New Jersey's Military and Coast Guard Facilities

Economic Contribution to the State Economy

June 2013

by

Rutgers, the State University of New Jersey

Edward J. Bloustein School of Planning & Public Policy

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EXECUTIVE SUMMARY

In 2010, New Jersey received 78 cents on each dollar sent by its taxpayers to Washington, D.C. Military bases remain major federal assets in the state, even after the state's loss of Fort Monmouth during the last round of actions by the Base Closure and Realignment Commission (BRAC). While the military's presence has declined in recent decades, the bases continue to contribute substantially to the New Jersey's economy.

After a data request was made to each installation within the State of New Jersey, Rutgers Economic Advisory Service, R/ECON™ ─ a part of Rutgers University's Edward J. Bloustein School of Planning and Public Policy, was retained to measure and model the economic contribution to the State's economy of the various military installations. The R/ECON™ input-output (I-O) model was used to measure the broader multiplier effects of the activity on base. The model is able to identify jobs (employment), labor income (earnings), gross domestic product (GDP or wealth) and output (something close to business revenues) generated in the State both directly and indirectly by the military activity on the bases.

Exhibit I shows estimates of economic activity that goes on annually within the state's military installations as obtained from the installations themselves. In net, the federal government spent nearly $5 billion within the state, which generates over 45,600 jobs that pay about $2.6 billion and add about $3.8 billion of wealth to state residents.

Exhibit I: Direct Effects of New Jersey's Military Installations, 2012

Base	Output ($1,000)	Employment	Earnings ($1,000)	GDP ($1,000)
Joint Base	2,938,939.0	35,395	1,757,075.0	2,533,137.0
Picatinny	1,455,612.3	5,196	527,270.2	913,627.2
Earle	32,532.2	295	17,628.7	25,092.7
Air Guard	109,555.7	2,376	71,828.0	102,377.9
Army Guard	232,829.3	1,641	148,932.9	176,795.3
Coast Guard	65,058.6	728	51,480.1	54,696.2
Total	4,834,527.1	45,631	2,574,214.9	3,805,726.3

Exhibit II displays the total economic impacts of each of the installations as well as their combined totals. The $4.8 billion in annual federal spending displayed in Exhibit I results in $9.6 billion in net business revenues. Of this, $6.5 billion is net wealth added in the form of GDP by the State. Of this GDP total, over $4.0 billion is in the form of labor income that supports an

estimated 73,234 jobs. While employing less than the State's large insurance industry, it is more than the combined employment of the State's communications and chemical industries.

It is worthwhile to note that Picatinny Arsenal's R&D character provide it with more potent multiplier effects (the difference between Exhibit II and Exhibit I). The same goes for those installations with relatively large shares of capital spending—Weapons Station Earle, the New Jersey Army National Guard, the Navy R&D mission at Lakehurst and the Army R&D Flight Activity also at Lakehurst.

Exhibit II: Total Effects of New Jersey's Military Installations, 2012

Base	Output ($1,000)	Employment	Earnings ($1,000)	GDP ($1,000)
Joint Base	5,935,300.0	51,989	2,715,516.0	4,220,370.0
Picatinny	2,789,759.7	13,834	921,348.6	1,708,408.1
Earle	68,287.1	481	28,756.2	44,717.2
Air Guard	220,963.6	2,982	107,415.5	165,317.6
Army Guard	487,212.2	2,890	228,591.3	319,423.9
Coast Guard	127,480.0	1,058	71,497.1	90,916.4
Total	9,629,002.6	73,234	4,073,124.7	6,549,153.2

The core finding of this study is that the military's presence within the State of New Jersey is a substantial one. Having shed many such facilities in the not too distant past, the State not only is now leaner but also retains less than 78 percent of the tax dollars that its businesses and households send annually to Washington, D.C. Thus maintaining and expanding this military core is nearly as critical for its continued economic welfare as it is to the State's homeland security missions.

I. INTRODUCTION

It has long been an issue that the State of New Jersey has received less funding from the federal government than its businesses and households send to Washington, D.C., in the form of taxes and fees. (See a detailed evidence for the most recent year in Appendix A.) This may not seem so unreasonable since among all 50 states, New Jersey is among the highest in income per capita. But what is most surprising is that it is one of just five states in this position: Illinois, Connecticut, Minnesota, and neighboring Delaware are the only others.[1]

Events in the not-so-distant past have not improved the federal government's apparent financial imbalance with the State. The closures of the Military Ocean Terminal Bayonne (MOTBY) and of Fort Monmouth caused the loss of a large number of jobs and billions of dollars of income to New Jersey (10,000 jobs and $6 billion in economic activity through the loss of Fort Monmouth alone), creating a starker situation. Indeed, military bases remain the most prominently identifiable icons of the Federal government's presence within the State of New Jersey. ***Thus, it is in the interest of the general welfare of the State's citizens and economy that further closure or mission realignment action within New Jersey by the U.S. Department of Defense or the Base Realignment and Closure Commission should be mitigated if not curtailed.***

The purpose of this study is to get a better handle on the extent of the economic presence of military and Coast Guard installations in New Jersey. The ongoing operations and various capital projects of the various facilities in the State clearly enhance the economy by paying wages paid to military and civilian personnel who live in the state and through purchases of equipment, material, and services. These activities not only have direct impacts in the form of the jobs associated with base operations, but also have further "multiplier" effects that ripple through the state and local economies, resulting in additional job creation and economic output.

This report uses the most recent available data to estimate the magnitude of the contribution of the many military and Coast Guard installations in the state and local economy. After a brief discussion of the general study approach, a description of the economic model, and the analytic methodology used, several substantive sections follow that pertain to each major installation. The military and Coast Guard installations in New Jersey consist of five distinct categories:

[1]This is possible since the federal government independently collects tariffs and fees from foreign agents, which it also redistributes.

1. Air Force –McGuire Air Force Base (JB MDL)

2. Army

2.1. Fort Dix (JB MDL)

2.2. Picatinny Arsenal

3. Navy

3.1. Naval Air Engineering Station Lakehurst (JB MDL)

3.2. Naval Weapons Station Earle

4. National Guard

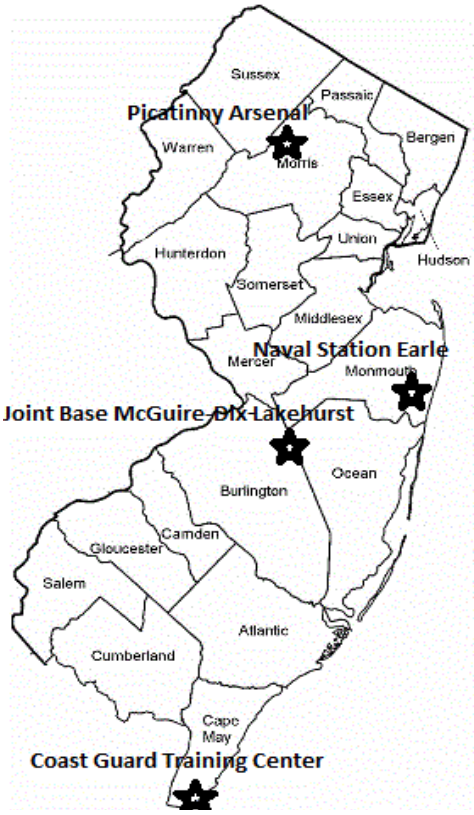
4.1. Air National Guard

4.2. Army National Guard

5. Coast Guard

We start out with an analysis of the Joint Base McGuire-Dix-Lakehurst (JB MDL) and follow with the remaining installations in turn. Each section begins with a brief description of its facilities. The description is followed by some details on the operations and capital spending reported for each installation. This is succeeded by presentation of an analysis of the results from the economic model. A set of conclusions follows the sections reporting on each installation.

Figure 1: Map of Major Military Installations in New Jersey



II. APPROACH

1. DATA COLLECTION

Through the New Jersey Council on Armed Forces and Veterans Affairs, Rutgers Economic Advisory Service (R/ECON™) of the Edward J. Bloustein School of Planning and Public Policy at Rutgers University put out a request to all military facilities for data on spending by installation. A detailed data request was prepared, which provided an outline for specific economic activity needed for impact analysis. Data were sought for each major mission when possible. Capital investment data were pursued for the prior five years. In all cases, attempts were made to distinguish purchases made from New Jersey and non-New Jersey suppliers. In selected cases direct contact was made to enable detailed conversations about the nature of the data provided. R/ECON™ staff followed up with the contact person(s) wherever the data needed was either missing or incomplete. The web sources were also tapped in cases where information was either unavailable or had gaps to be filled in.

Every effort was made to collate the provided data consistently across installations. Unfortunately, each installation had its own reporting systems. Some were able to provide details on goods and service purchases by supplier, while others had only gross contract figures by mission. Some were able to yield manpower and payroll figures by mission. Others reported manpower figures only and had no payroll data at the ready. Indeed, a large amount of time and effort was spent by the Study Team to ensure the data were complete and comparable to enable a reliable economic impact analysis.

2. R/ECON™ INPUT-OUTPUT MODEL

The ongoing operations and capital projects of the various military facilities require a wide variety of military and civilian expenditures, including wages paid to military personnel, purchases of equipment and material, staffing by contractor support services, construction of base housing and other facilities, stocking and operation of base commissaries, and various services (e.g., janitorial, laundry, consulting, research, IT, etc.). These expenditures, when made in New Jersey, not only have direct impacts in the form of the jobs associated with base activities, but also have further "multiplier" effects that ripple through the state and local economies, as those workers and businesses that benefit from the initial expenditures, in turn, spend those dollars on other consumer goods and business operations and investment

expenditures, which, in turn, become income for other workers and businesses. This income gets further spent, and so on, resulting in additional job creation and economic output.

2.1. Explanation of the Multiplier Effect

One means of estimating multiplier effects would be to conduct a survey of the business transactions of the primary contractor. The business questionnaire for this survey would ask for the names and addresses of the contractor's suppliers; what and how much they supply; the names and addresses of the contractor's employees; and the annual payroll. A related questionnaire would cover household spending of the employees of the surveyed firms. It would request a characterization of each employee's household budget by detailed line items, including names and addresses of the firms from which each line item is purchased.

Both questionnaires subsequently could be used to measure indirect and induced impacts of the primary contractor's activity. The business questionnaire would be sent to the business addresses identified by the primary contractor; the household questionnaire, in turn, would be sent to the homes of the employees of those businesses that responded to the survey. This "snowball-type" sampling would continue until time or money was exhausted. In order to keep each organization's or household's contribution to the project in proper perspective, its total spending would be weighted by the size of its transaction with its customers who were included in the survey activity. The sum of the weighted transaction values obtained through the surveys would be the total economic impact of the project.

This survey-based approach to estimating indirect and induced impacts consumes a great deal of money and time, however. In addition, response rates by firms and households on surveys regarding financial matters are notoriously low. Hence, in the rare cases where survey work has been conducted to measure economic impacts, the results have tended to be not statistically representative of the targeted network of organizations and households. As such, relatively less expensive economic models based on federal government data are often used to measure economic impacts.

The economic model that has proven to estimate the indirect and induced economic effects of events most accurately is the input-output model. Its advantage stems from its level of industry detail and its depiction of interindustry relations. As shown in Appendix A, a single calculation—known as the Leontief inverse—simulates the many rounds of business and

household surveys.[2] Input-output tables are constructed from nationwide Census surveys of businesses and households. The most difficult part of regional impact analysis is modifying a national input-output model so that it can be used to estimate impacts at a subnational level. Regionalization of the model typically is undertaken by the model producer and requires a large volume of data on the economy being modeled. This study employs a regional input-output model for the State of New Jersey to estimate the economic multiplier effects.

Input-output modeling focuses on the interrelationships of sales and purchases among sectors of the economy. This analytical method measures the effect of changes in expenditures in one industry on economic activity in all other industries, thus capturing both the direct and indirect impacts of any set of initial expenditures in the economy. The R/ECON™ Input-Output (I-O) Model is designed to measure these impacts for New Jersey and its counties. The model consists of 434 individual sectors of the economy, and is based on consistently measured economic data published by the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor Statistics, and the U.S. Census Bureau. It measures the direct and indirect impacts of investments and expenditures in terms of employment, income, gross domestic product, and state and local tax revenues, and has been used to estimate the impacts of a wide array of projects and activities, including:

- Construction of office buildings
- Operations of military installations
- Manufacture of military technologies
- Upgrading of electric utility infrastructure
- Construction and operation of liquid natural gas terminals
- Government tax incentives

The R/ECON™I-O model and its predecessors have proven to be the best of the non-survey-based regional input-output models at measuring a region's economic self-sufficiency. The models also have a wide array of measures that can be used to analyze impacts. In particular, R/ECON™ I-O produces one of the only regional economic models that enable an analysis of governmental revenue (i.e., tax) impacts and an analysis of gains in total regional wealth.

[2] A comprehensive description of input-output modeling and the R/ECON™ Model is provided in Appendix A.

2.2. Key Differences in Multiplier Effect: A Military Example

Differences in multiplier effects typically arise through economic leakage. That is, the ability of an activity to deliver economic benefit to a local geography depends on the extent that local firms can effectively compete in providing goods and services to support that activity. For this reason, when investigating the economic impacts of a military base one must have a specific geography in mind for the audience of the analysis. In the case of the present report, the target audience is policymakers the State of New Jersey. The impacts of military activity on the State's economy are necessarily less than the economic impacts of the same set of activities on the nation as a whole. This is because military facilities within New Jersey undoubtedly purchase goods and service from Pennsylvania; Maryland; Washington, DC; and beyond, yet within our nation's borders. Those activities plus, the money spent by New Jersey-based military families who live in other states, generate impacts outside of New Jersey yet within the rest of the United States. Similarly if the target geography had been smaller than the State—say Atlantic, Burlington, Cape May, Monmouth, Morris, or Ocean County—the total economic impacts necessarily would have been smaller than those for the State since incomes of base personnel who live outside of that area as well as the activity of any of the installation's contractors or suppliers outside of that county would not have been included in the analysis.

In light of the above, one can imagine differences in the economic impacts of different sorts of military activities that might otherwise be equivalent. Let us examine the case of two civilian individuals who make $100,000. One is a federal civil servant working on a military base, and the other is an employee of a small contractor that is located off base. Both live off base. In essence the difference in economic impacts between the two positions comes to the location of the overhead expenditures affiliated with both. As a federal contractor, a firm's overhead costs must be explicitly accounted and reported. They include such expenses as costs of property rent, legal and accounting services, marketing costs (including travel), personnel training, administrative and clerical salaries, office supplies (those not chargeable to a specific project, e.g., computers, pens and pencils, printer and copy paper), and utility bills. In the case of an on-base civil servant such costs are typically addressed by the government, by agencies generally outside of New Jersey, or they are provided by the military directly. Clearly utility bills and office supplies are likely to be similar for the on-base civil servant and the local contractor. Still, a local contracting firm is much more likely to purchase the goods and services locally. Prime examples are legal and accounting services. The local contractor is much more likely to consume

services from someone nearby. In doing so, they would enhance the multiplier effect of that $100,000 job by enabling the spending for the overhead costs to circulate within the local economy—something that is typically not enabled by the overhead support of the federal civil servant who works on base. And most importantly, the end cost for a contractor employee does not exceed that of a civil servant.

This example is elaborated, as it is just this sort of multiplier effect that makes certain facilities more appealing from the perspective of boosters for New Jersey's economy. That is, it is the set of locally engaged support services that should make certain facilities (e.g., Picatinny Arsenal, the NAVAIR and CERDEC Flight Activity Missions at the Joint Base) priorities for retention as parts of the State's ongoing economic activities. These activities fund a significant level of Contractor Support Services from local firms, and the economic side effect of those jobs provides significant additional local economic benefit. Moreover, it just such missions that policymakers should continue to acquire and hold onto when possible for enhancing the State's economy.

2.3. Explanation of Economic Measures

The results of R/ECON™ I-O include many fields of data. The fields most relevant to this study are the total impacts with respect to the following:

- **Jobs**: Employment, both part- and full-time, by place of work, estimated using the typical job characteristics of each detailed industry. (Manufacturing jobs, for example, tend to be full-time; in retail trade and real estate, part-time jobs predominate.) All jobs generated at businesses in the region are included, even though the associated labor income of commuters may be spent outside of the region. In this study, all results are for activities occurring within the time frame of one year. Thus, the job figures should be read as job-years, i.e.; several individuals might fill one job-year on any given project. These data by industry for a region are estimated from a combination of the data from the U.S. Bureau of Labor Statistics (U.S. BLS) series entitled the Quarterly Census of Employment and Wages (QCEW) (for extreme industry detail) and the U.S. Bureau of Economic Analysis (U.S. BEA) for a more complete picture of the jobs count, as this data series includes proprietors' as well as employed personnel.

- **Earnings**: "Earned" or "labor" income—specifically wages, salaries, and proprietors' income. Earnings in this case do not include nonwage compensation (i.e., benefits, pensions, or insurance), transfer payments, or dividends, interest, or rents. As in the case of jobs, a combination of QCEW and US BEA data are used to earnings totals for industries in the 434 sector R/ECON™ I-O model.

