The Army's Local Economic Effects

Christopher M. Schnaubelt, Craig A. Bond, Frank Camm, Joshua Klimas, Beth E. Lachman, Laurie L. McDonald, Judith D. Mele, Paul Ng, Meagan Smith, Cole Sutera, Christopher Skeels

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Preface

As a result of the Budget Control Act of 2011 and sequestration, the U.S. Army experienced an approximate $15.35 billion budget decrease in fiscal year (FY) 2013 and initiated a decrease of more than 106,000 soldiers and civilian employees from all components. Although full sequestration-level cuts were not imposed in FYs 2014 and 2015, their return could mean that the Army's cumulative total budget reductions would be more than $79 billion from its baseline for FYs 2016–2020. Even if automatic sequestration is legislatively altered or overturned, there could be pressure on the Army to further decrease its force size and expenditures as the United States continues to increase its ratio of debt to gross domestic product. Despite the near-term (and perhaps temporary) relief from sequestration, the 2014 *Quadrennial Defense Review* states that the Regular Army will decrease strength from its wartime high of 570,000 to 440,000–450,000 soldiers.[1]

Although key decisions have not yet been made, and there are numerous factors involved, plausible consequences for a return to sequestration-level funding include further decreases in the Army's Regular, Reserve, and Guard forces—cutting Regular Army end strength to 420,000, Army National Guard to 315,000, and U.S. Army Reserve to 185,000. The government civilian workforce in each of these components would also be reduced.

Decreasing Army spending, soldiers, and government civilian positions will produce broad economic effects in the states and communities that experience these reductions, including the loss of additional jobs and output linked to Army procurement and personal spending by soldiers and government civilians whose positions are eliminated. To help inform decisionmaking in the event that the Army experiences these cuts, the U.S. Army Quadrennial Defense Review Office asked the RAND Arroyo Center to provide an empirical understanding of how Army spending affects communities and states to help Army leaders more accurately inform Congress on the distribution of Army personnel and procurement spending and the ripple effects, or "backward linkages," that it supports. This report presents findings from RAND Arroyo Center research on the economic activity supported by Army spending at the local level across the nation.

This research was sponsored by the U.S. Army, G-8, and conducted within the RAND Arroyo Center's Strategy and Resources Program. The program director is Terrence Kelly, and the co–principal investigators for this report were Christopher Schnaubelt and Craig Bond. RAND Arroyo Center, part of the RAND Corporation, is a federally funded research and development center sponsored by the United States Army.

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[1] U.S. Department of Defense, *Quadrennial Defense Review 2014*, Washington, D.C., March 4, 2014

Contents

[1] Christopher M. Schnaubelt, Craig A. Bond, Frank Camm, Joshua Klimas, Beth E. Lachman, Laurie McDonald, Judith Mele, Paul Ng, Meagan Smith, Cole Sutera, and Christopher Skeels, *The Army's Local Economic Effects: Appendix B, Volume I: Alabama through Minnesota*, Santa Monica, Calif: RAND Corporation, RR-1119/1-A, 2015a. Available at http://www.rand.org/pubs/research_reports/RR1119z1.html

[2] Christopher M. Schnaubelt, Craig A. Bond, Frank Camm, Joshua Klimas, Beth E. Lachman, Laurie McDonald, Judith Mele, Paul Ng, Meagan Smith, Cole Sutera, and Christopher Skeels, *The Army's Local Economic Effects: Appendix B, Volume II: Mississippi through Wyoming*, Santa Monica, Calif: RAND Corporation, RR-1119/2-A, 2015b. Available at http://www.rand.org/pubs/research_reports/RR1119z2.html

Figures and Tables

Figures

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Summary

As a result of the Budget Control Act of 2011 and sequestration, the U.S. Army experienced budget decreases in fiscal year (FY) 2013, which included the downsizing of approximately 106,000 soldiers and civilian employees.[1] Although sequestration cuts were not required in FYs 2014 and 2015, the Army's cumulative total budget could decline even further if sequestration cuts return or if the U.S. Department of Defense issues guidance to implement similar reductions regardless of sequestration.[2] As indicated in the 2014 *Quadrennial Defense Review*, the Regular Army is planning to reduce its force strength from its wartime high of 570,000 to 440,000–450,000 soldiers. Furthermore, planned force structure changes will result in cutting end strength of the Army National Guard to 315,000 and the U.S. Army Reserve to 185,000.[3] The government civilian workforce in each of these components would also be reduced.

The withdrawal of Army procurement and personnel spending will reduce demand for local products and services in the states and communities that experience these reductions. In the short run, these areas will lose the additional jobs and output linked to Army spending.

This report presents findings from RAND Arroyo Center research on the economic activity supported by Army spending at the local level—namely, U.S. communities and states. We estimate the activity supported by Army spending in each of the 435 congressional districts of the 113th Congress using district-level input-output models and a national-level input-output model known as Impact Analysis for Planning. Each district-level model is used to estimate the direct, indirect, and induced effects of Army spending that take place within the district, and these results are used in conjunction with the national-level model to obtain the total economic effects of national-level Army spending on each district and state. Direct effects are the total Army spending within a district, while indirect and induced effects represent the local economic activity that supports both the direct spending and the in-district demand generated from Army spending outside the district. Indirect effects capture interindustry linkages, while induced effects capture the effects of household incomes.

This report provides the reader with estimates of the regional-level effects of national-level Army spending, including spending within and outside a region. The following tables summarize the results of the analysis. Table S.1 reports the range of results across the 435 congressional districts of the 113th Congress. All Army direct spending includes military and government civilian payroll and retiree pay for Regular Army, Army National Guard, and U.S.

[1] U.S. Army Environmental Command, *Supplemental Programmatic Environmental Assessment for Army 2020 Force Structure Realignment*, June 2014, p. 1-1.

[2] Interviews with U.S. Army G-8 personnel.

[3] U.S. Department of Defense, *Quadrennial Defense Review 2014*, Washington, D.C., March 4, 2014, p. 29.

Army Reserve, plus acquisition and services contracts, by congressional district. Army-driven economic output is the estimate of the value of all produced goods and services in a congressional district that is supported by direct Army spending. All Army personnel and additional employment is a measure of military and civilian personnel directly and indirectly supported by Army spending in congressional districts. Table S.2 reports similar results across states.

Because the model uses *national* Army spending to derive *local* economic effects, the ratio of economic output to direct spending, often termed the "output multiplier," would likely overestimate the economic impact of changes in *local* Army spending in a given region for two reasons. First, it includes the effects of both in-region and out-of-region Army spending on the economic activity within each district and state, while the economic impact analysis would only change final demand within the region. Second, in our analysis, local Army spending in a region is not necessarily equal to the change in final demand in a region due to potential subcontracting. Rather, our results are appropriate estimates of the effect of total, nationwide Army spending on each congressional district and state.

Table S.1
Army-Supported Economic Output and All Army Personnel and Additional Employment Congressional District Statistics, 2014 (2012$)

	All Army Direct Spending ($)	Army-Driven Economic Output ($)	All Army Personnel and Additional Employment
Average	$290.2 million	$913.6 million	9,171
Median	$120.8 million	$374.5million	4,178
Minimum	$14.6 million	$22.4 million	786
25th percentile	$66.6 million	$205.1 million	2,541
75th percentile	$246.9 million	$771.7 million	7,758
Maximum	$4.8 billion	$15.3 billion	111,303

NOTE: Average, minimum, maximum, and other percentiles calculated independently for each column.

Table S.2
Army-Supported Economic Output and All Army Personnel and Additional Employment State Statistics, 2014 (2012$)

	All Army Direct Spending ($)	Army-Driven Economic Output ($)	All Army Personnel and Additional Employment
Average	$2.5 billion	$8.0 billion	79,786
Median	$1.7 billion	$5.5 billion	62,222
Minimum	$85.5 million	$245.7 million	3,549
25th percentile	$513.8 million	$1.5 billion	17,113
75th percentile	$3.1 billion	$10.1 billion	108,690
Maximum	$14.0 billion	$45.0 billion	419,119

NOTE: Average, minimum, maximum, and other percentiles calculated independently for each column.

