ORNL/TM-2014/98

Macro-Economic Impacts of the Weatherization Assistance Program for Program Year 2008

Mark Burton
Larry Bray

September 2014

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

ORNL/TM-2014/98

Environmental Sciences Division

MACRO-ECONOMIC IMPACTS OF THE WEATHERIZATION ASSISTANCE PROGRAM FOR PROGRAM YEAR 2008

Mark Burton, University of Tennessee, Knoxville
Larry Bray, University of Tennessee, Knoxville

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Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6283
managed by
UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

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ACRONYMS

ARRA	American Recovery and Reinvestment Act
DOE	U.S. Department of Energy
NIPA	United States National Income and Product Accounts
OWIP	Office of Weatherization and Intergovernmental Programs
PY	Program Yea r
REMI	Regional Economic Models, Inc.
UNSNA	United Nations System of National Accounts
WAP	Weatherization Assistance Program

ACKNOWLEDGEMENTS

The work presented in this report was funded by the U.S. Department of Energy's (DOE) Office of Weatherization and Intergovernmental Programs (OWIP).

EXECUTIVE SUMMARY

The US Department of Energy's Weatherization Assistance Program (WAP) is a decades old initiative designed to help lower-income households reduce energy consumption and related household energy expenditures. Initially, the modestly funded program focused on small-scale energy-conserving measures. However, by 2008, based on its success, the program had grown to include more extensive energy-saving improvements supported by an annual federal appropriation of approximately $250 million and non-federal matching funds of roughly an equal amount. By virtue of its successes, this program was targeted for inclusion in the American Recovery and Reinvestment Act (ARRA) of 2009. Under ARRA, federal program funds were increased to approximately $5 billion.

Because the pre-ARRA program goals had been the reduction of household energy consumption and its financial burden, past WAP evaluations had been confined to those outcomes. However, in addition to these traditional goals, ARRA expenditures were also to provide broader economic stimulus. Therefore, evaluations have been expanded to include a traditional analysis of economic impacts as measured by changes in employment, incomes, and output. Moreover, these evaluations were to include both pre-ARRA expenditure levels as well as the expanded expenditures undertaken under the reinvestment act.

Though a series of discussions with various program managers, evaluators, and energy sector experts, the study team focused on two potential paths through which the WAP might be expected to affect broader regional economies. The first of these paths considers the extent to which expenditures for household energy-saving applications, education, technical assistance, and program management lead to iterative or multiplicative impacts in regional economic activity.

The second course through which the WAP was suspected to affect economic outcomes is through the program-induced reductions in necessary household energy expenditures. Specifically, it was hypothesized that the majority of the efficiency gains achieved through program activities are captured as additional income by participating households and that this, in turn, leads to measurable changes in regional activity.

Phase I of the WAP economic impact assessment has focused on the pre-ARRA program effects. Phase II, is to evaluate ARRA program expenditures. To allow comparison of the results, and because the ARRA-level expenditures have the potential to induce structural economic change, the study team chose to invest in economic simulation software provided through Regional Economic Models, Inc. (REMI). Unlike more simplistic input-output simulation packages, REMI is capable of accommodating both demand-side changes and structural, supply-side responses to economic stimuli.

Throughout the latter half of 2012, the study team worked to develop the necessary simulation inputs describing both WAP expenditures for 2008 and the resulting household energy expenditure savings. During this same period both groups worked to design, acquire, and calibrate the necessary REMI software products. Simulations were designed and executed during late 2012 and early 2013, based on six national sub-regions.

Region-specific REMI inputs and simulation outputs related to program expenditures are summarized in Tables E.S.1 and E.S.2. These results suggest that in a typical year, the pre-ARRA WAP expenditures were associated with a total of roughly 8,500 full-time equivalent jobs, $476 million in employee compensation and $1.2 billion in total economic activity. However, to date, efforts to capture the economic effects of the more than $20 million annual energy savings have failed to yield reportable results.

Table E.S.1 Summary of Simulation Inputs

Region	Program Expenditure	Present Value of 25-Year Energy Savings[1]
Far West	$39.6 M	$15.9 M
Prairie / Rockies	$35.8 M	$22.6 M
Southwest	$36.9 M	$13.4 M
Midwest	$179.4 M	$126.6 M
Southeast	$22.3 M	$24.3 M
Seaboard / Northeast	$106.7 M	$107.7 M
United States	**$420.9 M**	**$310.5 M**

Table E.S.2 Summary of Expenditure-Related Economic Outcomes (all $ values X 1m)

Region	Employment	Incomes	Output
Far West	920	49.4	130.5
Prairie / Rockies	652	34.4	83.6
Southwest	721	38.3	109.2
Midwest	2,976	166.3	432.6
Southeast	1,141	54.0	150.8
Seaboard / Northeast	2,025	133.7	315.4
United States	**8,435**	**$476 M**	**$1,222 M**

[1] As described in Section 4, the calculation of future savings relied on a three percent real discount rate.