- **Gross Domestic Product**: Also known as "value added"—the equivalent at the subnational level of gross domestic product (GDP). Value added is widely accepted by economists as the *best single measure of economic well-being*. It essentially measures wealth as accumulated over a specific period (usually a year) from all possible sources. For a firm, value added is the difference between the value of goods and services produced and the value of goods and nonlabor services purchased. For an industry, therefore, it is composed of labor compensation (net of taxes); proprietors' income; taxes; nonwage labor compensation; profit other than proprietors' income; capital consumption allowances; and net interest; dividends; and rents received. In the case of the R/ECON™ I-O model, the data are based on the most recent year as available from the U.S. BEA in their GDP by state data series which provides value added components for fairly aggregated set of industries.

- **Taxes**: Tax revenues generated by the activity. The tax revenues are detailed for the federal, state, and local levels of government. Totals are calculated by industry but provided only in total form due to inaccuracies caused by the application of indirect business tax estimates from the U.S. BEA figures.

    - *Federal tax revenues* include corporate and personal income, social security, and excise taxes, estimated from the calculations of value added and income generated.
    - *State tax revenues* include personal and corporate income, state property, excise, sales, and other state taxes, estimated from the calculations of value added and income generated (e.g., purchases by visitors).
    - *Local tax revenues* include payments to substate governments mainly through property taxes on new worker households and businesses. Local tax revenues can also include revenues from local income, sales, and other taxes.

- **Output***:* Output in revenue level at which businesses are taxed. It can be actual gross revenues, net revenues, or even just the basic average operating margin of an industry. Thus, it is undoubtedly the least reliable indicator of economic activity that is typically made available. It is used generally reported because it is the core data upon which input-output tables are built. Moreover, it is the largest number possible that can be reported vis-à-vis economic impacts. Still, because it often double counts activity and can overstate activity levels, reporting of its value should be restrained. It is included in this report only for the sake of completeness.

R/ECON™ I-O expresses the resulting jobs, earnings, and wealth impacts in various levels of industry detail. The most convenient application breaks the industry-level results at the supersector level:

1. Agriculture, Forestry, Fishing, and Hunting
2. Mining
3. Utilities
4. Construction
5. Manufacturing
6. Wholesale Trade
7. Retail Trade
8. Transportation and Warehousing
9. Information
10. Finance, Insurance, Real Estate, Rental, and Leasing
11. Professional and Business Services
12. Educational Services, Health Care, and Social Assistance
13. Arts, Entertainment, Recreation, Accommodation, and Food Services
14. Other Services (except Government)
15. Government

R/ECON™ I-O can provide results in two other industry breakdowns that detail subcategories under each of these 15 groups. These breakdowns use a three-digit NAICS specification (about 60 industries) and the full industry specification of the input-output model (about 434 industries). Jobs can also be decomposed into more than 100 occupation/skill categories in a separate table.

The model results, however, are only as good as the data that go into them. Thus, when the direct requirements are estimated, and the industry-level purchases are also estimated (as is the case in this study), care should be taken in interpreting model results, especially when they contain extreme categorical detail. Hence, the main body of report based on the above tables

tends to focus on fully aggregated results with the table of supersector results only made available as exhibits that get some contextual elaboration. The purpose of providing such detail is to enable a better idea of the quality of jobs that are likely to be created and of the types of industries that are most likely to be affected by the focus of the analysis.

III. CORE FINDINGS

1. JOINT BASE MCGUIRE-DIX-LAKEHURST

The Joint Base McGuire-Dix-Lakehurst (JB MDL) is a base located about 25 miles south southeast of Trenton. On October 1, 2009, McGuire Air Force Base, The U.S. Army's Fort Dix, and Naval Engineering Station Lakehurst were merged to form JB MDL. The ability to plan and train for joint missions across all three military services (Navy/Marines, Army, Air Force) plus the Coast Guard is part of what makes JB MDL unique. In addition it includes Active Duty, Reserve, National Guard, Civil Service, Research/Development/Test/Evaluation, Homeland Security personnel as well. The three services operate under different commanders: although overall administration is the responsibility of the US Air Force.

The facility itself covers 42,000 acres. From east to west the base extends over 20 miles. It houses almost 4,000 facilities and supports most types of combat and the latest techniques available with the expertise of over 40 commanders and 80 mission partners. JB MDL is home to the combined forces of the U.S. Army, U.S. Navy, and U.S. Air Force and is composed of the set of missions below.

1.1.McGuire Air Force Base

1.1.1. **The 87 Air Base Wing** consists of more than 3,100 officers, enlisted, and civilian personnel from the Air Force, Army and Navy and provides installation management to Joint Base McGuire-Dix-Lakehurst. The wing also provides mission-ready, expeditionary Airmen to support Unified Combatant Commanders in on-going military operations.

1.1.2. **The 305 Air Mobility Wing** extends America's global reach by generating, mobilizing and deploying 32 KC-10 and 15 C-17 aircraft to conduct strategic airlift and air refueling missions worldwide. Additionally, the Wing operates two of America's largest strategic aerial ports supporting the delivery of cargo to combatant commanders abroad. In addition to the war time contributions, the Wing has played significant part in many critical peacetime operations, such as Pacific Rim tsunami relief, Hurricane Katrina support and Operation TOMODACHI, the US assistance operation to Japan following an earthquake and tsunami in March 2011. The Wing

supports the Joint Base through cargo and passenger processing through the Aerial Port Squadron, airfield and ramp maintenance, and air traffic control services, and employs more than 2,300 men and women.

1.1.3. **514 Air Mobility Wing** is an associate Air Force Reserve unit assigned to the 22nd Air Force located at McGuire AFB and shares the responsibility with the 305th AMW of flying and maintaining the KC-10 and C-141 aircraft assigned to the 305th. It supports airlift, air-refueling, airdrop, and aeromedical evacuation missions using the KC-10 Extender C-141B Starlifter. It also recruits and trains Air Force reservists for active duty and enhances the nation's air mobility capability. More than 2,500 men and women, consisting of active duty military personnel exceeding 2,100, and more than 200 civilians make the support operations possible to keep the country safe.

1.1.4. **The 621stContingency Response Wing (CRW)**specializes in training and rapidly deploying personnel to quickly open airfields and establish, expand, sustain, and coordinate air mobility operations. Approximately 630 active duty and traditional personnel are at the Joint Base. Operations such as ENDURING FREEDOM, IRAQI FREEDOM, and NEW DAWN and humanitarian assistance deployments such as Hurricane Katrina and the Haiti and Pakistan Earthquake relief operations are tributes to the 621st CRW's capabilities and readiness in providing mission support whenever and wherever the requirement exists.

1.1.5. **The 108th Wing,** while located at Joint Base-McGuire is technically part of New Jersey's Air National Guard. See Section 4.1.2 for more information

1.1.6. **Fleet Logistics Support Squadron 64 (VR64)** transferred from Naval Air Station Joint Reserve Base Willow Grove, Pennsylvania, in 2011 to the Joint Base McGuire-Dix-Lakehurst because of the 2005 Defense Base Closure and Realignment Commission. The VR-64 has a critical role in the country's national security strategy and is entrusted to safely execute effective, responsive C-130 Hercules air logistics missions in direct support of the Fleet and Combatant Commanders worldwide. About 230 military personnel make this mission possible.

1.1.7. **The Army Air Force Exchange Service** (AAFES) provides quality merchandise and services to active duty, Guard and Reserve members, military retirees and their families at competitively low prices. A total of 261 civilians work at the Exchange.

1.2.Naval Lakehurst

Sharing common borders with Fort Dix and McGuire Air Force Base **a**nd with a rich heritage as the nation's lighter-than-air center, Naval Lakehurst is now the Aircraft Platform Interface expert for the Department of Defense. The presence of the Naval Air Systems Command dominates Naval Lakehurst, but it is also a major installation for the training of National Guard units.

1.2.1 Naval Air Systems Command (NAVAIR) provides full life-cycle support of naval aviation aircraft, weapons and systems operated by sailors and marines. The primary unit of NAVAIR at Lakehurst is the Naval Air Warfare Center Aircraft Division (NAWCAD), which supports research, development, test, evaluation, engineering and fleet support of Navy and Marine Corps air vehicle systems and trainers. In addition to providing test facilities, laboratories, and aircraft necessary to support the Fleet's acquisition requirements, the Naval Air Warfare Center Aircraft Division provides a variety of services to the Department of Defense, other Federal agencies as well as non-Federal customers. NAVAIR employs 36 active duty military personnel and 1,384 civilians. Some 150 contractor employees also work on the base.

1.2.2 Coms-Electronic Research Development and Engineering Center (CERDEC) at Lakehurst (JB MDL) supplies command, control, communications, computers, intelligence, surveillance and reconnaissance capabilities, technologies and integrated solutions for the soldier. CERDEC employs 36 civilians. Another 150 contractor employees also work on base.

1.2.3 Lakehurst Consolidated Logistics Training Facility, labeled a mobilization and training equipment site, consists of a field maintenance shop, unit training and equipment site, and combined support maintenance shop that cater to New Jersey's Army National Guard. The Logistics Training Center operates with 4 full-time reservists, 81 civilians, and a contractor. About 60 part-time reservists work at the facility at any given time as well.

1.2.4 U.S. Naval Mobile Construction 21stBattalion (NMCB-21)is comprised of Seabees from 15 Naval Reserve Centers located in Delaware, New Jersey, New York, and Pennsylvania. It is a Readiness Support Site (RSS) that includes administrative offices, a supply warehouse, and vehicle and camp maintenance shops. NMCB-21 presently operates with 10 full-time active duty reservists and 422 regular reservists. It is slated to discontinue operations in September 2013.

1.2.5 New Jersey Army National Guard Aviation Company gives mechanical and repair job training to soldiers in the Army's National Guard's Aviation Branch. The Aviation Company presently has 78 active duty reservists and 250 regular reservists.

1.2.6 US Army Recruiting Battalion, Mid-Atlantic promotes the Army and meets national recruiting goals by identifying committed young people. The battalion pursues its mission through collaborative partnering with the community leaders, corporate and civic organizations throughout the Mid-Atlantic region, and maintains ties with local educators, school boards, and administrators. The Recruiting Battalion has a staff of 28 military personnel, 18 civilians, and a contractor's employee.

1.3.Fort Dix

Fort Dix is the U.S. Army component of the Joint Base. It hosts a number of support facilities, commands and brigades. It supports and conducts reserve component training as well as mobilization/demobilization operations.

1.3.1. The 174thInfantry Brigade operates two active duty battalions at Joint Base McGuire-Dix-Lakehurst. It provides training support to mobilized reserve units, the Army National Guard, and Joint Service Warriors for overseas contingency operations in support of national defense.

1.3.2. 72nd Field Artillery Brigade Headquarters plans, coordinates, and enables post-mobilization, pre-deployment training in support of specified U.S. Army Reserve, Army National Guard, Navy, Air Force and Coast Guard units. On order, the Artillery Brigade also provides pre-mobilization training assistance within its capabilities for Army Reserve and Army National Guard units.

1.3.3. The 99thRegional Support Command administrates and gives logistical support to all U.S. Army Reserve units and commands in the Northeast, and supervises maintenance

support and equipment sites. The command is also gives facility support to all units in the 13-state region.

1.3.4. USAF Expeditionary Center has direct oversight for enroute and installation support, contingency response and partner capacity building mission sets within the global mobility enterprise. It is the Air Force's Center of Excellence for advanced mobility and expeditionary combat support training and education and provides administrative control for eight wings and groups within Air Mobility Command.

1.3.5. Army Support Activity supports and conducts reserve component training as well as mobilization/demobilization operations. It plans and executes other Army directed support missions, and, on order, establishes and operates a Joint Mobilization site.

1.3.6. Federal Correctional Institution, Fort Dix (FCI) is a low-security facility that housed4,760 male inmates in 2012.

1.3.7. Naval Reserve Fleet Support Command (NRFSC) is a U.S. Navy mission partner with Fort Dix with deployable, agile expeditionary forces that are made up of active duty and reserve mission specialists who are trained to support maritime security operations across the globe.

1.3.8. The 244thAviation Brigade Headquarters is the largest aviation brigade in the U.S. Army and conducts theater aviation operations to support military operations of war and/or operations other than war for the Combined Forces Land Component Commander.

1.3.9. The 75thTraining Command, Atlantic Training Division is a subordinate Division of the Army Reserve's 75th Training Command which is the Army's center of excellence for the development and delivery of training aimed at making staff leaders more effective. The Training Command offers virtual and gaming formats and provides high quality training to other military branches, non-military agencies, and partner nation military forces.

1.3.10. The 77thSustainment Brigade is essentially the former 77th Infantry Division and an active warrior unit.

1.3.11. Fleet Readiness Center-East & Aviation Support Detachment (FRC-E/ASD) maintains and provides logistics support to C-130 Hercules aircraft from Fleet Logistics Support Squadron 64, CH-53E Super Stallion helicopters from Marine Heavy Helicopter

Squadron 772, UH-1N Huey and AH-1W Cobra helicopters from Marine Light Attack Helicopter Squadron 773 Detachment B.

1.3.12. Golf Battery, 3rdBattalion, 14, Marine Regiment is an artillery unit that augments and reinforces active components in time of war, national emergency and at other times as national security requires.

1.3.13. Joint Forces Head Quarters, New Jersey Army and Air National Guard supports the U.S. Department of Homeland Security's various statewide operations in addition to the simulation exercises for terror attack response.

1.3.14. Marine Wing Support Squadron (MWSS-472) is a reserve aviation ground support unit of the United States Marine Corps. It is the primary home for all Airfield Operations specific Military Occupational Specialties (MOSs). The squadron is under the command of Marine Wing Support Group 47 and the 4th Marine Aircraft Wing.

1.3.15. Mid-State Correctional Facility Annex is a State of New Jersey Department of Corrections facility located on 12.24 acres of State property on Fort Dix. Mid-State's900 inmates are assigned work details and have the opportunity to participate in various work skill programs.

1.4.JB MDL Operations and Construction Data

During a prior study, JB MDL provided the study team with data on its service expenditures, military and civilian payroll expenditures, and construction expenditures for 2010. Expenditures on operations totaled nearly $4.1 billion dollars in 2010, while construction spending that year was $0.43 billion. Of the federal funds allocated – that for grants, military contracts, and payroll allocated directly to the Joint Base – the study team was able to verify about $0.93 billion of the spending on operations via the *2009 Department of Defense (DoD) Data Atlas*. The balance is composed largely of spending on service contracts and the payrolls for Contractor Support Services (CSS), with most of the latter allocated to base tenants that are officially located elsewhere in DoD databases. Assurances were made that no overlap existed between the service contracts and the payrolls of CSS personnel, who work on the base.

The focus of present study is to measure the economic impacts of activity at the base on the State of New Jersey. The study team therefore winnowed the list of expenditures, particularly service contracts, to those that were made to New Jersey-based organizations. These

expenditures totaled $2.5 billion dollars in 2012. Table 1.1 lists state-based expenditures by type of spending.

Table 1.1: Joint Base New Jersey-based Spending Estimates, 2012

Expenditure Group	In-State ($ million)
Appropriated Fund Personnel (Payroll)	853.3
Contractor Support Services (Payroll)	850.0
Services (in-state vendors)	300.0
Materials (BX, Health, Education, GPC, TDY)	135.0
Construction	400.0
Total	2,538.3

1.4.1.JB MDL Operation and Maintenance Spending. As mentioned previously, the Joint Base is the largest military installation in New Jersey. As shown in Table 1.2, in January 2013, in addition to the 14,376 full-time military personnel who worked on base and the 7,804 traditional reservists who visited it regularly, it was also the workplace for 1,451 contract workers and home to 4,841 military dependents and 5,456 prisoners. Moreover, 3,031 students arrived on the base weekdays to enhance their knowledge and skills. Data for March suggest that the population on the Joint Base is expanding after some retrenching the last couple of years. The expansion is occurring largely at McGuire AFB, which added 510 new full-time personnel, although Fort Dix experienced some modest expansion as well.

Moreover, the payroll of Contractor Support Services personnel who work in or near the Joint Base is not included in the military personnel totals. In 2010, the total payroll of Contractor Support Services at the Joint Base was equivalent to that for military and civilian payroll workers on the base. Thus, using $850.0 million as the payroll for this group and an annual pay rate of $42,000, which is slightly higher than that used in the 2010 study, we estimate that about 20,200 Contractor Support Services workers were engaged in activity related to the Joint Base in 2012.

Table 1.2: Joint Base Personnel and Payroll Estimates,January 2013

JB MDL	Full-time Personnel January 2013	Traditional Reserve	Annualized Payroll January 2013*
McGuire AFB	8,175	3,123	$486,700,000
Lakehurst	2,206	2,300	$172,200,000
Fort Dix	3,995	2,381	$194,300,000
Military Total	*14,376*	*7,804*	*$853,200,000*
Contractor Support Services	*20,200*	--	*$850,000,000*
Total	**34,576**	**7,804**	**$1,703,200,000**

*Payroll was roughly estimated using JB-wide pay rates from 2010 and data from the *DoD Data Atlas* for 2009.

In addition to the above, JB MDL estimates that about a third of the 2,100 on-base military dependents hold jobs. In recognition of the roughness of the estimate, the study team assumed that 700 military dependents hold jobs within commuting distance of the base. By distributing these jobs within the structure of the local economy, the study team allocated 652 of the 700 jobs to New Jersey (the remaining 48 are presumably employed in Pennsylvania) with an associated aggregate annual pay of about $25.2 million (about $38,700 per job).