Acknowledgments

BG Frank Muth and Mr. Timothy Muchmore, our sponsors in the U.S. Army Quadrennial Defense Review Office, provided critical support for and oversight of this project. Nicholas Garcia in the Department of Defense Office of the Actuary delivered essential data for this project and came through at the perfect moment. The assistance of Leatha Victoria Shipman Jackson with the Defense Manpower Data Center was also vital in obtaining the data we required.

RAND reviewers Howard Shatz and James Hosek provided many useful suggestions for improving this report. Christopher Skeels helped with programming design. Michelle Ziegler, Raphael Cohen, and Penelope Speed assisted in gathering and analyzing data and improving the presentation of maps and tables. Allison Kerns and Arwen Bicknell did an excellent job of editing.

Abbreviations

ARNG	Army National Guard
DEERS	Defense Enrollment Eligibility Reporting System
DMDC	Defense Manpower Data Center
DoD	U.S. Department of Defense
ESRI	Environmental Systems Research Institute
FICA	Federal Insurance Contributions Act
FPDS-NG	Federal Procurement Data System–Next Generation
FY	fiscal year
FSRS	Federal Subaward Reporting System
IMPLAN	Impact Analysis for Planning
I/O	input-output
NAICS	North American Industry Classification System
USAR	U.S. Army Reserve
ZCTA	ZIP Code Tabulation Area

CHAPTER ONE

Introduction

Background

As a result of the Budget Control Act of 2011 and sequestration, the U.S. Army experienced a budget decrease of approximately $15.35 billion in fiscal year (FY) 2013 and initiated the reduction of more than 106,000 soldiers and civilian employees.[1] Sequestration cuts were not necessary in FYs 2014 and 2015, but if they return, or if the U.S. Department of Defense (DoD) issues guidance to implement similar reductions regardless of sequestration, the Army's cumulative total budget decreases would be more than $79 billion from its baseline for FYs 2016–2020.[2] Even if automatic cuts are legislatively altered or overturned, there may be pressure on the Army to further reduce its force size and expenditures as the United States continues to increase its ratio of debt to gross domestic product. Despite the near-term (and perhaps temporary) relief from sequestration, the 2014 *Quadrennial Defense Review* states that the Regular Army will cut back from its wartime high force of 570,000 to 440,000–450,000 soldiers.

Although key decisions have not yet been made, and there are numerous factors involved, plausible consequences for force structure changes during this period include further decreases in the Army's active and reserve components—cutting Regular Army end strength to 420,000, Army National Guard (ARNG) to 315,000, and U.S. Army Reserve (USAR) to 185,000. The government civilian workforce in each of these components would also be reduced proportionately.[3]

Decreasing Army spending, soldiers, and government civilian positions could produce broader economic effects in the states and communities that experience these spending decreases. At least in the near term, these areas will lose the additional jobs and output linked to Army procurement and personal spending by soldiers and government civilians whose positions are eliminated.[4] Regardless of the source of cuts (e.g., legislatively mandated through sequestration, DoD guidance), a reduction in Army spending represents a withdrawal of demand from state and local economies, which will reverberate throughout the region.

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[1] U.S. Army Environmental Command, *Supplemental Programmatic Environmental Assessment for Army 2020 Force Structure Realignment*, June 2014, p. 1-1.

[2] Interviews with U.S. Army G-8 personnel.

[3] DoD, *Quadrennial Defense Review 2014*, Washington, D.C., March 4, 2014, p. 29.

[4] General-equilibrium effects (i.e., the changes in markets due to price changes) and other associated changes in behavior of consumers and firms in the local economy may mitigate or exacerbate some of the longer-term effects. This is discussed in more detail in Chapter Two.

Objective of the Study

The objective of this study was to provide Army senior leaders with an estimate of the economic activity supported by Army spending on U.S. communities and states. We estimated the effects of both district-level and out-of-district Army spending on each congressional district of the 113th Congress and aggregated these results to the state level. Because we included both in-region and out-of-region Army spending in the analysis, the results reported in the district- and state-level tables should not be used to calculate the per-dollar effect of increased or decreased Army spending in a district or state. Any attempt to do so should take into account only net final demand changes in a region, including any redistribution in spending that may occur.

Relationship to Other Studies

This report builds on earlier RAND Arroyo Center work that analyzed the economic effects of a range of possible reductions in Army force structure.[5] It estimated that the cumulative effects for all states and communities affected by a $15.8 billion annual reduction in the U.S. Army budget for FYs 2015–2019 (a total of $79 billion spread evenly over a five-year period) would be between $24.0 billion and $36.5 billion in lost output per year (nominal) and between 168,600 and 281,400 jobs lost. In using an input-output (I/O) approach, it did not include the effects of any price or behavioral changes (i.e., general equilibrium effects).

Additionally, the U.S. Army's *Supplemental Programmatic Environmental Assessment for Army 2020 Force Structure Realignment* examined the potential economic effects of force reductions on major U.S. Army installations in the United States.[6] However, this analysis focused on installations and excluded any potential reductions in ARNG and USAR. Table 1.1 summarizes its economic estimates.

Another study, performed by RAND's National Defense Research Institute in conjunction with the Hawaii Institute of Public Affairs and the Chamber of Commerce of Hawaii estimated the economic impact of total defense spending on the State of Hawaii.[7] Results (in 2009 dollars) showed that direct spending of $6.527 billion contributed a total of $12.2 billion in economic output and 101,533 full-time equivalent jobs to the state. As this study also used an I/O approach, no general equilibrium effects were estimated.

The first two national studies estimated the economic effects of assumed cuts in Army force structure. They assumed the size of personnel reductions and used average soldier and civilian pay to estimate the likely reductions in spending when these jobs were eliminated or moved elsewhere. These studies were predictive, positing that *if* these cuts took place, *then* these economic outcomes would result. The Hawaii study, however, was retrospective and descriptive, tracing the economic activity supported by defense spending in the state.

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[5] Christopher M. Schnaubelt, Craig A. Bond, Lilly C. Geyer, and W. Grant Wilder, *The Economic Impact of Army Downsizing on States and Communities*, Santa Monica, Calif.: RAND Corporation, 2014, Not available to the general public.

[6] U.S. Army Environmental Command, 2014.

[7] James Hosek, Aviva Litovitz, and Adam C. Resnick, *How Much Does Military Spending Add to Hawaii's Economy?* Santa Monica, Calif.: RAND Corporation, TR-996-OSD, 2011.

Table 1.1
Summary of *Supplemental Programmatic Environmental Assessment for Army 2020 Force Structure Realignment* Reductions and Economic Impacts

		Permanent Party Soldiers		Army Civilians			Estimated Economic Impacts	
Installation Name	Fiscal Year of Baseline	Baseline Population	Assessed Reduction	Baseline Population	Assessed Reduction	Total Assessed Installation Reduction	Income Change	Total Employment Change
Aberdeen Proving Ground, Maryland	2013	1,428	1,000	10,907	3,272	4,300	–$382,369,400.00	–7,321
Fort Belvoir, Virginia	2013	4,121	2,885	5,600	1,680	4,600	–$358,208,500.00	–6,479
Fort Benning, Georgia	2011	13,256	9,493	4,245	1,274	10,800	–$626,973,000.00	–13,859
Fort Bliss, Texas	2011	28,194	15,044	3,186	956	16,000	–$925,584,000.00	–20,864
Fort Bragg, North Carolina	2011	45,051	13,623	7,924	2,377	16,000	–$968,559,200.00	–21,563
Fort Campbell, Kentucky	2011	29,683	15,221	2,598	779	16,000	–$863,318,300.00	–19,605
Fort Carson, Colorado	2011	23,353	15,295	2,349	705	16,000	–$969,488,000.00	–21,331
Fort Drum, New York	2011	17,067	15,417	1,944	583	16,000	–$877,512,000.00	–19,102
Fort Gordon, Georgia	2011	5,604	3,922	2,538	761	4,600	–$282,631,700.00	–6,243
Fort Hood, Texas	2011	42,545	14,606	4,645	1,394	16,000	–$870,201,600.00	–18,915
Fort Huachuca, Arizona	2013	2,466	1,726	3,375	1,013	2,700	–$193,491,500.00	–3,820
Fort Irwin, California	2011	4,658	3,260	881	264	3,600	–$210,744,200.00	–4,545
Fort Jackson, South Carolina	2013	3,376	2,363	2,359	708	3,100	–$189,425,600.00	–4,242
Fort Knox, Kentucky	2011	7,624	5,954	5,503	1,651	7,600	–$431,208,500.00	–9,650
Fort Leavenworth, Kansas	2013	2,555	1,789	2,449	735	2,500	–$154,235,700.00	–3,213
Fort Lee, Virginia	2011	3,988	2,792	2,486	746	3,600	–$242,934,300.00	–4,914
Fort Leonard Wood, Missouri	2011	6,423	4,496	2,738	821	5,400	–$299,753,800.00	–6,857
Fort Meade, Maryland	2013	3,772	2,640	2,866	860	3,500	–$247,821,800.00	–5,150
Fort Polk, Louisiana	2011	9,298	6,039	1,538	461	6,500	–$369,438,700.00	–8,425
Fort Riley, Kansas	2011	17,853	15,357	2,142	643	16,000	–$865,132,400.00	–19,633
Fort Rucker, Alabama	2013	2,505	1,754	2,452	736	2,500	–$157,026,600.00	–3,389
Fort Sill, Oklahoma	2011	8,603	6,022	2,734	820	6,800	–$373,991,900.00	–8,482
Fort Stewart, Georgia	2011	16,370	15,317	2,277	683	16,000	–$853,849,000.00	–18,938
Fort Wainwright, Alaska	2011	6,342	5,485	1,088	326	5,800	–$413,485,400.00	–7,399
Joint Base Elmendorf–Richardson, Alaska	2011	6,316	5,169	545	164	5,300	–$355,047,800.00	–6,936