1. BACKGROUND AND MOTIVATION

The current document begins the process of evaluating the economic effects of the federal Weatherization Assistance Program (WAP). Historically, the WAP's primary purpose has been to help low-income households conserve energy and reduce related energy expenditures. While this principle focus has not changed, the program has recently been expanded to (1) reach a larger number of households and (2) provide an economic stimulus to a national economy that continues a slow recovery from recession. Together, the expanded program scale and additional economic role of the WAP suggest that measuring the program's aggregate economic influence will be useful to future policy-making in this area. It is this purpose that motivates the current proposal.

1.1 WEATHERIZATION ASSISTANCE PROGRAM– AN ABBREVIATED HISTORY

The federal Weatherization Assistance Program traces its origin to the rapid fuel price increases of the 1970's that placed unexpected financial hardships on millions of American households. Funded through the US Department of Energy (DOE) and administered by individual states, the program enables low-income families to permanently reduce energy bills by making their homes more energy efficient. Funds are used to improve the energy performance of dwellings using the most advanced technologies and testing protocols available in the housing industry.

Initially, funded activities were limited to small-scale, temporary measures designed to conserve heat. Gradually, however, the program has been expanded to include a variety of larger, more permanent strategies that support more efficient heating, cooling, and energy conservation. These include nearly every method of insulation and the installation of new heating and cooling equipment when it is efficient to do so.

Since the program's introduction in 1976, WAP expenditures have been funded through annual Congressional appropriations. While funding amounts have varied, prior to 2009, typical federal funding had grown to roughly $250 million per year.[2] The American Recovery and Reinvestment Act (ARRA) of 2009 significantly increased available funding by providing an additional $5 billion for WAP expenditures. As suggested by the legislation's title, the ARRA funding was not only intended to extend WAP benefits to a larger number of households, it was also envisioned as a policy response to national economic conditions.

1.2 ECONOMICS AND PROGRAM EVALUATIONS

Specific WAP methods and initiatives have been regularly evaluated to identify opportunities for improved program efficiency. However, because program goals have been oriented toward improving household outcomes, neither the discernible economic effects of program expenditures nor the economy-wide gains from increased aggregate energy efficiency have been evaluated.[3] The addition of ARRA funds to recent WAP expenditures changed both the scale and intent of DOE's weatherization program. This, in turn, produced the need for the analysis described here. This analysis is based on three goals.

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[2] In many cases, available federal funds have been used to leverage state and private resources, so that the $250 million in federal spending has generated annual spending that often approaches $500 million or more.

[3] To be clear, the "impact" analysis that is the current focus represents only a subset of the broader economic ramifications of the WAP or similarly designed energy programs. Reduced energy consumption and associated environmental outcomes convey benefits that are not easily measured and that often go uncaptured by routinely observed market transactions. However, their illusive nature does not diminish the importance of these benefits.

These include:

- Measuring the economic impacts of WAP related expenditure;
- Exploring the economy-wide effects of increased household energy efficiency; and
- Identifying the extent to which the ARRA-related increases in WAP expenditures dampened the broader effects of the recent economic downturn.

The current document describes initial efforts to treat the first two of these goals. The third is to be addressed in subsequent work.

Figure 1.1 depicts the fundamental analytical framework used in the current analytical phase. Program activity expenditures (installations, education, technical assistance, etc.) and funds expended for program management impact the goods and service producing sector directly. Additionally, energy savings accruing to participating households also have the potential to increase the demand for goods and services. Together, the three impacts initiate a sequence of iterative economic activities that spreads more widely through the regional and national economies. These indirect and induced effects can be estimated through the execution of economic simulations.

Within the pre-ARRA period – the focus of the current document – this framework does not explicitly include direct impacts on or interactions with the energy sector. However, the actual analytical framework, further described in Section 3, is designed to accommodate these interactions should they become more likely in the treatment of the ARRA program impacts to be estimated in this work's second phase.

Figure 1.1 Program Impacts

2. SPECIFIC METHODOLOGY

The development of the current modeling methodology was the result of two concerns. First, this process needed to capture the effects of both program expenditures and household energy savings. Second, a single methodology is necessary to evaluate both pre-ARRA program effects and the much larger (factor of 5-10) program expenditures under ARRA. Had it only been necessary to simulate pre-ARRA impacts, it might have been possible to rely on a demand-based simulation product. However, the magnitude of the ARRA program expenditures has the potential to generate supply-side effects in addition to the more easily captured demand-side impacts. Consequently, the study team, in consultation with the project sponsor, elected to use the more comprehensive software suite provided by Regional Economic Models, Inc. (REMI).

2.1 THE REMI MODEL

The REMI model incorporates aspects of four major modeling approaches: Input-Output, General Equilibrium, Econometric, and Economic Geography. Each of these methodologies has distinct advantages as well as limitations when used alone. The REMI integrated modeling approach builds on the strengths of each approach, while mitigating weaknesses where possible.