For purposes of analysis, the $300.0million in JB MDL service expenditures paid to New Jersey vendors were allocated across 73 industries, based on the type of work performed and/or the core business of the vendor organization. This allocation is provided in Table 1.3, with detail shown for those industries accounting for over 1 percent of the total service expenditures.

Table 1.3: Distribution of $300 Million in JB MDL Service Expenditures (paid to New Jersey-based vendors)

Industry	Percent
Engineering, architectural, and surveying services	70.9
Other electronic components	4.0
Computer and data processing services	3.9
Hotels	2.8
Job training and related services	2.8
Aircraft and missile equipment	2.6
Fabricated structural metal	1.9
Search and navigation equipment	1.9
Services to dwellings and other buildings (includes janitorial, pest control, inspection, etc.)	1.4
Trucking and courier services, except air	1.0
Wholesale trade, durable goods	1.0
Research, development, and testing services, except noncommercial	1.0
Other	4.7
Total	**100.0**

The estimated annual material, equipment and other procurements for the ongoing operations of the base are listed in Table 1.4. These include the supplies used to stock the base commissaries (Base Exchange and Government Purchase Card), expenditures on healthcare and education goods and services for base personnel, and per-diem expenditures for temporarily stationed military and civilian personnel (TDY). For purposes of analysis, it was assumed that commissary goods are purchased from in-state wholesalers who transport most goods in from out-of-state, and that temporarily stationed personnel per diems are spent strictly on accommodations (75 percent) and eating and drink establishments (25 percent).

Table 1.4: Material, Equipment and Other Procurement, 2012

Procurement Type	Expenditure ($ million)
BX (Base Exchange)	53.3
GPC (Government Purchase Card)	14.4
Health	16.1
Education	14.8
Temporary Duty (TDY) Costs	36.4
Total	**135.0**

Indeed, a full 31.8 percent of the operating expenditures were spent on service contracts and goods that originate outside of the state. The BX and GPC portions of the spending are discounted further since at best only the wholesale/retail margins on both (about 15 percent of the value of sales), as opposed to the full sales value of the goods purchased, can be fully attributed as state-based economic activity. That is, we assume all goods purchased at the BX and via GPC are produced outside of the state. Further, like other models of its ilk, the R/ECON I-O model gauges spending of households as a percentage of the income they earn. About 76 percent of personal income is assumed to spent—the rest is assumed to be saved or used to pay taxes (largely, property, sales, and income taxes).

1.4.2. **Capital Spending.** Finally, the Joint Base's construction expenditures were allocated across types of construction contractors and several other expenditure categories based on information provided by JB MDL in 2010. For use in the R/ECON™ Model, the amounts assigned to each contractor type were then further distributed across typical labor and material allocations for each type of contractor. The distribution of $428.3 in total construction and associated expenditures is provided in Table 1.5.[3]

Table 1.5: Distribution of $400 Million in Construction Expenditures by Contractor Type

Contractor/Expenditure Type	Percent
General contractors	90.8
Highway and street contractors	6.8
Painting, papering, decorating	1.3
Engineering, architectural, and surveying services	0.5
Personnel supply services	0.2
Real estate	0.2
Construction repair and maintenance	0.1
Total	**100**

[3] A number of other construction and associated sectors with expenditure shares of less than 0.1% are not reported.

1.5. Total Economic Impacts of the Joint Base

We break the economic impacts into two components, those for operations and those for capital spending. The rationale for this is that the capital spending is typically quite variable from one year to the next, since capital projects are quite lumpy. That is, some capital projects may span many years while others may take just three to four months. Moreover, the capital projects listed are strictly those not undertaken by base personnel or by contractors headquartered outside of the State of New Jersey. For this reason the capital spending applied in the analysis may represent no actual single year, but rather a best estimate of "expected" spending (external to the base's operations budget) in any given year.

1.5.1 **Operations Spending.** The data provided and as displayed in Section 1.4 were entered into the R/ECON™ I-O model. Table 1.6 summarizes the results. The direct effects (the first data column) of the base's operations in terms of jobs and earnings reflect the data from Section 1.4.1. The 34,576 jobs on base yield another 15,631 jobs via multiplier effects elsewhere in New Jersey's economy for a total of over 50,000 jobs contributed to the state's economy by the Joint Base's operations. Similarly, the $1.7 billion in labor income (earnings) generated directly by operational activity on the base, supports another $0.9 billion in labor income statewide. Thus, Joint Base operations contribute a total of about $2.6 billion in labor income to the state's economy on an annual basis. At $4.0 billion, the contribution of the Joint Base's operations to New Jersey's economy in terms of GDP is more than 50 percent larger than just that of labor income, which partly makes up GDP.

Table 1.6: Annual Economic Impacts on New Jersey's Economy of Joint Base Operations, 2012

	Direct effects	Indirect & Induced effects	Total
Output($1,000)	2,538,939	2,785,571	5,324,510
Jobs	34,576	15,631	50,207
Earnings($1,000)	1,703,300	895,332	2,598,632
GDP($1,000)	2,453,246	1,577,672	4,030,918

1.5.2 **Capital Spending.** Compared to operations spending, capital spending at the Joint Base is much lower as identified in Section 1.4.2—$400 million compared to the $2,539 million in operation spending. As can be observed in Table 1.7, the $400 million in annual capital spending directly employs on the order of 820 New Jersey workers in construction and related activities with aggregate earnings of about $53.8 million—about $65,660 in annual pay per job, which is above the state average pay per job of $62,900. Due to the relatively high pay rate of construction work, the 819 direct jobs supported 962 other jobs indirectly, which paid nearly as well and, hence, added another $63.1 million to the state's business payrolls. Thus the annual capital spending at the Joint Base yields about 1,780 jobs that are supported by $116.9 million in labor income. Only somewhat more wealth is generated beyond labor income to yield a gross annual GDP total of $189.5 million from the capital spending.

Table 1.7: Annual Economic Impacts on New Jersey's Economy of Joint Base Capital Spending, 2012

	Direct effects	Induced effects	Indirect & Total
Output ($1,000)	400,000	210,790	610,790
Jobs	819	962	1,782
Earnings ($1,000)	53,775	63,110	116,884
GDP ($1,000)	79,891	109,560	189,452

1.5.3 **Total Economic Impacts Operations and Capital Spending Combined.** Because the capital spending on outside contractors is dwarfed by operations spending at the Joint Base, the combined total economic impacts of all spending are very similar to those for the operating costs only. In fact with the exception of the direct output effects, the economic impacts of operations spending comprise between 90 percent to 98 percent of the impacts of capital and operations spending combined.

As can be seen from Table 1.8, activity at the Joint Base pumps nearly $3.0 billion into the New Jersey's economy annually. In doing so, it supports nearly 52,000 jobs that

generate $4.2 billion in wealth annually: of this, $2.7 billion is paid for the labor services of those jobs.

Table 1.8: Total Annual Economic Impacts on New Jersey's Economy of Activity at the Joint Base, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	2,938,939	2,996,361	5,935,300
Jobs	35,395	16,593	51,989
Earnings ($1,000)	1,757,075	958,442	2,715,516
GDP ($1,000)	2,533,137	1,687,232	4,220,370

2. PICATINNY ARSENAL

The **Picatinny Arsenal** installation is located on nearly 6,500 acres 35 miles west of New York City and contains more than 800 buildings, including 64 laboratories. It is the Joint Center of Excellence for Armaments and Munitions and specializes in the research, development, acquisition, and lifecycle management of advanced conventional weapon systems and advanced ammunition. The weaponry developed at Picatinny is used by all branches of the U.S. military. Its portfolio comprises nearly 90 percent of the Army's lethality and all conventional ammunition for joint warfighters. Approximately half of the workers at Picatinny are engineers and scientists.[4]

2.1. Missions at Picatinny Arsenal

The offices overseeing and contributing to the mission of the Picatinny are:

2.1.1. Program Executive Offices

- *Program Executive Office Ammunition (PEO AMMO)*is the life-cycle manager for the conventional ammunition, leap-ahead munitions and counter improvised explosive device products that increase the combat firepower of the warfighters;
- *The Program Executive Office–Soldier (PEO SOLDIER)* located at Picatinny develops, acquires, procures, fields and sustains safe, reliable, effective, state-of-the-art, cost-effective and sustainable Soldier Systems;
- *Program Executive Office Integration (PEO-INTEGRATION)* is a key Brigade Combat Team (BCT) Modernization supporting organization charged with ensuring integration across the Program Executive Offices and their associated portfolios that support the Capability Package materiel solutions and the emerging tactical network;
- *The Program Executive Officer for Ground Combat Systems (PEO GS)* manages the development, acquisition, testing, systems integration, product improvement and fielding of ground combat support weapons systems used by the Army and other U.S. military services.

2.1.2. **The Joint Munitions and Lethality Lifecycle Management Command (JM&L LCMC)** develops, acquires, fields and sustains value-added ammunition for the joint

[4] For more information please seehttp://www.pica.army.mil/picatinnypublic/about/index.asp.

warfighter through the integration of effective and timely acquisition, logistics and cutting-edge technologies.

2.1.3. The **US Army Armament Research, Development and Engineering Center(ARDEC)**is the Army's "Center of Lethality," a designation reflecting its important role as the provider of more than 90 percent of the Army's lethal armaments and munitions to warfighters.

2.1.4. **Assistant Secretary of the Army (Acquisition Technology and Logistics) Organization:** ASA (AT&L) Organization assists and advises the Secretary of Defense in matters concerning acquisition, technology, and logistics.

2.1.5. **Defense Contracting Management Agency (DCMA)** conducts contract administration services enabling the timely, cost-effective delivery of quality products to the warfighter.

2.1.6. The Army Contracting Center-New Jersey (ACC NJ) provides expert contracting support to the Army's "ammunition enterprise" by integrating the people, organizations, infrastructures and processes necessary for the effective life cycle management of conventional munitions for the joint warfighter.

2.1.7. The **Naval Surface Warfare Center, (NAVSEA)** provides research, development, evaluation and in-service support of energetic systems for the Navy's Energetic Enterprise.

2.1.8. **Civilian Human Resource Agency** hires civilian employees as needed.

2.2. *Operations and Maintenance Expenditures*

Data for the whole of Picatinny is difficult to obtain. Still, that for ARDEC, which employs about 55 percent of the base's personnel, was secured. It employs 3,299 civilian and 21 military jobs at Picatinny. Based on those numbers, the known affiliated payroll, and estimates of the sizes of other missions at Picatinny, estimates were derived for the entire base and appear in Table 2.1.

Table 2.1 Employment and Payroll at Picatinny, 2012

Civilians	Military	Payroll
5,811	208	510,746,960*

*includes 45.708 million expended in supply and services contracts.

ARDEC incurred $785,396,464 in expenditures in 2012, including a payroll total that amounted to $367,215,713. Other costs included in the total operating expenditures are travel, transportation and training costs amount to $20,422,858, $1,313,887 and $8,025,290, respectively. Equipment, supplies and printing costs for the ARDEC amounted to $37,967,566. Payments to contractors (for contracts regarding supplies and services) and government agencies amounted to $267,121,554 and $83,329,596 respectively. Total personnel and payroll for 2012:

The payroll for on base contract employees: 1,024 is covered in the payments to the contractors. Payments to the government agencies account for testing; engineering (approximately 60 percent); materials; modeling and analysis ("other government agencies are generally...outside of NJ"). The dollar amounts represent operating costs incurred for FY 2011 (and up to September 2011). The payments to contractors include costs of supply and services contracts awarded to NJ contractors. Engineering services constitute approximately 60 percent of the contracts; the remainder is IT supports services; program support and consulting services.

2.3. Capital Expenditures.

Capital spending accelerated at Picatinny after the last round of base realignments. Since 2010, it has waned somewhat as can be observed in Table 2.2. From present through 2016, base commanders understand that about $55.6 million will be invested annually by the base. About 30.0 percent will be for site works, 17.4 percent for utilities, and the rest (51.8 percent) will be for facilities.

Table 2.2 Capital Spending at Picatinny, 2008-2016
(millions of dollars)

FiscalYear	Site Works	Utilities	Facilities	**Total**
actual				
2008	12.3	3.3	49.9	65.5
2009	21.9	16.8	65.5	104.2
2010	21.9	14.8	81.4	118.0
2011	10.1	6.1	38.5	54.7
2012	16.5	7.6	42.5	66.6
annual estimate				
2013-2016	*16.6*	*9.7*	*28.8*	*55.6*

2.4. *Community Interaction*

2.4.1. Cooperative R&D Agreements. Picatinny has Cooperative R&D agreements with the various firms, corporations, universities and institutes. Active educational partnerships exist with universities namely Rutgers, University of Iowa, University of Hartford, University of Buffalo, and SUNY Binghamton. Agreements with NJIT and Seton Hall are pending conclusion.

2.4.2. **Community Service.** Members of the military families work in the medical field (dental assistant, physical therapy, nurse, etc.). Some family members work at in the Human Resources and Education fields. The service members and their families provide support and care to the wounded soldiers, participate in Army Emergency relief programs, and volunteer with Chapel. A number of spouses and families are actively engaged in Blood Drives and are involved with Girl Scouts.

Active Duty Military members and their family members participate in St. Patrick's Day, Memorial Day, and Veteran's Day observances and parades in the surrounding communities. They also attend many functions hosted by the Morris County Chamber of Commerce and United Way. Approximately 37 Military and family members were recognized at the last Picatinny Arsenal Volunteer Recognition Ceremony.

2.4.3. **Spending by Retirees.** Approximately 15 percent ($270,000) of the base's total Family and Morale, Welfare and Recreation customers are military retirees (the installation's Golf Course has the highest share of users). An estimated 85 percent of Post Exchange shoppers are military retirees. DeCA does not have a way to capture the amount of retiree spending. However, based upon a CCSS survey of 22,000, a percentage of which are retirees, the average monthly spending of retired patrons is estimated to be $358.77.

2.5. *Total Economic Impacts of Picatinny Arsenal*

2.5.1. **Total Economic Impacts of Operations.** he data provided and as displayed in Section 2.2 were entered into the R/ECON™ I-O model. Table 2.3 summarizes the results. The direct effects (the first data column) of the base's operations in terms of jobs and earnings reflect the data from Section 2.2. The nearly 5,000 jobs on base yield another 8,277 jobs via multiplier effects elsewhere in New Jersey's economy for a total of over 13,250 jobs contributed to the state's economy by the Picatinny's operations. Similarly, the $510.7

million in labor income (earnings) generated directly by operational activity on the base, supports another $377.7 million in labor income statewide. Thus, Picatinny operations contribute a total of about $888.4 million in labor income to the state's economy on an annual basis. At $1.65 billion, the contribution of the Picatinny's operations to New Jersey's economy in terms of GDP is almost twice than of just labor income, which partly makes up GDP. The substantial labor spillovers and GDP contribution are due to the R&D orientation of the facility.

Table 2.3: Total Economic Impacts of Picatinny Operations, 2012

Indirect & Direct effects	Induced effects	Total	
Output($1,000)	1,400,012.3	1,278,916.9	2,678,929.2
Employment	4,995	8,277	13,272
Earnings($1,000)	510,747.0	377,662.1	888,409.1
GDP($1,000)	888,667.0	764,321.1	1,650,928.1

2.5.2. Total Economic Impacts of Capital Spending. As can be observed in Table 2.4, the $55.6 million in annual capital spending directly employs on the order of 200 New Jersey workers in construction and related activities with aggregate earnings of about $16.5 million—about $82,260 in annual pay per job, which is substantially above the state average pay per job of $62,900. Due to the relatively high pay rate of construction work, the 201direct jobs supported another 562 jobs indirectly. But as these support jobs were paid substantially less, they comprised about the same aggregate amount as did the direct construction jobs to the state's business payrolls. Thus the annual capital spending at Picatinny yields about 562 jobs that are supported by $32.9 million in labor income. Somewhat more wealth is generated beyond labor income to yield a gross annual GDP total of $57.5 million from the capital spending.

Table 2.4:Total Economic Impacts of Picatinny Projected Capital Expenditures, 2013

Indirect & Direct effects	Induced effects	Total	
Output ($1,000)	55,600.0	55,230.5	110,830.5
Employment	201	361	562
Earnings ($1,000)	16,523.2	16,416.3	32,939.5
GDP ($1,000)	24,960.2	32,519.8	57,480.0

2.5.3. **Total Economic Impacts Operations and Capital Spending Combined.** Capital spending on outside contractors is very small compared to operations spending at Picatinny. Thus, the combined total economic impacts of all spending are very similar to those for the operating costs only. In fact with the exception of the direct output effects, the economic impacts of the base's operations spending comprise about 96 percent of the impacts of capital and operations spending combined.

As can be seen from Table 2.5, activity at Picatinny adds $1.5 billion to the New Jersey's economy annually. In doing so, it supports nearly 13,800 jobs that generate $1.7 billion in wealth annually: of this, about half—$921.3 million—is paid for the labor services of those jobs.