Table 1.1—Cont.

Installation Name	Fiscal Year of Baseline	Permanent Party Soldiers		Army Civilians		Total Assessed Installation Reduction	Estimated Economic Impacts	
		Baseline Population	Assessed Reduction	Baseline Population	Assessed Reduction		Income Change	Total Employment Change
Joint Base Langley–Eustis, Virginia	2011	4,872	3,410	2,510	753	4,200	–$283,369,100.00	–5,776
Joint Base Lewis–McChord, Washington	2011	31,084	14,459	5,138	1,541	16,000	–$971,551,600.00	–21,344
Joint Base San Antonio–Fort Sam Houston, Texas	2013	5,641	3,949	6,615	1,985	5,900	–$392,672,500.00	–8,485
USAG Hawaii (Fort Shafter), Hawai'i	2013	3,893	2,725	3,538	1,061	3,800	–$1,352,402,000.00	–26,776
USAG Hawaii (Schofield Barracks), Hawaii	2011	16,420	15,394	2,021	606	16,000		

SOURCE: Derived from U.S. Army Environmental Command, 2014, Chapter 4.

Summary of the Methodology

The current research is closest in methodology to the retrospective Hawaii report. We used data on total spending by the Army in conjunction with an I/O model to estimate the local economic effects of total nationwide Army spending on local economies at the congressional district and state level. This activity is generated through the supply chains associated with filling the final demand generated by direct Army spending in each region, as well as the demand generated for local products from other suppliers outside the region.

Data related to all Army direct spending during FYs 2012–2014 were collected from personnel and procurement records.[8] Such spending included pay and allowance for soldiers—Regular Army, ARNG, and USAR—as well as Army civil service employees. Instead of using average soldier and civilian wages, we used actual pay totals obtained and aggregated via the Defense Manpower Data Center (DMDC) database. We also included payments received by Army retirees from DoD's *Statistical Report on the Military Retirement System;*[9] acquisition, procurement, and contracted services purchased with Army funds by place of performance and North American Industry Classification System (NAICS) code as reported in the Federal Procurement Data System–Next Generation (FPDS-NG); and the Federal Subaward Reporting System (FSRS). We adjusted procurement data by reported first-tier subcontract in the year of the contract action to more accurately represent place of performance. The data were compiled at the three- or five-digit U.S. ZIP-code level, depending on the source, and thus produced a precise geographic distribution of direct Army spending. For states, spending was also split according to appropriations categories that were either component-specific or assigned to a civilian/retiree/survivor category. In some cases, the match between appropriations category and component is not apparent. As such, all procurement, RDTE, and spending not otherwise explicitly associated with a component or civilians/retiree/survivor payments are assigned to the Regular Army. [10]

Personnel counts were defined as the number of unique individuals registered in the Defense Enrollment Eligibility Reporting System (DEERS) database for each region in each fiscal year. Because we count unique individuals, those persons who reported multiple resi-

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[8] Issues with the data and the workarounds we employed are described in Chapters Two and Three and in Appendix A.

[9] U.S. Department of Defense, Office of the Actuary, *Statistical Report on the Military Retirement System: Fiscal Year 2012,* Department of Defense, 2013; U.S. Department of Defense, Office of the Actuary, *Statistical Report on the Military Retirement System: Fiscal Year 2013,* May 2014.

[10] ARNG direct spending includes ARNG military personnel, operations and maintenance, and military construction. This accounted for about 9 percent of Army spending in FY 2014. USAR direct spending includes USAR military personnel, operations and maintenance, and military construction. This accounted for about 5 percent of Army spending in FY 2014. Regular Army direct spending includes Regular Army military personnel, operations and maintenance, military construction, procurement, all RDTE, and spending not explicitly associated with a component other than government civilian pay, and payment to retirees and survivors . In FY 2014, Army procurement accounted for about 11 percent of the Regular Army direct spending, although both the Reserve and Guard also benefit from Army procurement. About 60 percent of Army procurement benefits the Regular Army, 10 percent benefits the Reserve, and 30 percent benefits the Guard based upon their proportionate shares of capital/materiel as calculated by the Army G-8, although the distributions vary from year to year. Army RDTE, which also benefits all components, accounted for about 5 percent, while several nonoperational Army responsibilities accounted for about 8 percent. These included civil works (Corps of Engineers), the Joint Improvised Explosive Device Defeat Organization, support to foreign militaries, chemical weapons demilitarization, and maintenance of military cemeteries, among others. These additional Army responsibilities are predominantly performed by Regular Army military and civilian personnel, but may include small percentages of Reserve and Guard contributions.

dences in different regions throughout the year will be counted multiple times (once for each region in which they reported a residence). As such, summing personnel counts over regions will overstate total personnel numbers. Additionally, because the DMDC data reports soldiers in the Active Guard/Reserve program within the active pay files, the number of soldiers assigned to ARNG and USAR units in a district and state was undercounted, while Regular Army soldiers were overcounted. However, these disparities do not influence the reported estimates of economic effects.

Assuming that spending on procurement and personnel represented the final demand (or end-use demand) generated at the district or state level, we then used the I/O models to estimate the economic activity associated with Army spending at each subnational geographic region. An I/O model is a representation of the linkages between major sectors of a regional economy in which each sector of the regional economy is assumed to require inputs from the other sectors to produce output. These inputs can come from local sources within the region, from other domestic sources outside the region, or foreign imports. *Final demand* refers to demand for goods and services that will not be subsequently used in a production process and resold. Because of the overall scale of Army spending nationwide, our methods estimate the economic activity generated by both direct Army spending within a region (i.e., spending on people, goods, and services within the region itself), as well as the intermediate demands (demand for goods and services that will be used in production and the subsequent products resold) generated in the region by Army spending outside the region in the rest of the nation. The resulting model outputs provide the estimated indirect and induced effects of Army spending in terms of economic output and employment supported.

How this Report Is Organized

Chapter Two and Appendix A explain the methodology and terminology used in the analysis, and Chapter Three describes the sources of data. Chapter Four provides definitions of the key terms used in the district and state-level reports, as well as some summary results across congressional districts and states. In addition, Chapter Four provides estimates of the economic effects of Army spending at the state level. Appendix B, presented in two separate volumes,[11] contains the detailed results of our analysis organized by state and congressional district.

