions of Fixed (2000) Dollars	$20.004	$6.570	$4.516	$5.025	$5.783	$7.183
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$10.105	$2.866	$1.961	$2.303	$2.698	$3.292

Maxima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	93.660	Southeast	2010
Total GDP	Billions of Fixed (2000) Dollars	$4.781	Southeast	2010
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	$2.320	Southeast	2010

Minima

Category	Units	Amount	Region	Year
Total Employment	Thousands (Jobs)	-2.006	Southwest	2019
Total GDP	Billions of Fixed (2000) Dollars	-$0.511	Southwest	2019
Real Disposable Personal Income	Billions of Fixed (2000) Dollars	-$0.510	Southwest	2019

Conclusion

Lawmakers structured the energy components of the Recovery Act to create jobs in the short term, and to provide meaningful investments in energy efficiency and independence in the long term. Thus, government expenditures in the program are capital investments; for example expenditures on the installation of insulation to weatherize homes. In the case of environmental remediation, the stimulus program accelerates nuclear waste site cleanup, which would otherwise need to happen over a longer time frame.

The macroeconomic impacts of the programs show that large capital investments stimulate economic activity in the short term due to a Keynesian multiplier effect, while the return on these investments are reflected in long-term economic growth. The short-term employment effects tend to dominate. Yet, since the capital expenditures have returns in terms of cost savings and productivity enhancements, one the initial stimulus funding is spent, there are long lasting increases in real disposable personal income and gross domestic product. Nevertheless, the long-term effects are still modest due to the small size of the programs and conservative assumptions. As more details on the program spending become available the studies may be worth revisiting.

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