Table 2.5: Total Economic Impacts of Annual Activity at the Picatinny Arsenal

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	1,455,612.3	1,334,147.4	2,789,759.7
Employment	5,196	8,638	13,834
Earnings ($1,000)	527,270.2	394,078.4	921,348.6
GDP ($1,000)	913,627.2	796,840.9	1,708,408.1

3. NAVAL WEAPONS STATION EARLE

The **Naval Weapons Station Earle** has two distinct physical sections in Monmouth County. Its Mainside is located in parts of Colts Neck Township, Howell Township, Wall Township, and Tinton Falls; and its Waterfront Area, which includes a pier complex, is on Sandy Hook Bay in the Leonardo section of Middletown Township. As a weapons station, it handles, stores, transports, renovates, and issues all types of naval weapons and ammunition.

Naval Weapons Station Earle is also home to many tenant organizations. These tenants include:

1. Combat Logistics Group Two,
2. Shore Intermediate Maintenance Activity,
3. Mobile Mine Assembly Unit Three, Superintendent of Shipbuilding Portsmouth Detachment Earle,
4. Explosive Ordnance Disposal Mobile Unit Two Detachment Earle,
5. Atlantic Ordnance Command Detachment Earle,
6. Public Works Center Site Earle, and
7. The Packaging, Handling, Storage, and Transportation Center.

3.1.Annual Operating and Maintenance Expenditures

Annual operating costs relating to jobs and missionpayroll are as in Table 3.1. Unfortunately no personnel count was reported by Earle. Assuming an average annual pay of $40,000 per year for each active duty naval personnel (in 2009 it was about $37,550 in New Jersey according to the*DoD Data Atlas*) implies that Earle maintains a paid military staff of about 206. Further assuming civilian pay is $85,000 per year, means that about 36 civilians are contracted annually to support the military staff.

Table 3.1: Operations and Maintenance Costs at Earle, 2012

Expenditure	Cost
Annual Payroll	$8,257,709.00
Contracts Support	$3,112,806.00
Annual Payroll	$13,425,000.00

3.2.Capital Spending

The Station handles weapons delivery. The total of its capital budgets for fiscal years 2013 and 2014 is $27 million to be allocated as noted in Table 3.2. We average this in the analysis, so that annual spending is estimated to be $13.5 million.

Table 3.2: Capital Spending at Earle, 2013-2014

Fiscal Year	Project	Budget
2013	Installation of solar panels, instant hot system, and motion sensors	$0.7 million
2014	Replacement of 2 old boilers; Energy Upgrades (building C-29)	$1.1 million
2014	Maintenance Dredging	$25 million

3.3.Community Interaction

The community services provided by the NWS Earle during the year 2011 include supporting Boy Scouts; promoting research and experimentation in science, engineering, and mathematics in local high schools; providing training in sexual assault prevention; responding to certain alarms for major fires in neighboring townships as part of mutual aid initiatives; responding to ordnance disposal requests; providing emergency management assistance; raising funds for wounded warriors; assisting the community educational institutions in their efforts to provide academic and vocational training for students with cognitive impairment, multiple disabilities, autism, and communication impairments; and providing free backpacks (loaded with school supplies) to NWS Earle school children as part of Operation Home-front's back to School Brigade Program..

The Earle sailors volunteer to collect and distribute gifts to area children and families affected by pediatric cancer; and to collect goods and food items to the local pantry as part of Feds Feed families program. The NWS Earle also supports quarterly TSA "Explosives & Explosive Effect (E&EE) training. The NWS Earle builds relations with the community by hosting, supporting, and participating in social, academic, and sporting events.

3.4.Environmentally Responsible Activities

The units at the NWS Earle are actively engage in environmentally responsible activities. During the year 2011, it hosted the Wendy Schmidt Oil Clean-up X-Challenge; the First Class Petty Officers Association collaborated with the NJ Clean Communities Program on a highway clean-up event; and the youth Center participated in annual beach clean-up in Belmar, NJ. The

Environmental department at Earle support and assist Coastal Ecosystem Learning Center (CELC) in Camden in increasing awareness through supporting projects and learning opportunities. The Station is collaborating with the NJ Department of Environmental Protection (DEP) in executing the Baykeeper Project, for which the establishment of an Oyster colony at 18 locations at the Pier complex has been approved. The NWS Earle also promotes opportunities for military youth to experience outdoors through fishing.

3.5.Economic Impacts of Naval Weapons Station Earle

3.5.1. **Economic Impacts of Operations at Naval Base Earle.** The data provided and as displayed in Section 3.1 were entered into the R/ECON™ I-O model. Table 3.3 summarizes the results. The direct effects (the first data column) of the base's operations in terms of jobs and earnings reflect the data from Section 3.1. The just more than 240 jobs on base yield about another 100 jobs via multiplier effects elsewhere in New Jersey's economy for a total of over 343 jobs contributed to the state's economy by Earle's operations. Similarly, the $13.4 million in labor income (earnings) generated directly by operational activity on the base, supports another $6.0 million in labor income statewide. Thus, Earle operations contribute a total of about $19.4 million in labor income to the state's economy on an annual basis. At $29.7 million, the contribution of Earle's operations to New Jersey's economy in terms of GDP is almost 50percent more than of just labor income, which partly makes up GDP.

Table 3.3: Operations and Maintenance Costs at Earle, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	19,032.2	19,079.8	38,112.0
Employment	242	101	343
Earnings ($1,000)	13,425.0	5,988.0	19,413.0
GDP ($1,000)	19,032.2	10,631.0	29,663.2

3.5.2. **Economic Impacts of Capital Spending at Naval Base Earle.** As can be observed in Table 3.3, the $13.5 million in annual capital spending directly employs on the order of 53 New Jersey workers in construction and related activities with aggregate earnings of about $4.2 million—about $79,300 in annual pay per job, which is substantially above the state average pay per job of $62,900. Due to the relatively high pay rate of

construction work, the 53 direct jobs supported another 84 jobs indirectly. But these support jobs were paid less, so they were paid only a bit more in aggregate than were the direct construction jobs by the state's businesses. Thus the annual capital spending at Earle yields about 138 jobs that are supported by $9.3 million in labor income. Somewhat more wealth is generated beyond labor income to yield a gross annual GDP total of $15.1 million from the capital spending.

Table 3.3: Capital Sending at Earle, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	13,500.0	16,675.1	30,175.1
Employment	53	84	138
Earnings ($1,000)	4,203.7	5,139.5	9,343.2
GDP ($1,000)	6,060.5	8,993.5	15,054.0

3.5.3. Total Economic Impacts Operations and Capital Spending Combined at Earle. Unlike at other major New Jersey military bases, capital spending on outside construction contractors is nearly as large as operations spending at Earle. Generally speaking, the economic impacts of the base's operations spending comprise somewhere around 60 percent of the impacts of capital and operations spending combined. As can be seen from Table 3.4, activity at Earle adds $32.5million to the New Jersey's economy annually. In doing so, it supports nearly 300 jobs that generate $44.7 million in wealth.

Table 3.4: Economic Impacts of All Activity at Naval Base Earle, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	32,532.2	35,754.9	68,287.1
Employment	295	185	481
Earnings ($1,000)	17,628.7	11,127.5	28,756.2
GDP ($1,000)	25,092.7	19,624.5	44,717.2

4. THE NATIONAL GUARD

The New Jersey National Guard is composed of two elements—the New Jersey Air National Guard and the New Jersey Army National Guard. As state militia units, neither is in the normal United States military chain of command. The New Jersey National Guard consists of over 9,000 Guardsmen who are currently engaged in several worldwide and homeland missions. In recent years, units have deployed to Iraq, Guantanamo Bay, Afghanistan, Germany, Kosovo, Kuwait, and Egypt. The Guard has also deployed to help with the recovery from Hurricane Katrina in New Orleans and more recently during the aftermath of Superstorm Sandy.

4.1.Air National Guard

Under the "Total Force" concept, New Jersey Air National Guard (ANG) units are considered Air Reserve Components of the United States Air Force (USAF). New Jersey ANG units are trained and equipped by the USAF. In addition, the New Jersey Air National Guard forces are assigned to Air Expeditionary Forces and are subject to deployment tasking orders along with their active duty and Air Force Reserve counterparts. New Jersey's ANG has two main components the 177th Fighter Wing and 108th Refueling Wing. Combined they have a strength of about 2,300 military personnel.

4.1.1. ***177th Fighter Wing*** is located at Atlantic City International Airport, in Egg Harbor Township. Its federal mission is to provide combat ready citizen-airmen and 18 F-16C fighter aircraft for worldwide deployment in support of USAF objectives. At the state level, the Air National Guard provides protection of life, property and preserves peace, order and public safety through emergency relief support during natural disasters; search and rescue operations; support to civil defense authorities; maintenance of vital public services. The Wing is also home to the 227th Air Support Operations Squadron (ASOS) which has the mission to provide specialized support to, and deploy with, ground force commanders with meteorological support. The ASOS members advise, plan, coordinate, and request close air support, tactical air reconnaissance, and tactical airlift for supported ground forces as needed. As of 2012 the 177th wing employed a total of 1,158 employees, which included 258 technicians, 757 traditional and 143 Air Guard Reserves (AGRs). The number of state employees stood at 33.

4.1.2. ***The 108th Wing's*** principal mission is air refueling and airlifting in support of Air Force, Navy and Marine Corps aircraft as well as aircraft of allied nations. The wing enhances the Air Force's capability to accomplish its primary missions of Global Reach and Global Power. The wing is also capable of transporting litter and ambulatory patients using patient support pallets during aeromedical evacuations.

In addition to their primary air refueling mission, the Wing also supports an Intelligence Squadron and a Contingency Response Group, and has supported US Air Force Flag operations in support of Air National Guard units requiring air refueling training during realistic combat scenario exercises. The 108th Air Wing employs more than 1,200 professional men and women, which include 241 technicians, 814 traditional and 148 Active Guard Reserve members.

4.1.3. **Operations and Maintenance Spending.** Annual expenditures incurred in operations and maintenance, including military and civilian pay, for the Air National Guard total nearly $133 million annually as shown in Table 4.1. As might be expected, payroll and fuel comprise most of the budget each year.

Table 4.1: Air National Guard Operations and Maintenance Spending, 2012

Expenditure Item	Spending
Gov't to Gov't Services	175,322
Fuels	54,874,333
Civilian Contract Goods	5,049,500
Shipment of Materials & Parts	140,000
Credit Card Purchases	1,532,000
Travel-TDV	2,776,903
Payroll	67,942,200
Supplies procured Via ESS/SBSS	702,6267
Total	$133,192,885

The payroll supported 2,342 military assigned personnel in 2012. About 390 reservists work full-time for the 108th. About 30 of the personnel are full-time staff members who work for the New Jersey State Government. And about 260 are full-time civilian technicians. Naturally the rest are largely traditional reservists.

The information in Table 4.1 is not filtered so that it contains only purchases made from New Jersey vendors. In fact since most of the nonpayroll spending is on fuel as

noted earlier. For the sake of conservatism, the study team opted to assume that the fuel was produced outside of the state since this was certain the case for fuel used in the Joint Base. In fact, the team opted only to use the wholesale margin (15%) of the line item titled "Civilian Contract Goods" plus Travel, which as previously was split such that 75% was assigned to accommodations and 25% for eating and drinking establishments.

4.1.4. **Capital Spending.** A break-out of expenditures on 177th Fighter Wing projects from 2008 to 2011 is shown in Table 4.3.In 2010 the 108th spent $7,879,419 for a base civil engineering building.

Table 4.3: Capital Spending by the New Jersey 177th Fighter Wing of New Jersey's Air National Guard, 2008-2011

Project	Financial Year	Amount Expended
ASOS Buildings	2008	$7,319,098.49
Firehouse Repair/Addition	2008	$305,687.59
Fire Suppression System for ONE Shelters	2008	$2,821,225.01
Total for 2008		13,186,011.09
Arm/Disarm Pads	2009	$3,920,546.00
Standing Seam Metal Roof	2009	$674,200.00
headquarters facility	2009	$7,647,151.77
Total for 2009		12,241,897.77
CE Design &Build HVAC System	2010	$339,000.00
Squad Ops Modifications	2010	$1,258,617.82
Munitions Administrative Facility	2010	$1,599,763.31
Total for 2010		3,197,381.13
Base Track	2011	$346,940.00
Aircraft Ramp Repairs	2011	$1,916,345.00
Vehicle Entry gates	2011	$167,500.00
Total for 2011		$2,430,785.00

The projects undertaken during the referred years consist of construction and repair of facilities. The decline in the expenditures is self-explanatory. With the erection of required facilities, and repairs and renovations no large expense under these heads of accounts is incurred in subsequent years. Most of the construction and repairs were carried out during financial years 2008 and 2009. The analysis will use and average of the investments made in 2010 and 2011 for the 177th and assume something on the order of civil engineering building is spent by the 108th annually so that about $10.0 million is spent annually by New Jersey's Air National Guard. About 80 percent of the costs will be assign to the construction of office building structures and rest to road/ramp repairs.

4.1.5. Total Economic Impacts of the New Jersey Air National Guard.

4.1.5.1.*Economic Impacts of Operations and Maintenance Spending.* The data provided and as displayed in Section 4.1.3 were entered into the R/ECON™ I-O model. Table 4.4 summarizes the results. The direct effects (the first data column) of the base's operations in terms of jobs and earnings reflect the data from Section 4.1.3. About 2,342 reservists on base yield about another 559 jobs via multiplier effects elsewhere in New Jersey's economy for a total of over 2,901 jobs contributed to the state's economy by Air National Guard operations. The low multiplier effect is due to the part-time status of most reservists. That is, in aggregate the 2,342 reservists received $69.2 million in labor income (earnings) generated directly by operational activity on the base. That is they were paid an average of about just $29,500. This is less than half the state's average pay rate. Meanwhile the indirect jobs supporting this effort as estimated to have been paid on the order of $58,300 per jobs, which is twice the reservists annual pay rate. In any case, the $62.9 million reservists were paid supports another $32.6 million in labor income statewide. Thus, the Air National Guard operations contribute a total of about $101.8 million in labor income to the state's economy on an annual basis. At $156.1 million, the contribution of the Air National Guard operations to New Jersey's economy in terms of GDP is almost a third more than of just labor income, which partly makes up GDP.

Table 4.4: New Jersey Air National Guard, Operations and Maintenance, 2012

Direct effects	Indirect & Induced effects	Total	
Output ($1,000)	99,555.7	103,105.9	202,661.6
Employment	2,342	559	2,901
Earnings ($1,000)	69,226.7	32,594.8	101,821.5
GDP ($1,000)	98,400.1	57,728.0	156,128.1

4.1.5.2.*Economic Impacts of Capital Spending.* As discussed in Section 4.1.4 and shown in Table 4.3, an average of $2.8 million in capital spending was spent annually on capital projects by New Jersey's Air National Guard from 2010-2011. Table 4.5 shows that directly employs on the order of just 34 New Jersey workers in construction and related activities with aggregate earnings of about $2.60 million—about $76,500 in annual pay per job, which is somewhat above the state average pay per job of $62,900. These direct jobs supported another 47 jobs indirectly making in aggregate $2.99million annually. Thus the

annual capital spending by the Air National Guard about 80 jobs that are supported by $5.59 million in labor income. Somewhat more wealth is generated beyond labor income to yield a gross annual GDP total of $9.19 million from the capital spending

Table 4.5: New Jersey Air National Guard, Capital Spending, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	10,000.0	8,302.0	18,302.0
Employment	34	47	80
Earnings ($1,000)	2,601.3	2,992.7	5,593.9
GDP ($1,000)	3,977.8	5,211.7	9,189.4

4.1.5.3.*Total Economic Impacts Operations and Capital Spending* Combined. As can be observed from the above, the economic impacts of outside construction contractors for the Air National Guard are, comparatively speaking, inconsequential. So, as can be seen from Table 4.5, Air National Guard activity in New Jersey is well represented by its operations alone. In net, it adds $109.6 million to the New Jersey's economy annually, supporting nearly3,000 jobs that generate $165.3 million in wealth.

Table 4.5: New Jersey Air National Guard, Capital Spending, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	109,555.7	111,407.9	220,963.6
Employment	2,376	606	2,981
Earnings ($1,000)	71,828.0	35,587.5	107,415.4
GDP ($1,000)	102,377.9	62,939.7	165,317.5

4.2. Army National Guard

More than 75 percent of New Jersey's 6,000 Army National Guardsmen are assigned to three organizations: 50th Infantry Brigade Combat Team, 42nd Regional Support Group, and 57th Troop Command.

4.2.1. **The 50th Infantry Brigade Combat Team** contains the bulk of soldiers in the NJARNG with over 50 percent of the state's troop strength (about 3,000 Soldiers) and equipment it provides the ability to respond to civil support missions across the range from natural disaster to full-spectrum homeland security missions.

4.2.2. **The 42nd Regional Support Group** (RSG) consists of elements that control and enable logistical support, to include distribution, transportation, finance and also military police and chemical, biological, radiological and nuclear response.

4.2.3. **The 57thTroopCommand** provides command and control for several logistical, administrative, and aviation units in the New Jersey Army National Guard; provides emergency response for floods and similar disasters along the New Jersey coast, including 16 UH-60 Blackhawk helicopters. The Command has subordinate battalions that perform a variety of services or combat roles, namely the 119th Corps Support Battalion in Hammonton, New Jersey, and the 1-150thGeneral Support Aviation Battalion at the Trenton-Mercer Airport, West Trenton, New Jersey. The 57thalso has a Headquarters Detachment, which is responsible for pay, administration, and training for the command headquarters.