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[11] Christopher M. Schnaubelt, Craig A. Bond, Frank Camm, Joshua Klimas, Beth E. Lachman, Laurie McDonald, Judith Mele, Paul Ng, Meagan Smith, Cole Sutera, and Christopher Skeels, *The Army's Local Economic Effects: Appendix B,* Volume I: *Alabama Through Minnesota*, Santa Monica, Calif: RAND Corporation, RR-1119/1-A, 2015a; Christopher M. Schnaubelt, Craig A. Bond, Frank Camm, Beth E. Lachman, Laurie McDonald, Judith Mele, Paul Ng, Meagan Smith, Cole Sutera, Joshua Klimas, and Christopher Skeels, *The Army's Local Economic Effects: Appendix B,* Volume II: *Mississippi Through Wyoming*, Santa Monica, Calif: RAND Corporation, RR-1119/2-A, 2015b.

CHAPTER TWO

Methodology

This chapter describes the I/O methodology in general, the terminology used, and the specific methodological process used in our analysis.

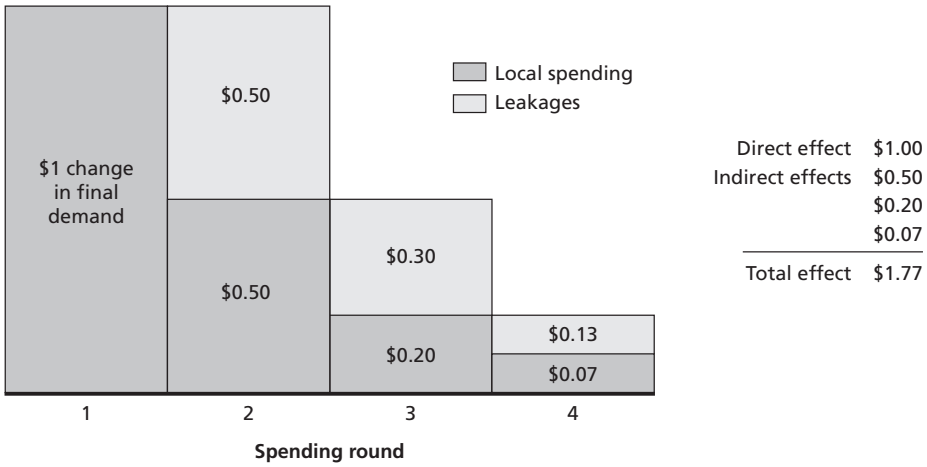
Input-Output Models

I/O models provide a means of estimating the economic effect of injections of spending (also termed end-use or final demand) into a regional economy, such as the spending by the Department of the Army in a congressional district. An I/O model is a representation of the linkages between major sectors of a regional economy (and, to a lesser degree, the linkages between these sectors and the rest of the country and rest of the world). Each sector of the regional economy is assumed to require inputs, called *intermediate demand*, from the other sectors to produce output. These inputs can come from local sources (i.e., within the region), from other domestic sources outside the region, or from foreign imports (i.e., outside the region). The total amount of intermediate demand that is sourced from outside the region is called the *leakage* from the local region.

The model traces the path of production that satisfies all final demand across industries and sectors, taking into account that a dollar of demand in one sector will stimulate the demand for inputs across other regional sectors, which will subsequently generate additional demands. The model thus calculates the ripple effects, or backward linkages, of a change in final demand throughout the regional economy, taking into account the source of the required change in inputs (i.e., the leakages). According to the structure of the model, the value of inputs used per dollar of output in an industry and the sources of those inputs are unaffected by the change in final demand. Figure 2.1 illustrates these ripple effects through an economy.

I/O model data are organized into tables, or matrices, with each sector of the economy given its own row and column and each region given its own table. Rows identify sales from a specific sector to the other sectors of the economy, identified in the columns. The sum of each row equals the total output for the specified sector in the specified region. Columns contain the inputs used by each sector. They represent the production technology used by an industry in terms of the local inputs used from each sector represented in the model. The cells that have the same row and column industry sector name are the intraindustry flows of inputs. Social accounting matrices, which augment I/O models to decompose final demand into its component parts (household, government, net exports, and investment), can be used to augment the structure and add detail to the models. These matrices form the I/O model known as Impact Analysis for Planning (IMPLAN), available from IMPLAN Group.

Figure 2.1
Illustration of Backward Linkages in a Regional Economy



SOURCE: Adapted with permission from Cletus C. Coughlin and Thomas B. Mandelbaum, "A Consumer's Guide to Regional Economic Multipliers," *Federal Reserve Bank of St. Louis Review*, Vol. 73, No. 1, January–February 1991, p. 21, Figure 1.
NOTE: Indirect effects include both intermediate demands generated by industry and incomes generated in region.
RAND *RR1119-2.1*

For example, consider the (aggregated) manufacturing sector in the national IMPLAN model.[1] The estimated total value of production in this sector for 2012 was approximately $7 billion (which equals the sum of both the manufacturing row and column). The manufacturing row shows that this sector sold $88 billion of its output to firms in the agriculture, forestry, fisheries, and hunting sector, $278 billion to firms in the construction sector, and $2 trillion to firms within manufacturing, with the remainder sold to other sectors or for end uses.

The manufacturing column shows the inputs used to produce the $7 billion output. In particular, the sector purchased $216 billion of inputs from the agriculture, forestry, fisheries, and hunting sector; $38 billion from construction; and (consistent with the corresponding row) $2 trillion from firms within manufacturing. The remainder of purchased inputs comes from other industry sectors and labor (i.e., income to households). The column also adjusts for taxes and includes profits to balance the accounts.

The relationships between a change in final demand and overall economic activity in an I/O model are summarized by *multipliers*. Multipliers show the total change in economic activity, given a direct change in final demand or employment. Therefore, they can be interpreted as the total economic change given a one-unit change in final demand.

Indirect effects represent the change given interindustry linkages alone, ignoring the potential effects on household income in the region. They are summarized with Type I multipliers and assume an "open" model. Potential effects on household income are called *induced effects*, which represent the changes in final demand within a region that occur due to the overall

[1] This example is taken from the default 11-sector aggregation (from 440 sectors) displayed in the IMPLAN interface.

change in labor demand from the direct change. Multipliers that sum the indirect and induced effects are called Type II multipliers and are based on "closed" models. Because Type II multipliers include both indirect and induced effects, they are typically larger than Type I multipliers. Both are positively related to the direct effects, or change in demand.[2] Table 2.1 provides a reference to the key terms used in the analysis.

Key Assumptions in Input-Output Analysis

I/O models, like all models, make a number of assumptions regarding the structure and response of the regional economy to a change in final demand. These assumptions, which serve to simplify the model and make it tractable, can lead to differences in estimates and observed effects if the assumptions do not hold. Therefore, the assumptions may also be interpreted as limitations. Table 2.2 summarizes these assumptions.

In general, the set of assumptions implicit in I/O analysis results in a lack of flexibility and feedback effects within a regional economy relative to a more complicated model that takes price changes and other adaptive behaviors into account. For example, suppose an I/O model predicts that an increase of $1 million of in-district spending will increase economic output by $1.5 million of total economic output. The estimate of total economic output is likely a maximum because the spending would tend to stimulate not only intermediate demands but also

Table 2.1
Key Economic and Mathematical Terms as Used in the Report

Term	Definition
End use or final demand	Demand for goods and services that will not be subsequently used in a production process and resold
Intermediate demand	Demand for goods and services that will be used in a production process and ultimately resold to firms
Direct effects	Total Army spending within a district
Indirect effects	The economic activity generated by changes in final demand attributable to interindustry linkages
Induced effects	The economic activity generated by changes in final demand attributable to changes in household incomes
Economic output	The value of all production in an industry or economy-wide
Leakages	The total amount of intermediate demand that is sourced from outside the region
Matrix	A two-dimensional array, or table, of industry sectors with multiple rows and columns
Vector	A one-dimensional array, or table, of industry sectors with multiple rows and one column
Multiplier	Total change in economic activity given a one-dollar change in final demand
Type I multiplier (associated with open model)	Total change in economic activity given a one-dollar change in final demand attributable to interindustry linkages
Type II multiplier (associated with closed model)	Total change in economic activity given a one-dollar change in final demand attributable to household incomes

[2] The technical term for a change in final demand in this type of analysis is a *shock*. For example, if an industry were to decide to build a new plant in an area, that would be called the initial shock to the system.