The REMI model, at its core, has the inter-industry relationships found in Input-Output models. As a result, the industry structure of a particular region is captured within the model, as well as transactions between industries. Changes that affect industry sectors that are highly interconnected to the rest of the economy will often have a greater economic impact than those for industries that are not closely linked to the regional economy.

General Equilibrium is reached when supply and demand are balanced. This tends to occur in the long run, as prices, production, consumption, imports, exports, and other changes occur to stabilize the economic system. For example, if real wages in a region rise relative to the U.S., this will tend to attract economic migrants to the region until relative real wage rates equalize. The general equilibrium properties are necessary to evaluate changes such as tax policies that may have an effect on regional prices and competitiveness.

REMI is sometimes called an “Econometric model,” as the underlying equations and responses are estimated using advanced statistical techniques. The estimates are used to quantify the structural relationships in the model. The speed of economic responses is also estimated, since different adjustment periods will result in different policy recommendations and even different economic outcomes. However, REMI, at its core, is deterministic rather stochastic.

Finally, the New Economic Geography features represent the spatial dimension of the economy. Transportation costs and accessibility are important economic determinants of interregional trade and the productivity benefits that occur due to industry clustering and labor market access. Firms benefit having access to a large, specialized labor pool and from having access to specialized intermediate inputs from supplying firms. The productivity and competitiveness benefits of labor and industry concentrations are called agglomeration economies, and are modeled in the economic geography equations.

The chief advantage of REMI, in comparison to other available economic simulation packages, is its ability to accommodate inter-temporal adjustments to the structure of regional economies that can result from exogenous policy change. The ability to capture these structural (or more lasting) changes is considered particularly important to the planned modeling of ARRA program expenditures.

2.2 DEFINING STUDY REGIONS

Very often, regional analyses are focused on some subset of a domestic economy such as a metropolitan area, individual state, or some subset of states. However, the current work incorporates the whole of the US economy, with the 48 contiguous states divided into six economic regions. Thus, the only "leakages" within the simulation process occur when purchases are made from international sellers. For this reason, the iterative economic process associated with a particular program expenditure continues longer than it otherwise would and the resulting employment, income, and output multipliers are observably bigger.

Figure 2.1 depicts the six primary regions considered within the current analysis. Initially, these regions were to be based on the boundaries defining federal climate regions. However, these climate ranges include groupings of non-contiguous states. The REMI simulation software is capable of accommodating these geographically disparate regions. However, regional definitions based in this manner can lead to structural anomalies in the presumed working of the regional economies and also make the interpretation or further disaggregation of model results exceedingly difficult. For these reasons, the initial inclination to use climate regions was abandoned in favor of the regions depicted in Figure 2.1.

Table 2.1 summarizes regional definitions and Table 2.2 provides summary statistics characterizing the six study regions.