4.2.4. **The 245th Regiment (Combat Army**), based at Fort Dix, programs and provides institutional training within assigned Career Management Fields (CMF's), Noncommissioned Officer Education System (NCOES), MOS-T and Officer Candidate School (OCS) missions based on the requirements identified by NGB-TR-I (Individual Training Branch), the Army Program for Individual Training (ARPRINT), the United States Army Reserve (USAR), and the Active Component (AC) in support of the Army's Modular Force. The Regiment trains Soldiers in response to the Army's current needs and Operational environment (OE). Additionally, it provides operational, training, administrative, logistical, and resource management support as required to accomplish the mission to train Soldiers.

4.2.5. **The 63rd Army Band** is stationed at the National Guard Training Center in Sea Girt, New Jersey. Like every other Army band, the 63rdpromotes readiness by performing music that enhances troop morale and unit esprit; provides music for troop gatherings and activities, military and religious ceremonies, and civilian affairs such as parades and other public events.

4.2.6. **Total Spending.** In 2012 The Army National Guard had a budget of about $232.8 million. Dominating this sum was the group's military payroll bill, which at $109.3 million employed 1,019 full-time personnel. These employees include 462 technician personnel and 525 Active Guard and Reserve military personnel. Of course the end

strength of the Army National Guard is somewhat more than this, totaling 6,101at the end of 2012. The Construction aspect of the budget ($49 million) is designated for a single building at the Lakehurst Naval Air Center. About 88 percent of the budget was for actual construction, the balance was for soft costs (design and oversight).

Table 4.6:General Budget of the New Jersey Army National Guard, 2012

Payroll	No. of Employees	Amount
National Guard Army Personnel	1,019	$109,286,164
Operation& Maintenance	-	$74,543,183
Construction	-	$49,000,000
Total	-	$232,829,348

4.2.7. **Operations and MaintenanceSpending.** In addition to the military payroll, civilian employees in Army uniform whose payroll totals $35 million are included in the Operations and Maintenance, Army National Guard costs of $74.5 million. Note further that about $1.5 million were awarded to New Jersey service vendors in pursuance of the federal procurement goals centered around awarding to small disadvantaged and minority owned, woman-owned and veteran-owned businesses. The businesses that received these awards are not necessarily New Jersey-based. But many out-of-state recipient vendors used sources within New Jersey to fill the military resourcing requirements.

Table 4.7: New Jersey Army National Guard Nonmilitary-Payroll Operating and Maintenance Spending Estimates, 2012

Nature of Expenditure	No. of Employees	Amount
O&M Civilian Payroll	550	$34,786,819
Equipment, Parts and Supplies	-	15,902,546
Contracted Services	-	1,490,864
Supplies and Services	-	22,362,955
Total		$74,543,183

4.2.8. Economic Impacts of the Army National Guard

4.2.8.1.*Economic Impacts of Operations and Maintenance Spending.* The data provided and as displayed in Section 4.2.4 were entered into the R/ECON™ I-O model. Table 4.8 summarizes the results. The direct effects (the first data column) of the base's operations in terms of jobs and earnings reflect the data from Section 4.2.4. About 1,569 reservists on base yield about another 1,113 jobs via multiplier effects elsewhere in New Jersey's economy for a total of over 2,682 jobs contributed to the state's economy by New Jersey

Army National Guard operations. This does not include the full reserve strength, which is largely recorded under the Joint Base section of this report (Section 1, Table 1.2). That is, the job count here mostly identified full time reservists, technicians, and civilians. In aggregate the 1,569 reservists received $144.1 million in labor income (earnings) generated directly by operational activity on the base. That is, they were paid an average of about just $91,825. This is nearly 50 percent more than the state's average pay rate. Meanwhile the indirect jobs supporting this effort are estimated to have been paid on the order of $63,600 per jobs—about the state average pay rate. Thus, the $144.1 million the reservists were paid supports another $70.8 million in labor income statewide. Thus, the Air National Guard operations contribute a total of about $214.9 million in labor income to the state's economy on an annual basis. At $296.5 million, the contribution of the Air National Guard operations to New Jersey's economy in terms of GDP is almost 27 percent more than that of just labor income, which is a component of GDP.

Table 4.8: Operating and Maintenance Impacts of the New Jersey Army National Guard, 2012

Indirect & Direct effects	Induced effects	Total	
Output ($1,000)	183,829.3	221,018.8	404,848.1
Employment	1,569	1,113	2,682
Earnings ($1,000)	144,073.0	70,778.0	214,851.0
GDP ($1,000)	169,486.9	126,975.2	296,462.1

4.2.8.2.*Economic Impacts of Capital Spending.* As discussed in Section 4.2.4 and shown in Table 4.6, an average of $49.0 million in capital spending has been spent annually on capital projects by New Jersey's Army National Guard recently. Table 4.9 shows that directly employs on the order of just 72 New Jersey workers in construction and related activities with aggregate earnings of about $4.9 million—about $67,500 in annual pay per job, which is somewhat above the state average pay per job of $62,900. These direct jobs supported another 136 jobs indirectly making in aggregate $8.9 million annually. Thus, the annual capital spending by the Air National Guard about 208 jobs that are supported by $13.7 million in labor income. Somewhat more wealth is generated beyond labor income to yield a gross annual GDP total of $23.0 million from the capital spending

Table 4.9: Total Economic Impacts of Capital Spending by the New Jersey Army National Guard, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	49,000.0	33,364.1	82,364.1
Employment	72	136	208
Earnings ($1,000)	4,859.9	8,880.4	13,740.3
GDP ($1,000)	7,308.4	15,653.4	22,961.8

4.2.8.3.*Total Economic Impacts Operations and Capital Spending Combined.* While at $49.0 million the activity of outside construction contractors for the Army National Guard is not inconsequential, it is still a relatively small contribution compared to that of the Guard's operations. So, as can be seen from a comparison of Table 4.10 to Table 4.8, the Army National Guard activity in New Jersey is generally well represented by its operations alone. In net, the Guard injects $232.84 million into New Jersey's economy annually, supporting just nearly 2,900 jobs that generate $319.4 million in wealth.

Table 4.10: Total Economic Impacts of All Spending by the New Jersey Army National Guard, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	232,829.3	254,382.9	487,212.2
Employment	1,641	1,249	2,890
Earnings ($1,000)	148,932.9	79,658.4	228,591.3
GDP ($1,000)	176,795.3	142,628.6	319,423.9

5. COAST GUARD INSTALLATIONS

The Fifth Coast Guard District is responsible for ensuring the safety and security of the oceans, coastal areas, and marine transportation system within America's Mid-Atlantic Region. New Jersey is at the northernmost reach of its maritime jurisdiction. Within New Jersey the Coast Guard has a few units. Training Center (TRACEN) Cape May is the most notable among them, although administratively speaking the Sector Field Office (SFO) in Atlantic City is more critical. Coast Guard units that report to the Atlantic City SFO are also stationed at Atlantic City, Beach Haven, Cape May, Fortesque, Manasquan, Ocean City, Shark River (Avon-by-the-Sea), and Townsend's Inlet (Avalon). The other main unit of the Coast Guard located within New Jersey is the Loran Support Unit, which as its name might suggest supports Long Range Navigation for private and military vessels and craft.

5.1. *Atlantic City Sector Field Office and Air Station*

The U. S. Coast Guard SFO and Air Station is located in Atlantic County at the Atlantic City International Airport along with the Federal Aviation Administration Technical Center. The Air Station supports the wide range of Coast Guard operations, such as search and rescue using MH-65D Dolphin Helicopters, law enforcement, port security, and marine environmental protection for both District One and District Five, encompassing the coastlines of Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland and Virginia including interior bays and rivers such as the Chesapeake, Delaware, Hudson and Long Island Sound. Several tenant commands also have components located at the Air Station, including the Electronics Systems Support Detachment Atlantic City.

5.1.1. **Station Atlantic City.** The Station is manned by 52 active-duty crew members as well as 22 enlisted reservists. The unit draws support from five Coast Guard Auxiliary Flotillas. It provides search and rescue, law enforcement, and environmental protection for an area of approximately 250 square miles of ocean, backbays and inlets. It does so with five rescue craft. Two of the craft are 21' and 23' SafeBoats. The two others are a 41' Utility Boat and a 47' Motor Life Boat. The unit also operates a seasonal rescue station at Station Great Egg in nearby Ocean City, New Jersey. Together the two units conduct about 400 search and rescue cases per year.

5.1.2. **Station Cape May.** With about 67 full-time equivalent personnel members, Cape May is one of the largest small boat Coast Guard stations on the East Coast with a large contingent of reserve personnel. As one of fourteen tenant commands located on TRACEN Cape May, the Station is housed in a new multi-mission building that sits on the waterfront of Cape May harbor. Station Cape May is equipped with two 45' Response Boat Mediums (RB-M), four 25' Response Boat Smalls(RB-S), and one 24' Special Purpose Craft –Shallow Water (SPC-SW) to accomplish its vast array of missions in the Delaware Bay, Atlantic Ocean and Intracoastal Waterways of New Jersey. Station Cape May annually performs over 70 search and rescue cases, 1,000 law enforcement boardings, and 3,300 underway hours. Stations Fortesque and Townsend's Inlet are under the command of Station Cape May. Located in Fortescue, New Jersey, Station Fortescue is responsible for the waters of Delaware Bay that exists south of a line drawn across Delaware Bay at Bombay Hook, Delaware, to a line drawn across the Bay from Bowers Beach, DE, to Reeds Beach, New Jersey. Located at Townsends Inlet, New Jersey, Station Townsends Inlet is responsible for the intracoastal waterway and waters off the coast of New Jersey.

5.1.3. **Station Barnegat Light.** Guardians of the Barnegat Shoals, Station Barnegat Light provides assistance to boaters who have trouble navigating the strong waves and shifting sands of the inlet. This station has primary missions are search and rescue and law enforcement but it also performs recreational boating safety, pollution response, and short range aids to navigation with heavy activity during the summer months. Station Beach Haven is under the command of Station Barnegat Light.

5.1.4. **Station Manasquan.** Coast Guard Station Manasquan Inlet has a crew of 30, who respond to about 600 search and rescue cases a year. The station's missions are search and rescue, law enforcement, and recreational boating safety. The station's area of responsibility is from Spring Lake to Seaside Heights in New Jersey (up to 48 miles offshore) and from the Manasquan River entrance to Toms River, New Jersey, plus all of Barnegat Bay in that area. The Manasquan Inlet is home to a fleet of commercial fishing and charter boats, plus it also is the Northern terminus of the Intracoastal Waterway

5.1.5. **Training Center Cape May.** Coast Guard Training Center (TRACEN) Cape May is the only enlisted accession point for the United States Coast Guard. It employs about 276

full-time equivalent personnel. In addition, TRACEN provides logistical support to twelve tenant commands that perform a number of operational and support missions for the Coast Guard including Search and Rescue; Military Readiness; Port & Environmental Safety; Commercial Vessel Safety; Enforcement of Laws & Treaties; Marine Environmental Response; Military Readiness; Recreational Boating Safety; and Waterways Management. In addition to Coast Guard Station Cape May, TRACEN also houses the Company Commander School and Recruiter School, plus it is the home port for the cutters Vigorous, Dependable, Finback, Ibis, and Mako. Vigorous and Dependable are 210-foot Reliance Class medium endurance cutters, which frequently make trips to the Caribbean. They are each manned with 77 crew members. Finback, Mako, and Ibis are 87-foot "Marine Protector" class patrol boats (WPB). Since September 11, 2001, their Homeland Security mission has been vital. All three WPBs normally patrol within 100 miles of Cape May, roughly from New York City to the Chesapeake Bay. They each are manned by 11 crew members.

5.1.6. **Health, Safety and Work-Life Regional Practice Cape May.** The mission of the Coast Guard Health Services Center (HSWL RP) Cape May is to provide medical, dental, and health care to active duty and reserve members in support of Coast Guard missions. It is manned by about 90 staff members.

5.1.7. **Aids to Navigation Team Cape May.** The Cape May Aids to Navigation Team (ANT) is responsible for approximately 720 Aids, 213 buoys, 230 lights, 10 Lighthouses, 719 dayboards, and 375 miles of waterway. Its area of responsibility runs from Shark River, New Jersey, to Indian River, Delaware. The unit operates a 49-foot Boat Utility Stern Loading (BUSL) and two 26' Trailerable Aids to Navigation Boats (TANBs). About 22 members comprise the staff of ANT.

5.1.8. **Investigative Services Cape May.** The Coast Guard Investigative Service (CGIS) is a centralized directorship managed by a professional criminal investigator who reports to the Assistant Commandant for Intelligence. The Coast Guard Investigative Service, therefore, officially is located outside the Coast Guard's operational chain of command. CGIS has a staff of two.

5.1.9. **Industrial Support Detachment Cape May.** Industrial Support Detachments in the Coast Guard typically are divided into two shops; one dedicated to naval support and includes industrial in-house prototype and parts fabrication capabilities and another one dedicated to aids to navigation (buoys, day beacons and lights, ranges, and lighthouses) and shore-side structural support. Cape May's facility houses 11 personnel.

5.1.10. **Electronic Support Detachment Cape May.** The Electronic Support Detachment (ESD) is responsible for organizational level maintenance and repairs on all Coast Guard standard command, control, communications, computers, and information technology (C4IT) systems. The ESD in Cape May is composed of 12 full-time staff members.

5.2. *Loran Support Unit*

Loran Support Unit is located in Wildwood, New Jersey, and is operated by the US Coast Guard. The unit is responsible for Long Range Navigation Systems (LRNS) and supports the Western Coast. The unit is responsible for navigating the ships and vessels in the western US waters. It does not only support the US Coast Guard but all the ships and aircrafts in the area, including the private ones.

5.3. *Operating and Maintenance Costs*

The Coast Guard is the largest employer in Cape May County, employing about 700 military and civilian personnel totaling nearly $50M in annual payroll in Fiscal Year 2011. All 700 personnel are assumed to reside in southern New Jersey. This job count does not include an estimated 150 year-round contract and Contractor Support Services employees who work at the Training Center in Cape May.

Table 5.1: Military and Civilian Personnel and Payroll Affiliated with Coast Guard Units in New Jersey

Employment	Number	Amount
Military	628	$42,941,108
Civilian	72	$6,816,750
Total	700	$49,757,858

Table 5.2: Summary of Coast Guard Operations Costs in New Jersey by Unit, Fiscal Year 2010-2011

Unit	FY10	FY11	Average
Station Cape May	$509,543	$559,378	$534,460
Aids to Navigation Team Cape May	141,557	100,872	121,214
Cutter FINBACK	33,884	47,727	40,806
Cutter IBIS	87,087	450,924	269,005
Cutter MAKO	60,125	69,900	65,013
Industrial Support Detachment	17,864	12,970	15,417
Electronics Support Detachment Cape May	22,376	20,477	21,426
Investigative Service Cape May	26,194	26,549	26,371
Cutter VIGOROUS	1,180,379	924,174	1,052,276
Cutter DEPENDABLE	1,002,400	1,202,852	1,102,626
Training Center Cape May	9,493,413	11,177,580	10,335,497
Medical Facility (HSWL RP Cape May)	1,840,408	2,210,884	2,025,646
Units Outside of Cape May	8,170,300	13,087,314	10,628,807
Total	$22,585,529	$29,891,600	$26,238,564

Table 5.3: Summary of Coast Guard Operations Costsin New Jersey by Type of Expenditure

Expenditure Item	FY2010	FY2011	Average
Travel	325,733	261,649	300,333
Telecomm	40,233	36,027	51,879
Utilities	2,496,580	2,356,277	2,462,554
Vehicles	237,674	260,399	240,486
Energy	1,519,576	1,675,612	2,231,447
Supplies/Services	6,902,224	9,669,633	8,087,351
Contracts	11,063,509	15,632,003	13,384,557
Total	22,585,529	29,891,600	26,758,607

5.4. *Capital Expenditures*

During the last five years only one major capital investment project was undertaken and it was at the Training Center Cape May. It was the construction of a new multi-mission building that houses both Station Cape May and the Aids to Navigation Team (ANT) Cape May. Construction costs of the multi-mission building are as below:

Table 5.3: Approximate Capital Spending by the Coast Guard in New Jersey in 2012

Task	Amount
Construction	10,607,997
Design	750,000
Electronic Outfitting	93,114
Inspection services	245,472
Total	11,696,583

5.5. ***Community Service***

The Coast Guard actively participates in serving the community through a variety of volunteer activities that include Food Banks, Habitat for Humanity and Life Rolls On. In particular, members from this area are especially impactful through the Partnership in Education Program. During the 2010-2011 school year, over 300 members devoted 1,700 hours to support 33 partner schools and organizations reaching over 6,000 students.

In Addition, the coast guard impacts the local economy and supports the community through the Training Center Cape May that hosts approximately 41,000 visitors annually. These visitors come to the Center from every corner of the United States to observe their loved one graduate from Recruit Basic Training. As the Coast Guard Training Center operates year round, their presence in the Cape May community is beneficial to the local economy, especially during the tourist off-season.