Table 2.2
Limitations of the Input-Output Approach

Limitation	Explanation
Fixed production functions and constant returns to scale (linearity)	Inputs for each industry are used in fixed proportions, implying that a doubling of output will require an exact doubling of inputs. No consideration is given to profitability or the potential for substitution between inputs.
Fixed prices	Prices are assumed not to adjust in response to economic factors, and thus, firms will not adjust their production on the basis of relative prices. Other macroeconomic feedback and adaptation mechanisms are also excluded.[a]
No supply constraints	Inputs, including labor, are assumed to be available at prevailing prices. Any constraints that preclude resource availability are not considered.
Constant proportions of local supply	Firms will purchase some fixed portion of their inputs from their local economy and from outside the local economy. The share from outside the local economy determines leakages from the system and is assumed to be constant.
No explicit time dimension	I/O models are static and assume a new equilibrium with a change in final demand.[b]
Perfect mobility of labor	Changes in demand for labor are assumed to be associated with changes in the associated income flows for those workers. An assumed decline in demand results in less economic activity and employment (in fixed proportions by sector), and the wages of the newly unemployed are assumed to leave the region.

SOURCES: Authors' interpretation as informed by Patrick Grady and R. Andrew Muller, "On the Use and Misuse of Input-Output Based Impact Analysis in Evaluation," *Canadian Journal of Program Evaluation*, Vol. 3, No. 2, 1988; Coughlin and Mandelbaum, 1991; David W. Hughes, "Policy Uses of Economic Multiplier and Impact Analysis," *Choices*, Vol. 18, No. 2, 2nd Quarter 2003; Rebecca Bess and Zoë O. Ambargis, "Input-Output Models for Impact Analysis: Suggestions for Practitioners Using RIMS II Multipliers," paper presented at the 50th Southern Regional Science Association Conference, New Orleans, La., March 23–27, 2011; and Schnaubelt et al., 2014.

[a] Feedback mechanisms include price changes due to changes in supply and demand across markets, and other adaptive mechanisms include economic redevelopment efforts, job training, and other policy effects. A type of modeling termed *general equilibrium modeling* includes the former and would likely yield different results from those obtained from I/O models.

[b] The length of time needed to establish this new equilibrium is specific to the problem and model.

price changes and other effects. So, the impact may be less severe, especially in the longer run.[3] The advantage to I/O models, however, is the simplicity of the approach.

In addition, any policy responses to a gain or loss in spending are not represented in the I/O structure.[4] One example might be a concerted effort on behalf of planning agencies in the region to develop incentive policies for redevelopment of assets previously owned by the Army. If such efforts are successful, the longer-run impacts of a change may be overstated by I/O analysis.

[3] However, if the increase in Army spending results in additional development activity due to agglomeration or other forward-linkage effects, estimates from an I/O model may be underestimated (i.e., smaller in magnitude than might actually happen).

[4] While these responses are not built into the model structure, they could, in theory, be modeled via additional changes to final demand if such estimates were available or calculated.

Defining 'Local'

We chose the congressional district as the primary unit of analysis for a number of reasons.

The data we use in this study provided for three possibilities: ZIP codes, counties, and congressional districts at the substate level. ZIP codes were immediately deemed impractical due to the sheer number—almost 42,000—and the frequently very small geographic size.[5]

Counties presented a plausible option that we considered during research design. They would allow the Army to give members of Congress details that congressional district–level analysis could not. However, there are more than 3,100 counties in the United States, compared with 435 congressional districts, which would have made reporting the results more challenging—the report would have been several thousand pages.[6] Furthermore, county-level results would be less comparable, as counties vary significantly in population and economy size. County populations in the United States range from less than 100, such as Loving County, Texas, to almost 10,000,000 in Downtown Los Angeles County, Calif.[7] In comparison, congressional district sizes are regulated by law and range from approximately 994,000 for Montana At-Large to approximately 526,000 for Rhode Island's First District, although their relative structures and economic activity vary significantly from district to district.[8]

Using congressional districts as the unit of analysis should also help the Army clearly inform members of Congress regarding the economic effects of Army spending on their constituents—the principal task with which we were asked to assist.

However, using congressional districts has one significant disadvantage—it excludes the District of Columbia and the territories of Guam, the Virgin Islands, and Puerto Rico from the analysis. This means that the economic effects of spending in these areas are not captured by the model, and we capture only activity in areas covered by congressional representation. In addition, although IMPLAN estimates regional economic models at the congressional district (as well as county) levels, the district-level models do not include trade flows between districts. Our methodology takes this into account, as we will describe.

Estimating the Economic Activity Associated with Army Spending at the District Level

To estimate the economic effect of Army spending in each of the 435 congressional districts and the 50 states, we used IMPLAN models at the district level and the national level. Each district-level model was used to estimate the direct, indirect, and induced effects of Army spending taking place within the district. The interindustry relationships were tailored to the unique characteristics of each district using a combination of local and national data as compiled within IMPLAN and summarized using Type II multipliers for each of the 440 sectors contained in the model.[9] The estimate of the effects of any spending activity on a regional

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5 United States Postal Service, *Postal Facts 2014*, p. 19

6 U.S. Census Bureau, *USA Counties,* web page, undated-c.

7 ———, "Community Facts," *American FactFinder* web page, undated-b.

8 U.S. Census Bureau, *Fast Facts for Congress,* web page, undated-a.

9 For detailed documentation of IMPLAN models, see IMPLAN Group, homepage, undated.

economy depended on the structure of the local economy and the size and distribution of the spending itself. Multipliers (or total activity given a change in final demand) varied across regions because of the composition of industries within the economy and the proportion of local inputs used in the production process.

For our analysis, we estimated the regional economic activity associated with all direct Army spending entering the regional and national economies in a fiscal year.[10] We implicitly assumed that this spending originated from outside the region and that direct Army spending in a region representsed final demand, unless it was passed through the region as a subcontract. This makes intuitive sense; the purpose of this spending is national defense, and the firms, consumers, and local government within a given region have little control over the ultimate distribution of spending at the national level. However, the district-level models cannot account for the economic activity in the district supported by Army spending in the rest of the country. Thus, Army spending in the rest of the country can generate intermediate demand for outputs from each district, which would not be captured by district-specific Army spending and a district-level I/O model.

The national-level IMPLAN model, however, included estimates of industry-specific trade flows across the country and, thus, in principle, captured all the interindustry relationships of national-level Army spending. We used this property to estimate the total effect of national-level Army spending on each district, including both final demand generated within the district and the intermediate demands for district products generated by spending outside of the district.[11]

Specifically, we used estimates of the total value of all goods and services produced by the economy (or economic output) as the measure of economic activity. We then apportioned this activity to each congressional district in proportion to each district's share of the sum of district-model effects, which included only the outcomes of direct Army spending within a district. Implicitly, this method modeled all interregional trade flows in proportion to the sector-specific share of national economic output supported by Army spending within a district. This assumption of linearity is consistent with the overall structure of I/O models. It also has the advantage of internal consistency, in that the sum of district-level effects can be aggregated to the state level, and the sum of the resultant state-level effects equals the economic activity estimated by the national model and national-level Army spending.[12]

The following procedure details the methods we used to estimate economic output and employment supported by Army spending in the United States.

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[10] In particular, we adjusted personnel expenditures for federal taxes that do not directly enter the regional (district-level) economy.

[11] While this procedure is appropriate for apportioning activity to subnational regions, it is not appropriate to use the national-level output figure as an estimate of the national-level impact of Army spending because, at the national level, all government spending is financed through either taxes or borrowing, so that a reduction in Army spending would likely be used to pay down debt, returned to taxpayers, or shifted to other forms of government demand. On the other hand, Army spending at the local level can be considered exogenous, or determined outside, rather than inside, the economic system.

[12] The internal consistency property applies to spending flows. Because our primary regional unit is the congressional district and individuals may claim multiple residences over the course of a fiscal year, sums of congressional district personnel counts to state or other aggregated levels will likely count some individuals multiple times.

Step 1: Construct the National and District Models

We used IMPLAN's 440-sector level of detail to create the 435 individual congressional district models and the one national model. In constructing each model, the IMPLAN software created two matrices of 440 rows by 440 columns containing the indirect (Type I) and induced output multipliers, which were summed to obtain Type II multipliers. The interpretation of rows and columns is as described earlier in this chapter. These output multipliers reflect region-specific differences in economic composition and the proportion of inputs that are supplied locally.