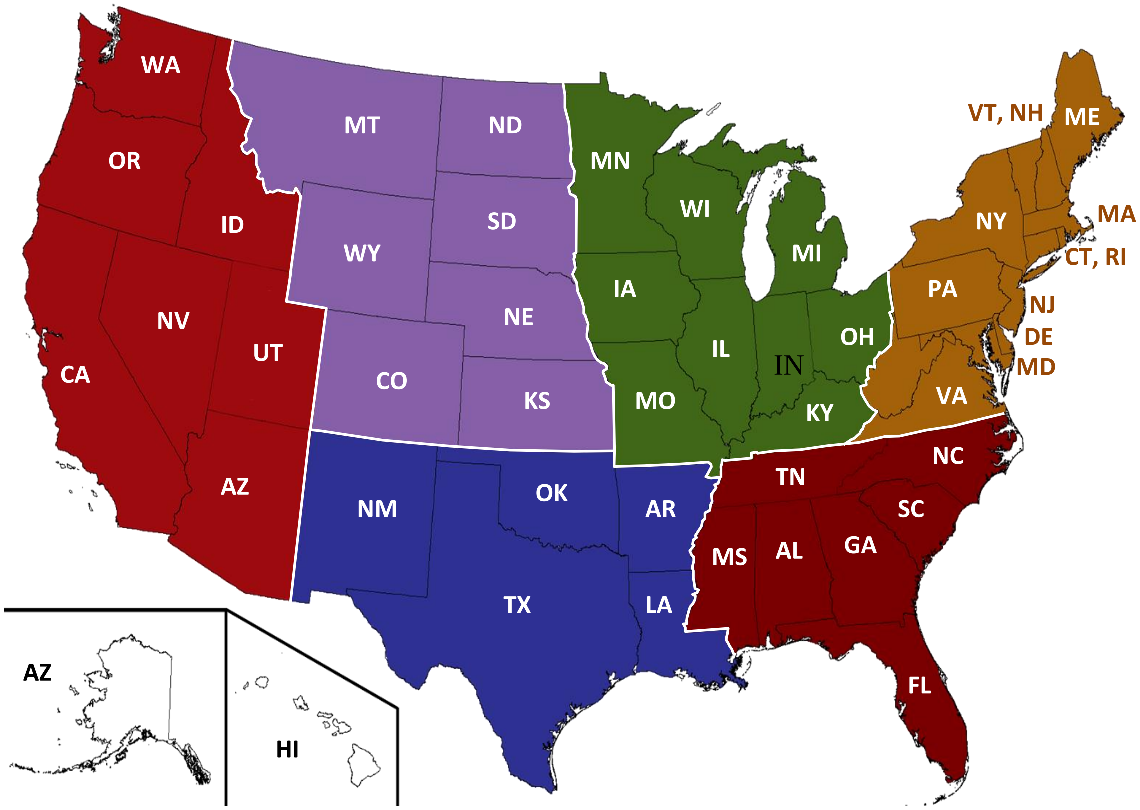

Figure 2.1 Simulation Study Regions

Table 2.1 Simulation Regional Definitions

Region No.	Name	States Included
1	Far West	Arizona, California, Idaho, Nevada, Oregon, Utah, Washington
2	Prairie / Rockies	Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Wyoming
3	Southwest	Arkansas, Louisiana, New Mexico, Oklahoma, Texas
4	Midwest	Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, Wisconsin
5	Southeast	Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee
6	Seaboard / Northeast	Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia

Table 2.2 Simulation Regional Characteristics

Characteristic / Region	Far West	Prairie / Rockies	Southwest	Midwest	Southeast	Seaboard / Northeast	United States
(Percent of US Total)	**19.9**	**4.2**	**12.6**	**20.8**	**18.5**	**23.1**	**100.0**
Percent 65 or Older	12.2	12.8	11.5	13.7	14.5	14.0	**13.3**
Percent White	78.4	88.7	78.5	83.8	72.4	76.7	**78.1**
Percent HS Degree	83.5	90.0	81.4	87.6	84.0	86.9	**85.4**
Percent Bachelors Degree	29.3	31.3	24.7	26.2	25.2	32.5	**28.2**
Percent Veterans	6.4	8.1	6.8	7.3	7.9	6.8	**7.1**
Average Time to Work	25.7	20.5	24.0	23.8	24.9	28.4	**25.4**
Average Household Size	2.8	2.5	2.7	2.5	2.6	2.6	**2.6**
Median Household Income	$58,638	$53,050	$48,348	$50,741	$46,328	$60,676	**$52,762**
Percent in Poverty	14.2	12.6	17.3	14.0	16.3	11.9	**14.3**
Percent Employed	33.2	38.5	33.4	37.8	33.5	38.1	**35.7**
Population Density	73	20	66	144	169	468	**87**

2.3 DEVELOPING REMI INPUTS

As a part of its evaluations, the project sponsor has collected information describing program, installation, education, and management expenditures, along with information describing the household characteristics, energy consumption, and energy-related expenditures of program participants. However, to acquire these data the sponsor must adhere to strict confidentiality standards, so that the form and extent of data made available to the study team was limited.[4] Within this context, the sponsor provided relatively disaggregated expenditure and energy savings data pertaining to single family structures and mobile homes. However, data describing program applications to multi-family structures was provided in a more aggregated form.

Program Expenditure Data

Table 2.3 summarizes the 2008 REMI-aligned program data that were used to simulate the impact of program expenditures across the six regions. Again, the installation data do not include multi-family dwellings. The effects of the multi-unit program components were developed by post-processing REMI estimates to reflect the additional expenditures. The inputs in Table 2.3 also exclude program activities in Alaska and Hawaii. However, the data does include non-federal expenditures that were induced, based on the availability of federal WAP funding.

Developing these data required several steps. First, the project sponsor provided state-specific tallies of various program activities and control expenditure totals for each activity category. The first step in the data preparation process was to use these data to calculate the representative activity-specific costs – for example, the cost of window installations to a single family home.[5] This was necessary to convert activity expenditures to expenditure categories that align with the REMI construct. This phase of the data preparation also helped identify expenditure anomalies within the sponsor-provided data. When such anomalies were identified, the study applied appropriate adjustments where available.

This stage of the data preparation also provided the opportunity to examine and, if necessary, adjust material manufacturing locations and flows. REMI is designed to assign the location of induced manufacturing activities to minimize the sum of production and transportation costs. Thus, when new demands for particular outputs emerge within a simulation, it is possible to identify the region from which these demands will be met. This process was traced within the data preparation and simulation processes to assure that the REMI-created goods movements were consistent with anecdotal information describing materials production locations. Within the current analysis, no anomalies were identified.[6]

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[4] Even those data that were provided can be used exclusively for the purpose of the current analysis and may not be used, distributed, or retained for any other purpose.