It is estimated that approximately 250 spouses work in the NJ area. An estimated 70 percent of the 700 Coast Guard employees have spouses and it is further estimated that approximately 50 percent of those spouses work in the NJ area.

Spending by Retirees. Training Center Cape May has a small Coast Guard Exchange and several recreational activities that sell goods and services to a variety of customers other than Coast Guard employees. In total, these other groups contribute an estimated $1.7 million to sales onboard the base annually.

Services by Families. The services performed by military families at Naval Weapons station Earle, include community services, environment improvements, response to civilian calls for assistance in various projects; and celebrations in commemoration of a number of events.

5.6. *Total Economic Impacts of the Coast Guard in New Jersey*

5.6.1. **Economic Impacts of Operations and Maintenance Spending.** The data provided and as displayed in Section 5.4 were entered into the R/ECON™ I-O model. Table 5.4 summarizes the results. The direct effects (the first data column) of the base's operations in terms of jobs and earnings reflect the data from Section 4.2.4. About 700 Coast Guard staff yield about another 288 jobs via multiplier effects elsewhere in New Jersey's economy for a total of over 988 jobs contributed to the state's economy by Coast Guard operations. In aggregate, Coast Guard personnel received $50.0 million in labor income (earnings) generated directly by operational activity on the base. That is, they were paid an average of about $71,000. This is nearly 12 percent more than the state's average pay rate. Meanwhile the indirect jobs supporting this effort are estimated to have been paid on the order of $60,150 per job—just under the state average pay rate. Thus, the $50.01 million Coast Guard staff were paid supports another $17.3 million in labor income statewide. So, Coast Guard operations contribute a total of about $67.1 million in labor income to the state's economy on an annual basis. At $83.5 million, the contribution of Coast Guard operations to New Jersey's economy in terms of GDP is almost 24 percent more than that of just labor income, which is a component of GDP.

Table 5.4: Operating and Maintenance Impacts of the Coast Guard, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	53,362.0	55,974.4	109,336.4
Employment	700	288	988
Earnings ($1,000)	49,757.8	17,325.0	67,082.8
GDP ($1,000)	52,026.3	31,463.3	83,489.6

5.6.2. **Economic Impacts of Capital Spending.** As discussed in Section 5.4 and shown in Table 5.3, an average of $11.7 million in capital investment funds has been spent annually on projects by the U.S. Coast Guard in New Jersey recently. Table 5.5 shows that directly employs on the order of just 28 New Jersey workers in construction and related activities with aggregate earnings of about $1.7 million—about $61,500 in annual pay per job, which is very close to the state average pay per job of $62,900. These direct jobs supported another 42 jobs indirectly making in aggregate $2.7 million annually.

Thus, the annual capital spending by the Coast Guard about 70 jobs that are supported by $4.4 million in labor income. Somewhat more wealth is generated beyond labor income to yield a gross annual GDP total of $7.4 million from the capital spending.

Table 5.5: Impacts of Capital Spending by the Coast Guard, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	11,696.6	6,447.0	18,143.6
Employment	28	42	70
Earnings ($1,000)	1,722.3	2,692.0	4,414.3
GDP ($1,000)	2,669.9	4,756.9	7,426.8

5.6.3. **Total Economic Impacts Operations and Capital Spending Combined.** Coast Guard activity in New Jersey amounted to about $65.1 million in 2012. This supported 1,058 jobs that generate $90.9 million in wealth for New Jerseyans.

Table 5.6: Total Economic Impacts of All Spending in New Jersey by the U.S. Coast Guard, 2012

	Direct effects	Indirect & Induced effects	Total
Output ($1,000)	65,058.6	62,421.4	127,480.0
Employment	728	330	1,058
Earnings ($1,000)	51,480.1	20,017.0	71,497.1
GDP ($1,000)	54,696.2	36,220.2	90,916.4

IV. CONCLUSIONS

New Jersey receives 78 cents on each dollar sent by its taxpayers to Washington, D.C. Major federal assets in New Jersey are the military bases that remain. While their presence has declined significantly in recent decades, the bases continue to contribute substantially to the New Jersey's economy. Exhibit III shows that the federal government spends nearly $5 billion within New Jersey in support of these military installations. This level of spending supports just more than 45,600 jobs, just more than $2.6 billion in labor income, and about $3.8 billion in GDP. This employment level is comparable to the presence within the state of either the telecommunications or chemical industries.

Exhibit III shows the amount of New Jersey economic activity in the state's military installations. Joint Base McGuire-Dix-Lakehurst maintains the lion's share of on-base military activity. With employment of 35,395, it retains 77.6 percent of all base employment in the State. It also supports 68.3 percent of the labor income generated on New Jersey bases annually. Picatinny Arsenal is the next largest installation with nearly 5,200 jobs on base, followed by New Jersey's Air and Army National Guards. The U.S. Coast Guard and Naval Weapons Station Earle shore up the set.

Exhibit III. Direct Effects of New Jersey's Military Installations, 2012

Base	Output ($1,000)	Employment	Earnings ($1,000)	GDP ($1,000)
Joint Base	2,938,939.0	35,395	1,757,075.0	2,533,137.0
Picatinny	1,455,612.3	5,196	527,270.2	913,627.2
Earle	32,532.2	295	17,628.7	25,092.7
Air Guard	109,555.7	2,376	71,828.0	102,377.9
Army Guard	232,829.3	1,641	148,932.9	176,795.3
Coast Guard	65,058.6	728	51,480.1	54,696.2
Total	4,834,527.1	45,631	2,574,214.9	3,805,726.3

The bases interact with New Jersey's economy in many ways. Minimally base personnel and their families spend their incomes off base for entertainment, amusement, tourism, and specialized services. Others live off base, buy or rent homes, eat out at local restaurants, attend schools, and undertake behavior that parallels the core of the state's consumer economy. Further still, the military relies on contractors that purchase goods and services from other state-based

suppliers, including wholesale establishments and manufacturers. This all leads to additional spending that permeates the State's economy in the form of what has become known as "the multiplier effect." Exhibit IV shows the size if the multiplier effects from New Jersey's on-base activity. They are also quite substantial in magnitude.

Exhibit IV: Indirect and Induced Impacts (Multiplier Effects) of New Jersey's Military Installations, 2012

Base	Output ($1,000)	Employment	Earnings ($1,000)	GDP ($1,000)
Joint Base	2,996,361.00	16,594	958,441.00	1,687,233.00
Picatinny	1,334,147.40	8,638	394,078.40	794,780.90
Earle	35,754.90	186	11,127.50	19,624.50
Air Guard	111,407.9	606	35,587.5	62,939.7
Army Guard	254,382.90	1,249	79,658.40	142,628.60
Coast Guard	62,421.40	330	20,017.00	36,220.20
Total	4,794,475.5	27,603	1,498,909.8	2,743,426.9

In the main, however, the multiplier effects are smaller than the more readily defined direct effects that largely exist on base. As discussed in the main body of this report, such multiplier effects tends to be measured using an economic impact model. For this report, the study team used the R/ECON™ I-O model for the State of New Jersey to measure them.

Note in Exhibit V the somewhat stronger multiplier effects emanating from Picatinny compared to other installations. This is due to the R&D nature of Picatinny Arsenal: it pays more per job and thereby enables more disposable income to be spent within the state. It also has a number of private contractors who are located off –base, but nearby. These contractors engaged even more heavily than does the federal government with the local economy and, thereby, enable the base's substantially larger multiplier effects. Weapons Station Earle and the National Guard exhibit the next strongest effects. This is likely due to the relatively large share the=at capital spending maintains annually within these installations.

Exhibit V: Multiplier Effects as a Share of Total Effects of New Jersey's Military Installations, 2012

Base	Output	Employment	Earnings	GDP
Joint Base	50.5%	31.9%	35.3%	40.0%
Picatinny	47.8%	62.4%	42.8%	46.5%
Earle	52.4%	38.7%	38.7%	43.9%
Air Guard	50.8%	19.5%	32.4%	37.3%
Army Guard	52.2%	43.2%	34.8%	44.7%
Coast Guard	49.0%	31.2%	28.0%	39.8%
Total	49.8%	37.7%	36.8%	41.9%

Exhibit VI displays the total economic impacts of each of the installations as well as their combined totals. The $4.8 billion in annual federal spending displayed in Exhibit III resultsin $6.5 billion in net wealth added to the state (as GDP). Of this GDP total, over $4.0 billion is in the form of labor income that supports an estimated 73,234 jobs. While less than employment the state's large insurance industry, it is more than the combined employment of the state's communications and chemical industries.

Exhibit VI: Multiplier Effects as a Share of Total Effects of New Jersey's Military Installations, 2012

Base	Output ($1,000)	Employment	Earnings ($1,000)	GDP ($1,000)
Joint Base	5,935,300.0	51,989	2,715,516.0	4,220,370.0
Picatinny	2,789,759.7	13,834	921,348.6	1,708,408.1
Earle	68,287.1	481	28,756.2	44,717.2
Air Guard	220,963.6	2,982	107,415.5	165,317.6
Army Guard	487,212.2	2,890	228,591.3	319,423.9
Coast Guard	127,480.0	1,058	71,497.1	90,916.4
Total	9,629,002.6	73,234	4,073,124.7	6,549,153.2

The point made in this study is that the military's presence within the State of New Jersey is a substantial one. Having shed many such facilities in the not too distant past, the State not only is now leaner but also retains less than 78 percent of the tax dollars that its businesses and households sends annually to Washington, D.C. Thus maintaining and expanding this military core is not just critical to the state's homeland security missions but also for its continued economic welfare.

APPENDIX A: THE FEDERAL GOVERNMENT'S DEBT TO NEW JERSEY

For decades, New Jersey has consistently been among the largest "donor" states in the nation.[5] "Donor" states are those states that pay more money to the federal government in federal income and other taxes than they receive in federal spending on grants, contracts, federal employee compensation, retirement and disability, and other federally funded programs. In fiscal year 2010, New Jersey ranked 48th among the 50 states in the ratio of federal spending received to federal taxes paid.[6] The state received $0.78 in federal expenditures for each dollar paid in federal taxes. Only Minnesota ($0.68) and Delaware ($0.60) ranked lower. This is in contrast to top beneficiary states such as Hawaii and Mississippi, which ranked 1st and 2nd, receiving $3.65 and $3.42 in federal funds, respectively, for each dollar paid in federal taxes. The ratio of federal spending to federal taxes paid for each of the 50 states, and their associated rankings, are presented in Table A1.

In absolute terms, in fiscal year 2010 New Jersey ranked last among the 50 states in terms of net flow of federal funds (i.e., federal tax payments less federal spending received). The state paid $22.9 billion more in taxes to the federal government than it received in federal expenditures (see Table A2). To put this lack of parity in perspective, the total local property tax levy (including municipal, county, and school components) in New Jersey in calendar year 2010 was just over $24 billion.[7] The school property tax has, of course, been a much debated issue within New Jersey. Indeed, several proposals for property tax reform were put forward in 2006 (see, e.g., Regional Plan Association, 2006).[8]

Of course, for its size New Jersey has a surprising large population, so that when normalized on this basis its net outflow status with the Federal government might not loom so large. The results of this normalization are shown in Table A3. On a per capita basis, New Jersey also

[5]See the last report by the Tax Foundation. 2007. "Federal Taxes Paid vs. Federal Spending Received by State, 1981-2005," last accessed in April 2011 at http://www.taxfoundation.org/taxdata/show/22685.html.

[6] This measure is based on a comparison of gross federal tax collections as reported by the Internal Revenue Service to total federal government expenditures as reported by the U.S. Census Bureau. No additional adjustments are made to the figures as reported.

[7]New Jersey Department of Community Affairs, Division of Local Government Services. See http://www.nj.gov/dca/lgs/taxes/09_data/09taxes.xls.

[8] See for example Chris Jones and Alex Perrotta with assistance from Sasha Corchado. 2006. "Fundamental Property Tax Reform II: A Guide for Evaluating Proposals," Regional Plan Association: New York. Last accessed In February 2011 at http://www.rpa.org/pdf/RPAproptax050206.pdf.

ranked near the bottom (48th) in 2009, sending a net flow of $2,630 per resident to the federal government.

TABLE A1. Ratio of Federal Dollars Received from to Federal Dollars Sent to Washington, D.C. by State, 2010

Rank	State	Ratio	Rank	State	Ratio
1	Hawaii	3.65	26	Oklahoma	1.54
2	Mississippi	3.42	27	Missouri	1.53
3	New Mexico	3.35	28	Indiana	1.45
4	West Virginia	3.13	29	Utah	1.45
5	Alaska	3.04	30	Georgia	1.41
6	Alabama	2.72	31	Louisiana	1.39
7	Virginia	2.65	32	Nevada	1.37
8	Montana	2.64	33	Washington	1.37
9	South Carolina	2.63	34	New Hampshire	1.36
10	Maine	2.33	35	North Carolina	1.34
11	Idaho	2.17	36	California	1.31
12	Kentucky	2.15	37	Pennsylvania	1.27
13	Vermont	2.11	38	Colorado	1.24
14	North Dakota	2.09	39	Massachusetts	1.20
15	Maryland	2.07	40	Texas	1.13
16	Arizona	1.95	41	Arkansas	1.06
17	South Dakota	1.94	42	Rhode Island	1.06
18	Kansas	1.70	43	Ohio	1.04
19	Iowa	1.67	44	Nebraska	1.02
20	Michigan	1.64	45	New York	1.01
21	Wyoming	1.64	46	Illinois	1.00
22	Florida	1.59	47	Connecticut	0.95
23	Wisconsin	1.59	48	New Jersey	0.78

24	Tennessee	1.56	49	Minnesota	0.68
25	Oregon	1.55	50	Delaware	0.59

Sources: *Internal Revenue Service Data Book, 2010, Publication 55B, March 2011; Consolidated Federal Funds Report for Fiscal Year 2010: State and County Areas, U.S. Census Bureau, August 2011.*

TABLE A2. Net Income from the Federal Government (Revenues minus Expenditures) by State 2010

Rank	State	Ratio	Rank	State	Ratio
1	Virginia	96,955,719	26	Oklahoma	13,218,590
2	California	81,101,609	27	Oregon	11,857,357
3	Florida	65,527,191	28	Iowa	11,754,593
4	Maryland	47,670,016	29	Alaska	9,544,843
5	Michigan	35,952,311	30	Colorado	9,321,392
6	Alabama	34,580,578	31	Maine	8,136,201
7	Arizona	30,656,774	32	Idaho	8,038,368
8	South Carolina	29,097,397	33	Montana	6,788,989
9	Pennsylvania	29,073,021	34	Utah	6,431,161
10	Kentucky	26,698,304	35	Nevada	5,123,424
11	Texas	26,586,488	36	South Dakota	4,610,174
12	Tennessee	24,498,061	37	North Dakota	4,502,057
13	Georgia	24,430,749	38	Ohio	4,336,656
14	Missouri	23,632,000	39	Vermont	3,725,373
15	Mississippi	23,244,879	40	New Hampshire	3,104,162
16	Wisconsin	22,637,637	41	Wyoming	2,444,309
17	North Carolina	21,481,748	42	Arkansas	1,574,732
18	New Mexico	19,283,185	43	New York	1,528,084
19	Indiana	19,040,146	44	Rhode Island	607,795
20	Washington	17,972,280	45	Nebraska	325,600
21	Hawaii	17,862,408	46	Illinois	-60,852
22	Kansas	14,330,646	47	Connecticut	-2,095,141
23	Massachusetts	13,781,921	48	Delaware	-5,546,353
24	West Virginia	13,475,736	49	Minnesota	-21,955,589
25	Louisiana	13,474,152	50	New Jersey	-22,901,696

Sources: *Internal Revenue Service Data Book, 2010, Publication 55B, March 2010; Consolidated Federal Funds Report for Fiscal Year 2010: State and County Areas, U.S. Census Bureau, August 2011.*

TABLE A3. Per Capita Net Income from the Federal Government (Revenues minus Expenditures) by State 2010

State	$	Rank	State	$	Rank
Hawaii	13,791	1	Florida	3,535	26
Alaska	13,665	2	Oregon	3,099	27
Virginia	12,300	3	Louisiana	3,000	28
New Mexico	9,595	4	Indiana	2,964	29
Maryland	8,364	5	Washington	2,697	30
Mississippi	7,874	6	Georgia	2,486	31
West Virginia	7,405	7	New Hampshire	2,344	32
Alabama	7,344	8	Utah	2,310	33
Montana	6,963	9	Pennsylvania	2,307	34
North Dakota	6,960	10	North Carolina	2,290	35
South Carolina	6,379	11	California	2,194	36
Kentucky	6,189	12	Massachusetts	2,090	37
Maine	6,172	13	Nevada	1,938	38
Vermont	5,992	14	Colorado	1,855	39
South Dakota	5,675	15	Texas	1,073	40
Idaho	5,200	16	Rhode Island	577	41
Kansas	5,084	17	Arkansas	545	42
Arizona	4,648	18	Ohio	376	43
Wyoming	4,491	19	Nebraska	181	44
Wisconsin	4,003	20	New York	78	45
Missouri	3,947	21	Illinois	(5)	46
Iowa	3,908	22	Connecticut	(596)	47
Tennessee	3,891	23	New Jersey	(2,630)	48
Michigan	3,606	24	Minnesota	(4,169)	49
Oklahoma	3,585	25	Delaware	(6,266)	50

Sources: *Internal Revenue Service Data Book, 2010, Publication 55B, March 2011; Consolidated Federal Funds Report for Fiscal Year 2010: State and County Areas, U.S. Census Bureau, August 2011.*

APPENDIX B: INPUT-OUTPUT MODELING AND THE R/ECON™ INPUT-OUTPUT MODEL

This appendix discusses the history and application of input-output analysis and details the input-output model, called the R/ECON™ I-O model, developed by Rutgers University. This model offers significant advantages in detailing the total economic effects of an activity (such as historic rehabilitation and heritage tourism), including multiplier effects.