Step 2: Estimate Direct Army Expenditures

The inputs to each model were the estimates of sector-specific Army spending in each region, which included spending on active and reserve personnel, civilians, retirees, and procurement and contracting data by place of performance. Army procurement data were sourced from FPDS-NG by place of performance at the ZIP-code level, with industry sectors reported by the appropriate year of the NAICS code.[13] The data were standardized to the 2007 NAICS codes and subsequently converted to the IMPLAN 440-sector classification, as outlined in Appendix A. Deobligations were recorded in the year in which they were recorded in the data.[14] The Army's military and civilian payroll data were sourced from DMDC and its DEERS and are reported by home ZIP code. The spending data at the ZIP-code level was then aggregated to the congressional district level, as outlined in Appendix A. For the military payroll data, all available (pretax) positive compensation categories from the active and reserve pay files were included. These amounts were adjusted for average Federal tax withholdings on taxable income by rank using the average rates implied by the Department of Defense's Compensation Greenbook for each year.[15] Given the large variation in state and local tax treatment of military pay, we made no adjustments for these withholdings. All else equal, this will slightly overstate take-home pay. Civilian and retiree payroll data included actual witholdings for Federal, state, and local taxes.

These assignments created 435 district-specific sets of direct Army spending, each with 440 rows (one for each IMPLAN sector) and one column. In mathematical terms and in the technical language of I/O modeling, these sets of numbers are called vectors (see Table 2.1). Because the original data were in nominal terms, these dollars were converted to 2012 dollars using the GDP deflator provided by the Bureau of Economic Analysis. These vectors represent the final demand that was assumed to be associated with each district. For the national analysis, we summed the 435 district-specific input vectors to create the national analogue.

Step 3: Estimate District-Level Economic Activity from District-Specific Army Spending

Economic effects for each district-level model were calculated by multiplying the Type II output multiplier matrix (440 rows by 440 columns) constructed in Step 1 by the direct-spending vector (440 row by 1 column) created in Step 2. This produced a table (440 rows by 1 column) representing the overall economic output that direct Army spending supports in the

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[13] Codes can vary slightly over years.

[14] A deobligation enters as the opposite sign of a planned expenditure. Deobligations have the effect of increasing the variance of direct acquisition and procurement spending from year to year where they occur. Personnel spending is expected to be more constant over time.

[15] U.S. Department of Defense, *Military Compensation*, undated.

district by sector. These results did not include the changes in economic output in each district driven by changes in Army spending in the rest of the country. We applied the same calculations to the national-level model; however, the national region included all relevant trade flows between districts.

At the district level, it is possible that one or more of the industry sectors associated with acquisitions and procurement in the regional IMPLAN model were associated with zero economic activity (i.e., no output or employment for that sector). In these cases, the Type II multiplier is equivalent to zero. Although this is reasonable for subnational regional economies, it does create the potential for a mismatch between reported direct-level Army spending in those sectors and the economic model used to calculate impacts. Potential reasons include errors in the place of performance or NAICS code of the spending data, errors in the IMPLAN model, or both.

For example, IMPLAN sector 285 is "aircraft engine and engine parts manufacturing" (2007 NAICS code 336412). Although this is a $46 billion industry at a national level, not all district-level models contain positive output and/or employment in this sector (i.e., employment and output in this sector are assumed to be zero for this district). If the procurement and/or acquisitions data used in the analysis identify a positive contract (or negative, in the case of a deobligation) for this sector, either the input data have been misclassified (in the case that true activity in this sector is zero), or the IMPLAN model is incorrect (in the case that true activity is this sector is nonzero).

In these cases, it is assumed that the contracting or subcontracting spending assigned to the zero economic activity sectors is fully passed through the region to other (unspecified) districts. Because this spending is included in the national-level spending figures, it is not "lost" but rather reallocated proportionally across districts in accordance with our allocation procedure (see Step 4). We do not believe that this problem will induce major distortions into the analysis, but it is possible that this assumption results in either over- or underestimated overall economic activity in any given district.[16]

Step 4: Adjust for Trade Flows Between Regions

The district-level models potentially underestimate the amount of economic activity in a district supported by total Army spending by ignoring the effects of demand generated by Army spending in the rest of the country. For example, a reduction in personnel spending in Colorado's First Congressional District (CO 1) may affect the demand for certain goods in Virginia's Second Congressional District (VA 2) if CO 1 imports items from VA 2. However, the district-level models implicitly keep spending in the rest of the country fixed. This implies, for this example, that the reduction in demand in VA 2 is not taken into account in Step 3 of the process.

To account for these effects, we assumed that the national-level economic activity derived from total Army spending and the national I/O model captured all relevant trade flows between

[16] Specifically, there were initially six districts (CA-32, IL-6, MN-3, TX-30, TX-33, and WI-6) across the three fiscal years for which the total economic output figures exceeded the total direct spending, suggesting either that a substantial proportion of spending was passed through in this manner or that a significant deobligation was recorded in a given year. To correct for these major discrepancies, we reallocated Army spending to similar sectors.

regions,[17] and we apportioned these effects (by sector) to each district using that district's share of the sum of district-level effects. We describe this process next.

Step 4a: Calculate the Sum of the District-Level Effects

To create the denominator of the district-level shares, we summed the 435 district-level vectors of economic output by sector as calculated in Step 3. Because these results exclude trade flows between regions, they will be less than or equal to the national-region estimates.

Step 4b: Calculate District-Level Shares

We calculated the share of national-level effects allocated to each district by dividing each district's output effect from Step 3 by the sum of all districts' output from step 4a.

Step 4c: Calculate District-Level Effects with Trade Flows

We multiplied the district-level shares from Step 4b by the national output impact in Step 3 by sector to produce 435 district impact vectors adjusted for trade flows. These represented our estimate of the impact of all Army spending nationwide on the economic output of each congressional district.

To summarize, the national model is used to estimate the economic activity supported by nationwide Army spending, including all trade flows. We also had the economic activity supported by direct district-level Army spending for each congressional district. Each district's share of the summed district-level economic activity was multiplied by the economic activity from the national model to obtain the trade-adjusted district-level effects. The trade-flow effect accounts for the intermediate demand generated by out-of-district spending on each district. By construction, the trade-adjusted district-level effects minus the economic activity supported by direct district-level spending is the trade-flow effect.

In using the national-level model to estimate trade flows, we attempted to capture the impact of the demand generated by direct district-level and indirect out-of-district Army spending on each congressional district. This was necessary because we had no specific information on trade flows between congressional districts or information on the ultimate place of performance of assumed contracts that are fully passed through to other districts. Despite these limitations, we believe that the methodology used in this report provides a reasonable estimate of the distribution of overall direct and indirect procurement and acquisitions activity across congressional districts based on the overall structures of those local economies and provides a means of accommodating conflicts in the data.

Step 5: Estimate Employment Changes

The last task was to estimate the changes in district employment supported by Army spending. We estimated employment directly related to Army personnel (service members and civilian employees) directly from the spending data by counting the number of unique individuals paid by the Army in each region in each fiscal year. These figures included part-time employees.[18]

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[17] Implicit in this assumption is that the pattern of trade generated by Army spending is not different from nationwide sector averages. The extent to which this assumption is valid has not, to our knowledge, been formally tested.

[18] Because we used spending as our inputs into IMPLAN, we did not use the estimates of direct employment provided by the IMPLAN model in the direct employment calculation. The available data does not include drill pay for Reservists in months where they received both active duty and drill pay. We believe this underestimate amounts to no more than 2 to 3.5 percent of reserve pay. Additionally, because the DMDC data reports soldiers in the Active Guard/Reserve program within

We estimated employment directly related to procurement and acquisition activity by sector, as well as any employment associated with intermediate and induced demand in a region, using the district-specific ratio of output to employment contained within the IMPLAN software. For all sectors not associated with Army personnel, we multiplied the employment ratio by the sector-specific output estimates from Step 4c to obtain employment estimates.[19] Summing across all sectors in a region yielded the total number of non-Army jobs attributable to Army spending.