[5] Continuing this example, the sponsor provided data did not include the actual number of installed windows. However, the data does provide the average number of square feet for single family dwellings and construction industry data yield estimates of the average number, size, and installation costs for windows based on square-footage.

[6] In the pre-ARRA simulations, program-related materials use was small relative to overall industry output, so that anomalies were not expected. However, future simulations aimed at capturing the effects of ARRA expenditures may yield different results.

Table 2.3 REMI-Aligned Program Expenditure Inputs

REMI Industry / Region	Far West	Prairie / Rockies	Southwest	Midwest	Southeast	Seaboard / Northeast	United States
Adhesive	$2,052,594	$771,002	$1,592,141	$6,250,754	$1,728,764	$3,754,907	$16,150,162
Air Cond., Refrig., & Warm Air Thing Equip	$2,411,569	$2,344,878	$1,651,851	$12,968,954	$1,500,336	$3,794,639	$24,672,228
Air Purification And Ventilation Equip	$385,529	$43,420	$129,198	$552,807	$53,753	$146,650	$1,311,358
All Other Misc. Electrical Equip. And Comp.	$26,922	$41,999	$12,628	$436,686	$8,165	$45,329	$571,728
Asphalt Shingle And Coating Materials	$102,130	$33,218	$47,479	$246,341	$58,346	$66,140	$553,654
Audio And Video Equipment	$0	$68	$1,297	$4,833	$1,166	$16,808	$24,172
Automatic Environmental Control	$0	$6,341	$0	$4,556	$0	$1,952	$12,849
Cement	$0	$3,597	$10,050	$45,097	$1,065	$15,794	$75,603
Electric Light Bulb And Parts	$381,436	$83,368	$135,149	$835,751	$173,747	$307,159	$1,916,611
Hardware	$234,211	$222,233	$326,794	$706,588	$237,814	$526,211	$2,253,851
Household Refrigerator And Home Freezer	$563,115	$424,019	$367,619	$2,937,304	$317,988	$1,455,764	$6,065,810
Lighting Fixture	$95,232	$11,711	$93,294	$343,621	$44,011	$132,261	$720,131
Mineral Wool Mfg	$2,620,197	$4,950,864	$4,232,002	$20,370,545	$2,013,129	$11,327,430	$45,514,168
Ornamental And Arch. Metal Prds	$1,602,019	$875,442	$1,069,514	$5,609,451	$1,211,567	$4,509,661	$14,877,654
Other Education Services	$737,986	$213,298	$331,967	$2,103,388	$372,248	$788,491	$4,547,379
Plastics Pipe And Pipe Fitting	$9,851	$3,959	$1,961	$23,172	$0	$25,366	$64,308
Plastics Pkging Materials And Unlam. And Sheet	$744,197	$136,505	$721,456	$2,105,166	$85,492	$873,738	$4,666,554
Printing	$189,772	$59,429	$102,438	$344,939	$121,083	$176,508	$994,170
Residential Maint. And Repair	$8,591,071	$6,282,473	$7,984,464	$44,197,648	$5,268,645	$21,350,118	$93,674,420
Resin Syn Rubber Etc.	$3,425	$14,726	$31,708	$75,373	$24,450	$33,225	$182,908
Small Electrical Appliances	$2,036,967	$919,088	$1,436,057	$8,786,982	$806,106	$2,620,259	$16,605,459
Veneer And Plywood	$220,302	$82,333	$191,431	$692,794	$120,443	$184,454	$1,491,756
Wood, Windows, Doors, And Millwork	$285,906	$198,597	$308,288	$943,617	$323,832	$737,763	$2,798,003
	$23,294,431	$17,722,568	$20,778,786	$110,586,367	$14,472,150	$52,890,627	$239,744,936

Materials And Installation Total							
Training And Technical Assistance	$6,734,487	$6,151,973	$6,792,299	$22,377,312	$3,491,420	$13,822,067	$59,369,559
Program Management	$4,899,861	$10,222,080	$6,873,568	$22,076,321	$4,105,364	$24,832,846	$73,010,041
PROGRAM TOTAL	**$34,928,780**	**$34,096,622**	**$34,444,652**	**$155,040,001**	**$22,068,935**	**$91,545,540**	**$372,124,536**

Household Energy Expenditures

Participant energy savings for single-family applications are summarized by region and fuel type in Table 2.4. REMI economic simulation products allow individual savings to be inputted for each year within a user-defined time horizon. Accordingly, in the current analysis user savings were calculated for each of the 25 years extending between Program Years (PY) 2008 and PY 2032. Table 2.4 provides values for 2008, 2013, and for the discounted present value of the 25 year savings stream.[7]

In a general equilibrium sense, the fuel savings realized as a result of program expenditures represent an efficiency gain that will be evidenced as a change in one or more economic outcome. However, from a practical standpoint, the most tractable assumption is that these savings accrue to the participating households and can be observed as changes in household activity.