ESTIMATING MULTIPLIERS

The fundamental issue determining the size of the multiplier effect is the "openness" of regional economies. Regions that are more "open" are those that import their required inputs from other regions. Imports can be thought of as substitutes for local production. Thus, the more a region depends on imported goods and services instead of its own production, the more economic activity leaks away from the local economy. Businessmen noted this phenomenon and formed local chambers of commerce with the explicit goal of stopping such leakage by instituting a "buy local" policy among their membership. In addition, during the 1970s, as an import invasion was under way, businessmen and union leaders announced a "buy American" policy in the hope of regaining ground lost to international economic competition. Therefore, one of the main goals of regional economic multiplier research has been to discover better ways to estimate the leakage of purchases out of a region or, relatedly, to determine the region's level of self-sufficiency.

The earliest attempts to systematize the procedure for estimating multiplier effects used the economic base model, still in use in many econometric models today. This approach assumes that all economic activities in a region can be divided into two categories: "basic" activities that produce exclusively for export, and region-serving or "local" activities that produce strictly for internal regional consumption. Since this approach is simpler but similar to the approach used by regional input-output analysis, let us explain briefly how multiplier effects are estimated using the economic base approach.

If we let **x** be export employment, **l** be local employment, and **t** be total employment, then

$$\mathbf{t} = \mathbf{x} + \mathbf{l}$$

For simplification, we create the ratio **a** as

$$\mathbf{a} = \mathbf{l/t}$$

so that $\mathbf{l} = \mathbf{at}$

then substituting into the first equation, we obtain

$$\mathbf{t} = \mathbf{x} + \mathbf{at}$$

By bringing all of the terms with t to one side of the equation, we get

$$\mathbf{t} - \mathbf{at} = \mathbf{x} \text{ or } \mathbf{t}\,(1-\mathbf{a}) = \mathbf{x}$$

Solving for **t,** we get $\mathbf{t} = \mathbf{x}/(1-\mathbf{a})$

Thus, if we know the amount of export-oriented employment, **x,** and the ratio of local to total employment, **a**, we can readily calculate total employment by applying the economic base multiplier, 1/(1-**a**), which is embedded in the above formula. Thus, if 40 percent of all regional employment is used to produce exports, the regional multiplier would be 2.5. The assumption behind this multiplier is that all remaining regional employment is required to support the export employment. Thus, the 2.5 can be decomposed into two parts the direct effect of the exports, which is always 1.0, and the indirect and induced effects, which is the remainder—in this case 1.5. Hence, the multiplier can be read as telling us that for each export-oriented job another 1.5 jobs are needed to support it.

This notion of the multiplier has been extended so that **x** is understood to represent an economic change demanded by an organization or institution outside of an economy—so-called final demand. Such changes can be those affected by government, households, or even by an outside firm. Changes in the economy can therefore be calculated by a minor alteration in the multiplier formula:

$$\Delta\mathbf{t} = \Delta\mathbf{x}/(1-\mathbf{a})$$

The high level of industry aggregation and the rigidity of the economic assumptions that permit the application of the economic base multiplier have caused this approach to be subject to extensive criticism. Most of the discussion has focused on the estimation of the parameter **a**. Estimating this parameter requires that one be able to distinguish those parts of the economy that produce for local consumption from those that do not. Indeed, virtually all industries, even services, sell to customers both inside and outside the region. As a result, regional economists

devised an approach by which to measure the *degree* to which each industry is involved in the nonbase activities of the region, better known as the industry's *regional purchase coefficient*. Thus, they expanded the above formulations by calculating for each industry ***i***

$$\mathbf{l}_i = \mathbf{r}_i\mathbf{d}_i$$

and

$$\mathbf{x}_i = t_i - \mathbf{r}_i\mathbf{d}_i$$

given that $\mathbf{d}_i$ is the total regional demand for industry ***i***'s product. Given the above formulae and data on regional demands by industry, one can calculate an accurate traditional aggregate economic base parameter by the following:

$$\mathbf{a} = \mathbf{l}/\mathbf{t} = \Sigma\mathbf{l}_{ii}/\Sigma\mathbf{t}_i$$

Although accurate, this approach only facilitates the calculation of an aggregate multiplier for the entire region. That is, we cannot determine from this approach what the effects are on the various sectors of an economy. This is despite the fact that one must painstakingly calculate the regional demand as well as the degree to which they each industry is involved in nonbase activity in the region.As a result, a different approach to multiplier estimation that takes advantage of the detailed demand and trade data was developed. This approach is called input-output analysis.

REGIONAL INPUT-OUTPUT ANALYSIS: A BRIEF HISTORY

The basic framework for input-output analysis originated nearly 250 years ago when François Quesenay published *Tableau Economique* in 1758. Quesenay's "tableau" graphically and numerically portrayed the relationships between sales and purchases of the various industries of an economy. More than a century later, his description was adapted by Leon Walras, who advanced input-output modeling by providing a concise theoretical formulation of an economic system (including consumer purchases and the economic representation of "technology").

It was not until the twentieth century, however, that economists advanced and tested Walrus's work. Wassily Leontief greatly simplified Walrus's theoretical formulation by applying the Nobel prize–winning assumptions that both technology and trading patterns were fixed over time. These two assumptions meant that the pattern of flows among industries in an area could be considered stable. These assumptions permitted Walrus's formulation to use data from a single time period, which generated a great reduction in data requirements.

Although Leontief won the Nobel Prize in 1973, he first used his approach in 1936 when he developed a model of the 1919 and 1929 U.S. economies to estimate the effects of the end of World War I on national employment. Recognition of his work in terms of its wider acceptance and use meant development of a standardized procedure for compiling the requisite data (today's national economic census of industries) and enhanced capability for calculations (i.e., the computer).

The federal government immediately recognized the importance of Leontief's development and has been publishing input-output tables of the U.S. economy since 1939. The most recently published tables are those for 1987. Other nations followed suit. Indeed, the United Nations maintains a bank of tables from most member nations with a uniform accounting scheme.

FRAMEWORK

Input-output modeling focuses on the interrelationships of sales and purchases among sectors of the economy. Input-output is best understood through its most basic form, the *interindustry transactions table* or matrix. In this table (see figure 1 for an example), the column industries are consuming sectors (or markets) and the row industries are producing sectors. The content of a matrix cell is the value of shipments that the row industry delivers to the column industry. Conversely, it is the value of shipments that the column industry receives from the row industry. Hence, the interindustry transactions table is a detailed accounting of the disposition of the value of shipments in an economy. Indeed, the detailed accounting of the interindustry transactions at the national level is performed not so much to facilitate calculation of national economic impacts as it is to back out an estimate of the nation's gross domestic product.[9]

For example, in Figure A1, agriculture, as a producing industry sector, is depicted as selling $65 million of goods to manufacturing. Conversely, the table depicts that the manufacturing industry purchased $65 million of agricultural production. The sum across columns of the interindustry transaction matrix is called the *intermediate outputs vector*. The sum across rows is called the *intermediate inputs vector*.

[9] The following section is a very brief primer on the subject of input-output analysis. For more details, please see the ultimate text on the subject by Miller and Blair (2009).

A single *final demand* column is also included in Figure B1. Final demand, which is outside the square interindustry matrix, includes imports, exports, government purchases, changes in inventory, private investment, and sometimes household purchases.

Figure B1:
Interindustry Transactions Matrix (Values)

	Agriculture	Manufacturing	Services	Other	Final Demand	Total Output
Agriculture	10	65	10	5	10	$100
Manufacturing	40	25	35	75	25	$200
Services	15	5	5	5	90	$120
Other	15	10	50	50	100	$225
Value Added	20	95	20	90		
Total Input	100	200	120	225		

The *value added* row, which is also outside the square interindustry matrix, includes wages and salaries, profit-type income, interest, dividends, rents, royalties, capital consumption allowances, and taxes. It is called value added because it is the difference between the total value of the industry's production and the value of the goods and nonlabor services that it requires to produce. Thus, it is the *value* that an industry *adds* to the goods and services it uses as inputs in order to produce output.

The value added row measures each industry's contribution to wealth accumulation. In a national model, therefore, its sum is better known as the gross domestic product (GDP). At the state level, this is known as the gross state product—a series produced by the U.S. Bureau of Economic Analysis and published in the Regional Economic Information System. Below the state level, it is known simply as the regional equivalent of the GDP—the gross regional product.

Input-output economic impact modelers now tend to include the household industry within the square interindustry matrix. In this case, the "consuming industry" is the household itself. Its spending is extracted from the final demand column and is appended as a separate column in the interindustry matrix. To maintain a balance, the income of households must be appended as a row. The main income of households is labor income, which is extracted from the value-added row. Modelers tend not to include other sources of household income in the household industry's row. This is not because such income is not attributed to households but rather because much of this other income derives from sources outside of the economy that is being modeled.

Figure B2: Direct Requirements Matrix

	Agriculture	Manufacturing	Services	Other
Agriculture	.10	.33	.08	.02
Manufacturing	.40	.13	.29	.33
Services	.15	.03	.04	.02
Other	.15	.05	.42	.22

The next step in producing input-output multipliers is to calculate the *direct requirements matrix*, which is also called the technology matrix. The calculations are based entirely on data from Figure B1. As shown in Figure B2, the values of the cells in the direct requirements matrix are derived by dividing each cell in a column of Figure B1, the interindustry transactions matrix, by its column total. For example, the cell for manufacturing's purchases from agriculture is 65/200 = .33. Each cell in a column of the direct requirements matrix shows how many cents of each producing industry's goods and/or services are required to produce one dollar of the consuming industry's production and are called *technical coefficients*. The use of the terms "technology" and "technical" derive from the fact that a column of this matrix represents a recipe for a unit of an industry's production. It, therefore, shows the needs of each industry's production process or "technology."

Next in the process of producing input-output multipliers, the *Leontief Inverse* is calculated. To explain what the Leontief Inverse is, let us temporarily turn to equations. Now, from figure 1 we know that the sum across both the rows of the square interindustry transactions matrix (**Z**) and the final demand vector (**y**) is equal to vector of production by industry (**x**). That is,

$$\mathbf{x} = \mathbf{Z}\mathbf{i} + \mathbf{y}$$

where **i** is a summation vector of ones. Now, we calculate the direct requirements matrix (**A**) by dividing the interindustry transactions matrix by the production vector or

$$\mathbf{A} = \mathbf{Z}\mathbf{X}^{-1}$$

Where $\mathbf{X}^{-1}$ is a square matrix with inverse of each element in the vector **x** on the diagonal and the rest of the elements equal to zero. Rearranging the above equation yields

$$\mathbf{Z} = \mathbf{A}\mathbf{X}$$

Figure B3: Total Requirements Matrix

	Agriculture	Manufacturing	Services	Other
Agriculture	1.5	.6	.4	.3
Manufacturing	1.0	1.6	.9	.7
Services	.3	.1	1.2	.1
Other	.5	.3	.8	1.4
Industry Multipliers	.33	2.6	3.3	2.5

where**X** is a square matrix with the elements of the vector **x** on the diagonal and zeros elsewhere. Thus,

$$\mathbf{x} = (\mathbf{AX})\mathbf{i} + \mathbf{y}$$

or, alternatively,

$$\mathbf{x} = \mathbf{Ax} + \mathbf{y}$$

solving this equation for **x** yields

$$\mathbf{x} = (\mathbf{I}-\mathbf{A})^{-1}\mathbf{y}$$

Total Output = Total Requirements * Final Demand

The Leontief Inverse is the matrix $(\mathbf{I}-\mathbf{A})^{-1}$. It portrays the relationships between final demand and production. This set of relationships is exactly what is needed to identify the economic impacts of an event external to an economy.

Because it does translate the direct economic effects of an event into the total economic effects on the modeled economy, the Leontief Inverse is also called the *total requirements matrix.* The total requirements matrix resulting from the direct requirements matrix in the example is shown in Figure B3.

In the direct or technical requirements matrix in Figure B2, the technical coefficient for the manufacturing sector's purchase from the agricultural sector was .33, indicating the 33 cents of agricultural products must be directly purchased to produce a dollar's worth of manufacturing products. The same "cell" in Figure 3 has a value of .6. This indicates that for every dollar's worth of product that manufacturing ships out of the economy (i.e., to the government or for

export), agriculture will end up increasing its production by 60 cents. The sum of each column in the total requirements matrix is the *output multiplier* for that industry.

MULTIPLIERS

A *multiplier* is defined as the system of economic transactions that follow a disturbance in an economy. Any economic disturbance affects an economy in the same way as does a drop of water in a still pond. It creates a large primary "ripple" by causing a *direct* change in the purchasing patterns of affected firms and institutions. The suppliers of the affected firms and institutions must change their purchasing patterns to meet the demands placed upon them by the firms originally affected by the economic disturbance, thereby creating a smaller secondary "ripple." In turn, those who meet the needs of the suppliers must change their purchasing patterns to meet the demands placed upon them by the suppliers of the original firms, and so on; thus, a number of subsequent "ripples" are created in the economy.

The multiplier effect has three components—direct, indirect, and induced effects. Because of the pond analogy, it is also sometimes referred to as the *ripple effect*.

- A *direct effect* (the initial drop causing the ripple effects) is the change in purchases due to a change in economic activity.
- An *indirect effect* is the change in the purchases of suppliers to those economic activities directly experiencing change.
- An *induced effect* is the change in consumer spending that is generated by changes in labor income within the region as a result of the direct and indirect effects of the economic activity. Including households as a column and row in the interindustry matrix allows this effect to be captured.

Extending the Leontief Inverse to pertain not only to relationships between *total* production and final demand of the economy but also to *change*s in each permits its multipliers to be applied to many types of economic impacts. Indeed, in impact analysis the Leontief Inverse lends itself to the drop-in-a-pond analogy discussed earlier. This is because the Leontief Inverse multiplied by a change in final demand can be estimated by a power series. That is,

$$(\mathbf{I}-\mathbf{A})^{-1}\,\Delta\mathbf{y} = \Delta\mathbf{y} + \mathbf{A}\,\Delta\mathbf{y} + \mathbf{A}(\mathbf{A}\Delta\mathbf{y}) + \mathbf{A}(\mathbf{A}(\mathbf{A}\,\Delta\mathbf{y})) + \mathbf{A}(\mathbf{A}(\mathbf{A}(\mathbf{A}\,\Delta\mathbf{y}))) + \ldots$$

Assuming that $\Delta\mathbf{y}$—the change in final demand—is the "drop in the pond," then succeeding terms are the ripples. Each "ripple" term is calculated as the previous "pond disturbance"

multiplied by the direct requirements matrix. Thus, since each element in the direct requirements matrix is less than one, each ripple term is smaller than its predecessor. Indeed, it has been shown that after calculating about seven of these ripple terms that the power series approximation of impacts very closely estimates those produced by the Leontief Inverse directly.

In impacts analysis practice, **Δy** is a single column of expenditures with the same number of elements as there are rows or columns in the direct or technical requirements matrix. This set of elements is called an *impact vector*. This term is used because it is the*vector* of numbers that is used to estimate the *economic impacts* of the investment.

There are two types of changes in investments, and consequently economic impacts, generally associated with projects—*one-time impacts* and *recurring impacts*. One-time impacts are impacts that are attributable to an expenditure that occurs once over a limited period of time. For example, the impacts resulting from the construction of a project are one-time impacts. Recurring impacts are impacts that continue permanently as a result of new or expanded ongoing expenditures. The ongoing operation of a new train station, for example, generates recurring impacts to the economy. Examples of changes in economic activity are investments in the preservation of old homes, tourist expenditures, or the expenditures required to run a historical site. Such activities are considered changes in final demand and can be either positive or negative. When the activity is not made in an industry, it is generally not well represented by the input-output model. Nonetheless, the activity can be represented by a special set of elements that are similar to a column of the transactions matrix. This set of elements is called an economic disturbance or impact vector. The latter term is used because it is thevector of numbers that is used to estimate the impacts. In this study, the impact vector is estimated by multiplying one or more economic *translators* by a dollar figure that represents an investment in one or more projects. The term translator is derived from the fact that such a vector *translates* a dollar amount of an activity into its constituent purchases by industry.

One example of an industry multiplier is shown in Figure B4. In this example, the activity is the preservation of a historic home. The *direct impact* component consists of purchases made specifically for the construction project from the producing industries. The *indirect impact* component consists of expenditures made by producing industries to support the purchases made

for this project. Finally, the *induced impact* component focuses on the expenditures made by workers involved in the activity on-site and in the supplying industries.