Estimating the Economic Activity Associated with Army Spending at the State Level

The state-level estimates of Army-supported economic activity are simply the sum of the district-level effects for each state. This calculation is appropriate because we used the national-level model (and national-level Army spending) to estimate total trade flows across the nation and apportioned these according to district-specific shares from the district-level models. Thus, the calculation implicitly aggregates the intrastate trade flows as represented in the national-level model. As noted, however, the direct Army personnel counts may be overstated if an individual claimed multiple residences in the same state in the same fiscal year. As such, the state-level counts will likely overstate overall force strength in a state.

An alternative approach would be to construct the state-level IMPLAN models and use these subregions in the same manner as for the congressional districts (i.e., apportion effects according to steps 4a through 4c, but replacing districts with states). This approach aggregates intrastate (and thus interdistrict for a given state) trade flows via the state-level multipliers associated with each model.

If IMPLAN used estimates of congressional-level trade flows to aggregate its models, these approaches would be equivalent. However, IMPLAN uses a county-level trade flow model to build multipliers at the multiple county, state, and national levels. So, there may be differences in results at the state level.

We opted to sum the results of the congressional district analyses to obtain state-level estimates to maintain additivity from the district to state to national levels of aggregation.

Differences in This Analysis and Standard Input-Output Studies

A major difference in the methodology used in this study and more-traditional I/O analysis is that our estimate of total economic activity supported by Army spending within a congressional district includes changes in final demand on a district's goods and services from two sources: Army spending directly in the district and Army spending from outside the district that affects demand within the district via supply chain relationships (or backward linkages).

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the active pay files, the number of soldiers assigned to ARNG and USAR units in a district and state was undercounted while Regular Army soldiers were overcounted. However, these disparities do not influence the reported estimates of economic effects.

[19] The government sectors in IMPLAN to which this personnel spending is assigned do not supply outputs to the rest of the economy and have intraindustry multipliers of 1.

Because the model uses *national* Army spending to derive *local* economic effects, the ratio of economic output to direct spending, often termed the *output multiplier*, would likely overestimate the economic impact of changes in *local* Army spending in a given region. Furthermore, as already discussed, we assumed that any contract or procurement spending assigned to a NAICS code for which there is zero economic output in the appropriate IMPLAN sector at the district level is subcontracted out of the district. Thus, the actual change in final demand within a district may be less than that recorded in the direct spending figures, although the total amount of direct Army spending is consistent at the national level. Thus, while the sum of reported district-level direct spending (or, alternatively, the sum of state-level reported direct spending) equals the national direct spending total, the proportion of changes in final demand at the district level may not equal the proportion of reported direct spending at the district level.

As a result, the ratio of total effects to direct Army spending presented in this report may not be an accurate measure of the per-dollar effect of increased *local* Army spending in a district or state.[20] Rather, our results are appropriate estimates of the effect of *total*, *nationwide* Army spending on each congressional district and state.

Because of these issues, these ratios may take on values that are not consistent with single-region I/O analysis. For example, in the case of relatively small demand in a district generated by out-of-district Army spending but a relatively high degree of contract pass-through (thus creating a gap between reported direct spending and the change in final demand), the ratio of total to direct effects may be less than 1. Similarly, in the case of relatively large demand generated by out-of-district Army spending, the ratio of total to direct effects may appear well above 2, even for small geographic areas, such as congressional districts. Therefore, we do not report standard district-level or state-level output and employment multipliers in this report.

[20] Using this report's notation, for example, a standard output multiplier would be calculated by dividing Army-driven economic output by all Army direct spending.

CHAPTER THREE

Data Sources

This chapter briefly describes the models and data used in analyzing the economic contributions of Army spending. Because the representation of the regional economies in the IMPLAN model (especially at the congressional district level) and the Army spending data are subject to error, estimates of the economic activity associated with Army spending are also subject to error. The relative magnitudes of these errors are unknown (and unknowable), although they are likely smaller at more-aggregated levels of geography. For those errors that are detectable (but not correctable due to a lack of data), we estimate an approximate magnitude of 5 percent on average. Since pay constitutes roughly 45 percent of the Army budget, this may induce an error of 2–3 percent in our average estimates of Army direct spending. However, the errors are probably not equally distributed, so the error rate may be higher in some congressional districts and states. We have based our estimates on the best available data, and our method of adjusting for trade flows should contribute to error minimization.

The IMPLAN Model

We obtained the regional multipliers and sector spending patterns from the IMPLAN Group. IMPLAN estimates spending patterns using data from the U.S. Bureau of Economic Analysis and the U.S. Census Bureau. It estimates employment numbers from the U.S. Bureau of Labor Statistics and County Business Pattern data. The multipliers are constructed using the Benchmark I/O tables from the U.S. Bureau of Economic Analysis. These models are estimated at the national, state, county, congressional district, and ZIP-code levels.[1] We used the 2012 congressional district models and the national-level model. Trade flows were not estimated at the ZIP-code or congressional district levels, but they were estimated at the county level and up. As described in Chapter Two, Step 4 in our process adjusted our models to estimate the demand of a sector's national output in each district. Appendix A describes the mapping of ZIP codes to congressional districts, as well as the mapping of NAICS industry codes into IMPLAN sectors.

[1] IMPLAN Group, "IMPLAN Data Sources," web page, 2014.

Procurement Data Sources

This report used procurement data for the Department of the Army obtained from FPDS-NG and the FSRS.[2] The FPDS-NG includes all reported public contract actions made by the government with private contractors (first-tier awardees) valued at $3,000 or more; it excludes contract actions defined as micropurchases, which are made with a government purchase card through the Army government payment card program.[3] It is therefore possible that direct Army spending may be underestimated by as much as 3 percent per year at the national level.

FPDS-NG contains obligated dollars per fiscal year by the place of performance (logged by ZIP code) and the NAICS code. The first-tier contract awards, contracts made directly by the Army, are available at the nine-digit ZIP-code level (ZIP+4). ZIP+4 codes are unique to individual congressional districts. This allows us to identify and apportion all first-tier awardee data to the specific congressional district in which it was performed. Because of the manner in which the data are reported, a multiyear contract may be recorded as completely obligated in one fiscal year. In such cases, our methods would overestimate the spending in that year and underestimate spending in the other years of the contract.

The FSRS contains all contract actions made by first-tier awardees to other private contractors (first-tier subs) when the contract amount is valued at or above $25,000.[4] We subtracted the amount received by the first-tier sub from the first-tier awardee's place-of-performance ZIP code and NAICS code total and added the amount to the first-tier sub's place of performance and NAICS codes total.

FSRS data are available at the five-digit ZIP-code level. Some ZIP codes are not unique to congressional districts. For instance, ZIP code 22407 of Fredericksburg, Virginia, includes parts of Virginia's First and Seventh Congressional Districts. Per IMPLAN methodology, we divide the economic activity in the ZIP code region by the number of congressional districts it touches. Appendix A provides additional details.

For state-level tables, we attributed each contract action identified in FSRS to a particular component of the Army by looking at the appropriation used to fund the spending.[5] If the appropriation could be explicitly tied to the ARNG or USAR (for example, "operations and maintenance, Army Guard," or "operations and maintenance, Army Reserve"), we associated the spending with one of those components. If an analogous appropriation (for example, "operations and maintenance, Army") did not explicitly identify a component, we associated it with the Regular Army component. We also associated appropriations relevant only to Regular Army members and families (for example, "family housing construction, Army" and the Homeowners Assistance Fund) with the Regular Army. Finally, we associated all other spend-

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[2] Specifically, we included all actions initiated by all Army contracting offices.

[3] In FY 2009, the government payment card program included approximately 53,300 cards with cardholders making about 4.5 million transactions valued at $4.5 billion. This represented approximately 3 percent of the Army's $140.7 billion dollar budget request for FY 2009. Inspector General, DoD, *Army Needs to Identify Government Purchase Card High-Risk Transactions*, Washington, D.C., DODIG-2012-043, January 20, 2012; LTG David F. Melcher and MG Edgar E. Stanton III, "Army FY 2009 Budget Overview," briefing, February 2008.

[4] Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, *Federal Subaward Reporting System (FSRS)*, web page, undated.