It is also possible to assume varying household responses to the accrued energy expenditure savings. Households may choose to save or spend all or part of these savings. They may even monetize the present value of future savings through home equity loans or other borrowing wherein the future savings act as a form of collateral. However, within the current analysis, the simplest treatment was to assume that 100 percent of energy-related savings accrue to participating households and that these household spend 100 percent of the savings in the period in which they are accrued. This was the approach (at least, initially) that was carried forward into the REMI simulations.

[7] For current purposes, a real discount rate of three percent was applied to calculate the present value.

Table 2.4 REMI-Aligned Reduced Energy-Expenditure Inputs (Single-Family Units Only)

Region / Fuel	2008	2013	Present Value of 25-Year Stream
Far West			
Electricity	$507,985	$544,139	$6,266,419
Natural Gas	$352,812	$284,177	$4,375,932
Fuel Oil / Other	$221,510	$220,324	$3,341,281
Regional Total	**$1,082,307**	**$1,048,640**	**$13,983,632**
Prairie / Rockies			
Electricity	$345,819	$368,238	$3,313,414
Natural Gas	$710,075	$582,800	$9,774,736
Fuel Oil / Other	$483,268	$503,281	$8,054,103
Regional Total	**$1,539,162**	**$1,454,319**	**$21,142,253**
Southwest			
Electricity	$538,248	$429,613	$5,158,507
Natural Gas	$338,806	$257,660	$4,077,797
Fuel Oil / Other	$219,763	$216,361	$3,308,665
Regional Total	**$1,096,817**	**$903,634**	**$12,544,969**
Midwest			
Electricity	$1,959,079	$2,117,297	$22,499,203
Natural Gas	$4,263,856	$3,176,392	$52,153,570
Fuel Oil / Other	$2,105,957	$2,183,556	$34,724,217
Regional Total	**$8,328,892**	**$7,477,245**	**$109,376,990**
Southeast			
Electricity	$858,081	$906,485	$11,095,032
Natural Gas	$357,559	$272,401	$4,383,298
Fuel Oil / Other	$551,043	$558,895	$8,628,405
Regional Total	$1,766,683	$1,737,781	$24,106,735
Seaboard / North East			
Electricity	$1,336,783	$1,374,734	$13,683,607
Natural Gas	$1,735,686	$1,312,496	$21,049,641
Fuel Oil / Other	$3,561,489	$3,557,716	$57,700,247
Regional Total	**$6,633,958**	**$6,244,946**	**$92,433,495**
SINGLE FAMILY TOTALS	**$20,447,819**	**$18,866,565**	**$273,588,074**
PROGRAM TOTALS	**$23,126,482**	**$21,338,085**	**$309,428,110**

3. SIMULATIONS, ADAPTATION, AND FINDINGS

3.1 SIMULATING EXPENDITURE IMPACTS

The first simulations executed within the study process involved capturing the effects of the 2008 program expenditures. Again, these data, aggregated by REMI region, included both federal and non-federal matching expenditures. The result was a set of direct expenditures that totaled a little more than $420 million.

Simulation results are summarized in Tables 3.1 and 3.2. They suggest that, in addition to benefiting subject households and reducing energy consumption the WAP, in its pre-ARRA form, was responsible for generating approximately 8,560 private sector full-time-equivalent jobs that generated roughly $476 million in annual incomes (2012 dollars). The corresponding increases in value added and in total economic output were $750 million and $1.22 billion, respectively.[8]

National-level industry-specific employment results are summarized in Table 3.2. These results help explain the regional values provided in Table 3.1. On the whole, the WAP program expenditures most greatly affected economic activity within the installation, service management, and retail sectors – activities that are typically conducted at a local or regional level. The program impacts on manufacturing, including the manufacture of materials and components were very modest.[9] Accordingly, the economic impacts within each of the study regions are generally proportional to the expenditures within that region. The lone exception to this pattern appears to be in the Southeast, where program expenditures had a disproportionately large influence on economic activity.[10]

The REMI simulation software allows the imposition of a time horizon of the user's choosing. Within the current analysis, the program expenditure impacts for one year were simulated over both a 15-year and a 25-year time horizon. The results, however, suggest that the impacts of any given year's expenditure are transitory and almost fully exhausted within that year. This is typical of construction oriented economic activity and largely as expected. It should be noted, however, that the ongoing nature of the WAP leads to these impacts on what is *also* an ongoing basis.

[8] In national accounts such as the United Nations System of National Accounts (UNSNA) or the United States National Income and Product Accounts (NIPA), gross value added is obtained by deducting intermediate consumption from gross output. Thus gross value added is equal to total output net of basic inputs such as raw materials or energy. Total economic output includes the value of basic inputs and generally equals the value of all final sales.