Figure B4: Components of the Multiplier for the Historic Rehabilitation of a Single-Family Residence

Direct Impact	Indirect Impact	Induced Impact
Excavation/Construction Labor Concrete Wood Bricks Equipment Finance and Insurance	Production Labor Steel Fabrication Concrete Mixing Factory and Office Expenses Equipment Components	Expenditures by wage earners on-site and in the supplying industries for food, clothing, durable goods, entertainment

REGIONAL INPUT-OUTPUT ANALYSIS

Because of data limitations, regional input-output analysis has some considerations beyond those for the nation. The main considerations concern the depiction of regional technology and the adjustment of the technology to account for interregional trade by industry.

In the regional setting, local technology matrices are not readily available. An accurate region-specific technology matrix requires a survey of a representative sample of organizations for each industry to be depicted in the model. Such surveys are extremely expensive.[10] Because of the expense, regional analysts have tended to use national technology as a surrogate for regional technology. This substitution does not affect the accuracy of the model as long as local industry technology does not vary widely from the nation's average.[11]

Even when local technology varies widely from the nation's average for one or more industries, model accuracy may not be affected much. This is because interregional trade may mitigate the error that would be induced by the technology. That is, in estimating economic impacts via a regional input-output model, national technology must be regionalized by a vector of regional purchase coefficients,[12] **r**, in the following manner:

[10]The most recent statewide survey-based model was developed for the State of Kansas in 1986 and cost on the order of $60,000 (in 1990 dollars). The development of this model, however, leaned heavily on work done in 1965 for the same state. In addition the model was aggregated to the 35-sector level, making it inappropriate for many possible applications since the industries in the model do not represent the very detailed sectors that are generally analyzed.

[11]Only recently have researchers studied the validity of this assumption. They have found that large urban areas may have technology in some manufacturing industries that differs in a statistically significant way from the national average. As will be discussed in a subsequent paragraph, such differences may be unimportant after accounting for trade patterns.

[12]A regional purchase coefficient (RPC) for an industry is the proportion of the region's demand for a good or service that is fulfilled by local production. Thus, each industry's RPC varies between zero (0) and one (1), with one implying that all local demand is fulfilled by local suppliers. As a general rule, agriculture, mining, and manufacturing industries tend to have low RPCs, and both service and construction industries tend to have high RPCs.

$$(\mathbf{I}-\mathbf{rA})^{-1}\,\mathbf{r}\cdot\Delta\mathbf{y}$$

or

$$\mathbf{r}\cdot\Delta\mathbf{y} + \mathbf{rA}\,(\mathbf{r}\cdot\Delta\mathbf{y}) + \mathbf{rA}(\mathbf{rA}\,(\mathbf{r}\cdot\Delta\mathbf{y})) + \mathbf{rA}(\mathbf{rA}(\mathbf{rA}\,(\mathbf{r}\cdot\Delta\mathbf{y}))) + \ldots$$

where the vector-matrix product **rA** is an estimate of the region's direct requirements matrix. Thus, if national technology coefficients—which vary widely from their local equivalents—are multiplied by small RPCs, the error transferred to the direct requirements matrices will be relatively small. Indeed, since most manufacturing industries have small RPCs and since technology differences tend to arise due to substitution in the use of manufactured goods, technology differences have generally been found to be minor source error in economic impact measurement. Instead, RPCs and their measurement error due to industry aggregation have been the focus of research on regional input-output model accuracy.

A COMPARISON OF THREE MAJOR REGIONAL ECONOMIC IMPACT MODELS

In the United States there are three major vendors of regional input-output models. They are U.S. Bureau of Economic Analysis's (BEA) RIMS II multipliers, Minnesota IMPLAN Group Inc.'s (MIG) IMPLAN Pro model, and CUPR's own R/ECON™ I–O model. R/ECON™ has had the privilege of using them all. (R/ECON™ I–O builds from the PC I–O model produced by the Regional Science Research Corporation's (RSRC).)

Although the three systems have important similarities, there are also significant differences that should be considered before deciding which system to use in a particular study. This document compares the features of the three systems. Further discussion can be found in Brucker, Hastings, and Latham's article in the Summer 1987 issue of *The Review of Regional Studies* entitled "Regional Input-Output Analysis: A Comparison of Five Ready-Made Model Systems." Since that date, R/ECON™ and MIG have added a significant number of new features to PC I–O (now, R/ECON™ I–O) and IMPLAN, respectively.

MODEL ACCURACY

RIMS II, IMPLAN, and RECON™ I–O all employ input-output (I–O) models for estimating impacts. All three regionalized the U.S. national I–O technology coefficients table at the highest levels of disaggregation (more than 400 industries). Since aggregation of sectors has been shown to be an important source of error in the calculation of impact multipliers, the retention of maximum industrial detail in these regional systems is a positive feature that they share. The

systems diverge in their regionalization approaches, however. The difference is in the manner that they estimate regional purchase coefficients (RPCs), which are used to regionalize the technology matrix. An RPC is the proportion of the region's demand for a good or service that is fulfilled by the region's own producers rather than by imports from producers in other areas. Thus, it expresses the proportion of the purchases of the good or service that do not leak out of the region, but rather feed back to its economy, with corresponding multiplier effects. Thus, the accuracy of the RPC is crucial to the accuracy of a regional I–O model, since the regional multiplier effects of a sector vary directly with its RPC.

The techniques for estimating the RPCs used by R/ECON™ and MIG in their models are theoretically more appealing than the location quotient (LQ) approach used in RIMS II. This is because the former two allow for cross hauling of a good or service among regions and the latter does not. Since cross hauling of the same general class of goods or services among regions is quite common, the CUPR-MIG approach should provide better estimates of regional imports and exports. Statistical results reported in Stevens, Treyz, and Lahr (1989) confirm that LQ methods tend to overestimate RPCs. By extension, inaccurate RPCs may lead to inaccurately estimated impact estimates.

Further, the estimating equation used by CUPR to produce RPCs should be more accurate than that used by MIG. The difference between the two approaches is that MIG estimates RPCs at a more aggregated level (two-digit SICs, or about 86 industries) and applies them at a desegregate level (over 500 industries). CUPR both estimates and applies the RPCs at the most detailed industry level. The application of aggregate RPCs can induce as much as 50 percent error in impact estimates (Lahr and Stevens, 2002).

Although both R/ECON™ I–O and IMPLAN use an RPC-estimating technique that is theoretically sound and update it using the most recent economic data, some practitioners question their accuracy. The reasons for doing so are three-fold. First, the observations currently used to estimate their implemented RPCs are based on 20-years old trade relationships—the Commodity Transportation Survey (CTS) from the 1977 Census of Transportation. Second, the CTS observations are at the state level. Therefore, RPC's estimated for substate areas are extrapolated. Hence, there is the potential that RPCs for counties and metropolitan areas are not as accurate as might be expected. Third, the observed CTS RPCs are only for shipments of

goods. The interstate provision of services is unmeasured by the CTS. IMPLAN replies on relationships from the 1977 U.S. Multiregional Input-Output Model that are not clearly documented. R/ECON™ I–O relies on the same econometric relationships that it does for manufacturing industries but employs expert judgment to construct weight/value ratios (a critical variable in the RPC-estimating equation) for the nonmanufacturing industries.

The fact that BEA creates the RIMS II multipliers gives it the advantage of being constructed from the full set of the most recent regional earnings data available. BEA is the main federal government purveyor of employment and earnings data by detailed industry. It therefore has access to the fully disclosed and disaggregated versions of these data. The other two model systems rely on older data from *County Business Patterns* and Bureau of Labor Statistic's QCEW forms, which have been "improved" by filling-in for any industries that have disclosure problems (this occurs when three or fewer firms exist in an industry or a region).

MODEL FLEXIBILITY

For the typical user, the most apparent differences among the three modeling systems are the level of flexibility they enable and the type of results that they yield. R/ECON™ I–O allows the user to make changes in individual cells of the 434-by-434 technology matrix as well as in the 11 434-sector vectors of region-specific data that are used to produce the regionalized model. The 11 sectors are: output, demand, employment per unit output, labor income per unit output, total value added per unit of output, taxes per unit of output (state and local), nontax value added per unit output, administrative and auxiliary output per unit output, household consumption per unit of labor income, and the RPCs. The R/ECON™ I–O model tends to be simple to use. Its User's Guide is straightforward and concise, providing instruction about the proper implementation of the model as well as the interpretation of the model's results.

The software for IMPLAN Pro is Windows-based, and its User's Guide is more formalized. Of the three modeling systems, it is the most user-friendly. The Windows orientation has enabled MIG to provide many more options in IMPLAN without increasing the complexity of use. Like R/ECON™ I–O, IMPLAN's regional data on RPCs, output, labor compensation, industry average margins, and employment can be revised. It does not have complete information on tax revenues other than those from indirect business taxes (excise and sales taxes), and those cannot be altered. Also like R/ECON™, IMPLAN allows users to modify the cells of the 400-by-400 technology matrix. It also permits the user to change and apply price deflators so that dollar

figures can be updated from the default year, which may be as many as four years prior to the current year. The plethora of options, which are advantageous to the advanced user, can be extremely confusing to the novice. Although default values are provided for most of the options, the accompanying documentation does not clearly point out which items should get the most attention. Further, the calculations needed to make any requisite changes can be more complex than those needed for the R/ECON™ I–O model. Much of the documentation for the model dwells on technical issues regarding the guts of the model. For example, while one can aggregate the 538-sector impacts to the one- and two-digit SIC level, the current documentation does not discuss that possibility. Instead, the user is advised by the Users' Guide to produce an aggregate model to achieve this end. Such a model, as was discussed earlier, is likely to be error ridden.

For a region, RIMS II typically delivers a set of 38-by-471 tables of multipliers for output, earnings, and employment; supplementary multipliers for taxes are available at additional cost. Although the model's documentation is generally excellent, use of RIMS II alone will not provide proper estimates of a region's economic impacts from a change in regional demand. This is because no RPC estimates are supplied with the model. For example, in order to estimate the impacts of rehabilitation, one not only needs to be able to convert the engineering cost estimates into demands for labor as well as for materials and services by industry, but must also be able to estimate the percentage of the labor income, materials, and services which will be provided by the region's households and industries (the RPCs for the demanded goods and services). In most cases, such percentages are difficult to ascertain; however, they are provided in the R/Econ™ I–O and IMPLAN models with simple triggering of an option. Further, it is impossible to change any of the model's parameters if superior data are known. This model ought not to be used for evaluating any project or event where superior data are available or where the evaluation is for a change in regional demand (a construction project or an event) as opposed to a change in regional supply (the operation of a new establishment).

MODEL RESULTS

Detailed total economic impacts for about 434 industries can be calculated for jobs, labor income, and output from R/ECON™ I–O and IMPLAN only. These two modeling systems can also provide total impacts as well as impacts at the one- and two-digit industry levels. RIMS II provides total impacts and impacts on only 38 industries for these same three measures. Only the

manual for R/ECON™ I–O warns about the problems of interpreting and comparing multipliers and any measures of output, also known as the value of shipments.

As an alternative to the conventional measures and their multipliers, R/ECON™ I–O and IMPLAN provide results on a measure known as "value added." It is the region's contribution to the nation's gross domestic product (GDP) and consists of labor income, nonmonetary labor compensation, proprietors' income, profit-type income, dividends, interest, rents, capital consumption allowances, and taxes paid. It is, thus, the region's production of wealth and is the single best economic measure of the total economic impacts of an economic disturbance.

In addition to impacts in terms of jobs, employee compensation, output, and value added, IMPLAN provides information on impacts in terms of personal income, proprietor income, other property-type income, and indirect business taxes. R/ECON™ I–O breaks out impacts into taxes collected by the local, state, and federal governments. It also provides the jobs impacts in terms of either about 90 or 400 occupations at the user's request. It goes a step further by also providing a return-on-investment-type multiplier measure, which compares the total impacts on all of the main measures to the total original expenditure that caused the impacts. Although these latter can be readily calculated by the user using results of the other two modeling systems, they are rarely used in impact analysis despite their obvious value.

In terms of the format of the results, both R/ECON™ I–O and IMPLAN are flexible. On request, they print the results directly or into an Excel® file. It can also permit previewing of the results on the computer's monitor. Both now offer the option of printing out the job impacts in either or both levels of occupational detail.

RSRC EQUATION

The equation currently used by RSRC in estimating RPCs is reported in Treyz and Stevens (1985). In this paper, the authors show that they estimated the RPC from the 1977 CTS data by estimating the demands for an industry's production of goods or services that are fulfilled by local suppliers (*LS*) as

$$\boldsymbol{LS = D^{e(-1/x)}}$$

and where for a given industry $\boldsymbol{x = k\, Z_1^{a_1} Z_2^{a_2} P_j Z_j^{a_j}}$ and *D* is its total local demand.

Since for a given industry RPC = *LS*/*D* then

$$\ln\{-1/[\ln(\ln LS/\ln D)]\} = \ln k + a_1 \ln Z_1 + a_2 \ln Z_2 + S_j a_j \ln Z_j$$

which was the equation that was estimated for each industry.

This odd nonlinear form not only yielded high correlations between the estimated and actual values of the RPCs, it also assured that the RPC value ranges strictly between 0 and 1. The results of the empirical implementation of this equation are shown in Treyz and Stevens (1985, table 1). The table shows that total local industry demand (Z_1), the supply/demand ratio (Z_2), the weight/value ratio of the good (Z_3), the region's size in square miles (Z_4), and the region's average establishment size in terms of employees for the industry compared to the nation's (Z_5) are the variables that influence the value of the RPC across all regions and industries. The latter of these maintain the least leverage on RPC values.

Because the CTS data are at the state level only, it is important for the purposes of this study that the local industry demand, the supply/demand ratio, and the region's size in square miles are included in the equation. They allow the equation to extrapolate the estimation of RPCs for areas smaller than states. It should also be noted here that the CTS data only cover manufactured goods. Thus, although calculated effectively making them equal to unity via the above equation, RPC estimates for services drop on the weight/value ratios. A very high weight/value ratio like this forces the industry to meet this demand through local production. Hence, it is no surprise that a region's RPC for this sector is often very high (0.89). Similarly, hotels and motels tend to be used by visitors from outside the area. Thus, a weight/value ratio on the order of that for industry production would be expected. Hence, an RPC for this sector is often about 0.25.

The accuracy of R/ECON™ estimating approach is exemplified best by this last example. Ordinary location quotient approaches would show hotel and motel services serving local residents. Similarly, IMPLAN RPCs are built from data that combine this industry with eating and drinking establishments (among others). The result of such an aggregation process is an RPC that represents neither industry (a value of about 0.50) but which is applied to both. In the end, not only is the R/ECON™'s RPC-estimating approach the most sound, but it is also widely acknowledged by researchers in the field as being state of the art.

ADVANTAGES AND LIMITATIONS OF INPUT-OUTPUT ANALYSIS

Input-output modeling is one of the most accepted means for estimating economic impacts. This is because it provides a concise and accurate means for articulating the interrelationships among industries. The models can be quite detailed. For example, the current U.S. model currently has about 450 industries representing many six-digit North American Industrial Classification System (NAICS) codes. The R/ECON™ model used in this study has 434 sectors. Further, the industry detail of input-output models provides not only a consistent and systematic approach but also more accurately assesses multiplier effects of changes in economic activity. Research has shown that results from more aggregated economic models can have as much as 50 percent error inherent in them. Such large errors are generally attributed to poor estimation of regional trade flows resulting from the aggregation process.

Input-output models also can be set up to capture the flows among economic regions. For example, the model used in this study can calculate impacts for a county, as well as a metropolitan area or a state economy.

The limitations of input-output modeling should also be recognized. The approach makes several key assumptions. First, the input-output model approach assumes that there are no economies of scale to production in an industry; that is, the proportion of inputs used in an industry's production process does not change regardless of the level of production. This assumption will not work if the technology matrix depicts an economy of a recessional economy (e.g., 2008) and the analyst is attempting to model activity in a peak economic year (e.g., 2007). In a recession year, the labor-to-output ratio tends to be excessive because firms are generally reluctant to lay off workers when they believe an economic turnaround is about to occur.

A less-restrictive assumption of the input-output approach is that technology is not permitted to change over time. It is less restrictive because the technology matrix in the United States is updated frequently and, in general, production technology does not radically change over short periods.

Finally, the technical coefficients used in most regional models are based on the assumption that production processes are spatially invariant and are well represented by the nation's average technology. In a region as large and diverse as New Jersey, this assumption is likely to hold true.

REFERENCES

Miller, Ronald E. and Peter D. Blair. (2009) *Input-Output Analysis: Foundations and Extensions*, 2nd edition. Cambridge, U.K.: Cambridge University Press.

Stevens, Benjamin H., George I. Treyz, and Michael L. Lahr. (1989) "On the Comparative Accuracy of RPC Estimating Techniques," in: Ronald E. Miller, Karen R. Polenske, and Adam Z. Rose (eds) *Frontiers in Input-Output Analysis*. (New York, Oxford University Press), pp. 245-257.

Treyz, George I. and Benjamin H. Stevens. (1985) "The TFS Regional Modelling Methodology," *Regional Studies*, 19, 547-562.