[9] This outcome is underscored by the large proportion of output represented by increased incomes.

[10] The data suggest that this disproportionate effect may be traceable to the manufacture of insulation or other fibrous materials. However, available information is inconclusive.

Table 3.1 2008 Expenditure Impacts

Region / Impact	Units of Measure	Value
US Total		
Gross Domestic Product (GDP)	Millions of Fixed (2012) $	$750.00
Output	Millions of Fixed (2012) $	$1,222.20
Personal Income	Millions of Fixed (2012) $	$470.00
Total Employment	Individuals (Jobs)	8,435
Midwest		
Gross Domestic Product (GDP)	Millions of Fixed (2012) $	$261.60
Output	Millions of Fixed (2012) $	$432.60
Personal Income	Millions of Fixed (2012) $	$166.30
Total Employment	Individuals (Jobs)	2,976
Seaboard / Northeast		
Gross Domestic Product (GDP)	Millions of Fixed (2012) $	$197.50
Output	Millions of Fixed (2012) $	$315.40
Personal Income	Millions of Fixed (2012) $	$133.70
Total Employment	Individuals (Jobs)	2,025
Rockies / Prairie		
Gross Domestic Product (GDP)	Millions of Fixed (2012) $	$53.70
Output	Millions of Fixed (2012) $	$83.60
Personal Income	Millions of Fixed (2012) $	$34.30
Total Employment	Individuals (Jobs)	652
Southeast		
Gross Domestic Product (GDP)	Millions of Fixed (2012) $	$92.50
Output	Millions of Fixed (2012) $	$150.80
Personal Income	Millions of Fixed (2012) $	$54.00
Total Employment	Individuals (Jobs)	1,141

Region / Impact	Units of Measure	Value
Southwest		
Gross Domestic Product (GDP)	Millions of Fixed (2012) $	$64.40
Output	Millions of Fixed (2012) $	$109.20
Personal Income	Millions of Fixed (2012) $	$38.30
Total Employment	Individuals (Jobs)	721
Far West		
Gross Domestic Product (GDP)	Millions of Fixed (2012) $	$80.50
Output	Millions of Fixed (2012) $	$130.50
Personal Income	Millions of Fixed (2012) $	$49.40
Total Employment	Individuals (Jobs)	920

Table 3.2 Total Program-Expenditure Private Sector Employment by Industry (No Wealth Effects) (Employment in Full-Time-Equivalent (FTE) Positions)

Rank	Industry	FTEs
1	Management, scientific, and technical consulting services	1,103
2	Construction	1,019
3	Retail trade	753
4	Management of companies and enterprises	612
5	Offices of health practitioners	334
6	Food services and drinking places	254
7	Wholesale trade	242
8	Services to buildings and dwellings	191
9	Educational services	183
10	Securities, commodity contracts, and other financial investments and related activities	180
11	Real estate	175
12	Private households	166
13	Monetary authorities, credit intermediation, and related activities	160
14	Business support services; Investigation and security services; Other support services	151
15	Lime, gypsum and other nonmetallic mineral product manufacturing	146
16	Employment services	120
17	Ventilation, heating, air-conditioning, and refrigeration equipment manufacturing	111
18	Personal care services	100
19	Architectural, engineering, and related services	97
20	Truck transportation	96
21	Architectural and structural metals manufacturing	92
22	Hospitals	87
23	Amusement, gambling, and recreation industries	84
24	Household appliance manufacturing	79
25	Legal services	79
26	Accounting, tax preparation, bookkeeping, and payroll services	78
27	Accommodation	68
28	Other professional, scientific, and technical services	66
29	Nursing and residential care facilities	60
30	Plastics product manufacturing	56
31	Paint, coating, and adhesive manufacturing	53
32	Computer systems design and related services	52
33	Insurance carriers	47
34	Agencies, brokerages, and other insurance related activities	46
35	Religious organizations; Grant making and giving services, and social advocacy organizations	45
36	Automotive repair and maintenance	44
37	Individual and family services; Community and vocational rehabilitation services	44
38	Independent artists, writers, and performers	43
39	Telecommunications	43
40	Other wood product manufacturing	41
41	Civic, social, professional, and similar organizations	41
42	Advertising and related services	36
43	Office administrative services; Facilities support services	36
44	Printing and related support activities	35

Rank	Industry	FTEs
45	Outpatient, laboratory, and other ambulatory care services	34
46	Couriers and messengers	33
47	Warehousing and storage	32
48	Child day care services	28
49	Newspaper, periodical, book, and directory publishers	28
50	Performing arts companies; Promoters of events, and agents and managers	28
	Other Industries	832
	TOTAL	**8,560**

Economic impacts are generally characterized as having three components – direct effects, indirect impacts and induced effects. Direct effects are the impacts immediately attributable to the subject activity – in the current setting, the employment and incomes that result directly from program expenditures. The indirect effect is the business to business transactions required to satisfy the direct activity – for example, a program contractor's purchase of insulation. Finally, the induced effect is derived from the incomes spent on goods and services by people working to satisfy the direct and indirect demands. Practically speaking, the distinction between indirect and induced impacts is largely semantic. Both types of impacts reflect the iterative or "ripple" effects of the initial direct expenditure throughout the broader economy.

Within the current context, the values provided in Table 3.1 reflect the total of direct, indirect, and induced effects. In the case of output, it is immediately possible to identify "multipliers" by dividing the total effect by the direct program expenditure that produced it. For example, in the Seaboard / Northeast region, the direct program expenditure was $107 million, while the corresponding sum of all impact categories was $331 million. Thus, the sum of the indirect and induced effects was $224 million and the output multiplier for this region was 3.37.[11] Table 3.3 summarizes the same calculations for all six regions and the nation as a whole. All values appear within the range of what is expected. However, as noted above, expenditures seem to have a particularly pronounced effect in the Southeast region and are of a noticeably greater direct magnitude in the Midwest.[12]

[11] The sponsor-provided data did not include estimates of direct job creation or associated incomes, nor does REMI provide these as accessible simulation outputs. Consequently, it is not possible to easily develop corresponding employment or earnings multipliers. However, these will generally be of a magnitude similar to the output multipliers.

[12] As observed, insulation expenditures appear focused in the Southeast. At the same time, program expenditures for electrical components seem measurably greater in the Midwest.

Table 3.3 Regional Impact Decomposition and Multipliers

Region	Program Expenditures	Total Program Output Effects	Output Multiplier
Far West	39,609,403	133,355,440	3.3668
Prairie / Rockies	35,982,598	79,457,173	2.2082
Southwest	36,872,948	105,366,593	2.8576
Midwest	179,443,048	450,923,015	2.5129
Southeast	22,298,703	137,020,988	6.1448
Seaboard / Northeast	106,684,380	331,129,659	3.1038
US Total	**420,891,080**	**1,237,252,869**	**2.9396**

3.2 SIMULATING THE EFFECTS OF ENERGY SAVINGS

The second aim of the analysis was to capture the economic impacts associated with reduced household energy expenditures. The supposition was that the reduced energy expenditures would be sufficiently small, even in aggregate, so that they would have no measurable impact on the behaviors of energy providers. However, the study team hypothesized that affected households would substitute alternative uses for savings that *could* produce observable increases in other regional sectors, particularly those involving consumer goods.

Oak Ridge National Laboratory provided energy savings estimates by energy type and study region for a single year, 2008. The actual data include estimated savings over an extensive time horizon. These estimates reflect both projected increases in energy costs and the assumed inevitable degradation of the WAP-sponsored improvements.

A variety of methods were used to incorporate these savings into the REMI simulations. The first method involved reducing regional energy expenditures for each year by the indicated amount. This resulted in no observable impacts.

As an alternative, the energy savings were next treated as an independent increase in household incomes. This method yields marginal increases in regional employment and incomes that are roughly equal to seven percent of the economic impacts associated with program expenditures. However, when simulations conducted under this method are actually conducted *simultaneously* with the expenditure simulations, the effects of additional household spending disappear almost entirely.

The most recent avenue of exploration involved attempting to apply a hedonic method that would subsume current and projected energy savings within an array of factors that determine household values. However, an exhaustive search of available literature reveals no tangible variation in housing values that can be reliably attributed to the types of improvements represented by the WAP expenditures.

In the end, the study team was left to conclude that the magnitude of household energy savings, when spread across large program regions was not sufficient to generate observable effects from increased household expenditures made possible by program-related savings.

4. CONCLUSIONS

Historically, WAP has been undertaken with the purpose of improving the wellbeing of lower-income households. Thus, the broader economic impacts associated with the WAP have not been of particular interest. An informal comparison of aggregate spending data to corresponding domestic employment figures suggests that, using the same resources, private sector activity or other public sector programs would have created approximately 5,000 jobs with individual earnings much like those estimated in association with the WAP expenditures

The WAP under ARRA has been materially different than programs of earlier years. Most notably, the magnitude of federal program expenditures was substantially increased. This funding increase was not only intended to improve the wellbeing of participating households, but was also meant to provide an economic stimulus to an ailing national economy.

Because of the expanded program reach, the WAP, under ARRA, has almost certainly had economic impacts that are greater in magnitude than those of earlier years. It is, however, also possible that the expanded program size has produced economic outcomes that are different both in nature and measurability from those associated with lesser funding levels. Specifically, it is possible that the ARRA-funded WAP:

- has been sufficient in size to stimulate an energy sector response;
- has produced household energy savings with impacts that are detectable through the same analytical methods that were unproductive in the current analysis; and
- may have produced effects that are sufficient to shed some initial light on how future markets are likely to value both energy-related and non-energy benefits.