[5] Appropriations in the FPDS data are identified by Treasury Account Symbols (TAS): Agency Identifier and Main Account Code. These codes are described in the FAST Book, Book II, Part II—"Appropriation and Other Fund Account Symbols and Titles—Major Agencies."

ing (for example, "procurement or chemical demilitarization construction, defense-wide") with the Regular Army. See Appendix A for more details. This assignment explicitly linked the obligations represented by our data to the type of appropriation that Congress uses to allow the spending. However, it is possible that additional dollars were appropriated to Army components but used for spending not captured by our data and/or not appropriated to the Army specifically but the spending was managed by the Army. Thus, our results do not show the effect of all appropriated dollars to the Army but rather the effect of all obligated dollars contained in FSRS that are associated with the Army.[6]

Personnel Data

Army employment numbers and payroll data were obtained from DMDC and its DEERS for Regular Army, USAR, ARNG, and civilian personnel. DMDC is a military personnel management organization that maintains current and historical records of personnel numbers, as well as the total compensation and benefits received by military personnel.[7] All service members and their eligible family members are required to register with DEERS to receive health care benefits. The requirement should provide accurate locations for where the majority of payroll dollars accrue and where they are spent.[8]

DEERS was used to count soldiers serving in any Army component (Regular Army, USAR, and ARNG) in each domestic ZIP code in each fiscal year. The DEERS data is a monthly file that contains records of each registered service member and their dependents. The data was filtered to include only Army personnel, eliminate dependent information, and eliminate Individual Ready Reserve. Unique counts of each service member were then calculated in each fiscal year and then aggregated to the district level. Counts do not include service members with missing home ZIP codes or those with addresses outside of the United States.

The active and reserve pay files contain 150 data elements with such information as demographics, special and incentive pays (medical, hazardous duty, bonuses), basic pay, and allowances (e.g., variable housing allowance, overseas housing basic allowance for quarters, federal and state taxes, and separation pay).[9] The civilian pay file consists of extracts from the Defense Civilian Pay System and contains pay information for DoD civilians, such as demographics, pay amounts, leave, and hours worked. However, the files available to us do not indicate to which component the civilian personnel are assigned. Therefore, we use a single category of Government Civilian Personnel that includes all Army civilians without distinguishing whether they are funded by the Regular Army, USAR, or ARNG.

The active and reserve pay files are monthly individual-level files. The civilian pay files are biweekly. We summed all pay and tax fields at the home ZIP-code level across the months, creating fiscal-year totals. This is a straightforward task after adjusting for missing values coded

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[6] Another way to say this is that total spending by the Army contracting offices in the data is not the same as total appropriated spending by the Army according to Treasury Account Symbols (TAS). We include all available data for the former, but use the codes from the latter to split out this spending by component.

[7] DMDC, "DMDC Web," web page, undated.

[8] The district-level IMPLAN models take into account the average proportion of goods and services purchased locally versus outside of the district.

[9] The data for this project was pulled from the Unit Cohesion File developed and maintained at RAND.

in the data. The data are summed to the fiscal year and either the five-digit or three-digit ZIP-code level, depending on the source.

Regular Army, USAR, and ARNG payroll data are available at the five-digit ZIP-code level for FYs 2012 through 2014. Total positive compensation for all available fields was used to calculate ZIP-level gross pay by rank, and average realized federal tax rates on taxable income by rank and fiscal year was calculated from the Department of Defense's Compensation Green Books. No adjustment was made for state and local taxes. In addition, the ZIP code field in the data was blank for September, 2014; we assume they were unchanged from August, 2014. The five-digit ZIP code totals were apportioned to congressional districts per IMPLAN's methodology (see Appendix A).

Civilian service, retiree, and survivor payroll amounts are available at the three-digit ZIP-code level, as are Regular Army, ARNG, USAR, civilian employment numbers, and the counts of retirees and survivors.[10] The retiree and survivor payroll amounts were taken from DoD's *Statistical Report on the Military Retirement System*.[11] We did not have the 2014 survivor payments, so we estimated these by assuming that survivor payments follow a linear trend over the three years. The change in the number of survivors from FYs 2013 to 2014 will be the same as the change from FYs 2012 to 2013. The retiree payment amounts are monthly payments in thousands made to retired personnel before tax withholdings. Our civilian payroll files include pre- and posttax fields.

We estimated the amount withheld from retiree payments by dividing the civilian payroll pretax field by the posttax field and multiplying the result by the retiree payments. To reflect the total payments received each fiscal year by retirees, we multiplied the monthly payment by 12. Retiree payment tax rates are typically lower than tax rates on the employed. Therefore, our calculations likely underestimated the amount received by retired personnel.

We converted all spending figures to 2012 dollars using the GDP deflator published by the Bureau of Economic Analysis.[12]

Geographic Data

A geographic information system is a class of software for managing, storing, manipulating, analyzing, visualizing, and using geospatial data. For this study, we used ArcGIS software from Environmental Systems Research Institute. (ESRI). Within this geographic information system, geospatial features are represented as polygons (for larger areas), lines (for linear features), and points (for a point location). The DoD Military Installations, Ranges and Training Areas data set was used for geographic information on military installation polygons. These installation polygon data are for Regular Army installations, joint installations, and larger-area ARNG sites. Larger-area ARNG polygon sites are installations that have areas larger than 40,000 acres. However, not all the larger ARNG sites were in this data set, so these sites are represented as points instead. ARNG sites represented as points on the map were provided by the Chief of the Real Estate Branch of the ARNG's Installation Division but were created and

[10] See Table A.1 in Appendix A for a description of data available at the nine-, five-, and three-digit levels.

[11] DoD Office of the Actuary, 2013; DoD Office of the Actuary, 2014.

[12] Bureau of Economic Analysis, "Table 1.1.9. Implicit Price Deflators for Gross Domestic Product," *National Income and Product Accounts Tables*, web page, March 27, 2015.

curated by ARNG Support for Real Property, R&K Solutions Inc. Geographic information on USAR sites represented as points on the map were provided by the U.S. Army Reserve Command headquarters office. Congressional district data are derived from ESRI and the U.S. Census Bureau's USA 113th Congressional Districts data set.[13] ESRI and U.S. Census Bureau 2013 Populated Places data are used for city points. Base-map data, including highways, state borders, and water features, are derived from the 2013 ESRI USA Base Map data set.

Relationship of Component-Level Data Splits with Related RAND Research

The RAND Arroyo Center is also conducting another policy analysis for the Army that splits Army spending among Army components in a different way to address a different question. Other policy decisions might call for allocating spending among components in still other ways; in fact, other RAND analyses have used other assignments when appropriate.

For example, when designing force structure, the Army must decide to provide a specific operational capability with a Regular Army brigade combat team or a set of ARNG units that can provide exactly the same operational capability as the Regular Army brigade combat team. When addressing this decision, it is useful to know what it costs to create and sustain each option. The estimation of such cost naturally requires that we determine what assets and materiel each option requires and what it costs the Army as a whole to acquire and sustain the assets and materiel associated with each option. Such costing assigns items purchased using procurement appropriations to the Regular Army or ARNG component that our analysis places in the Army-wide category. The assignment of procurement spending in different ways occurs because these two analyses are supporting different policy decisions.

We raise this point to help the reader understand that the assignment used here may not be useful when addressing questions other than that of asking how congressional spending decisions affect local economies within the United States. More generally, we wish to avoid any misunderstanding of differences between how RAND allocates spending among Army components in different analyses.

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[13] ESRI, ArcGIS software, USA Base Map data set, 2013; U.S. Census Bureau, *Cartographic Boundary Shapefiles—Congressional Districts*, revised October 2014; U.S. Census Bureau, *TIGER/Line Shapefiles*, last revised April 2015.

CHAPTER FOUR

Results

This chapter provides a brief description of the key terms used in the district- and state-level results, as well as a summary of the range of results. We also present state-level results sorted alphabetically and from highest to lowest effect in terms of economic output. Detailed congressional district and state-level estimates of the economic activity supported by national Army spending are provided in Appendix B.[1]

Key Terms and Definitions

District and State Level Tables

The following terms are used in the tables contained in this chapter and in the tables presented in Appendix B.

All Army direct spending is the primary input into the I/O models. It is the estimated amount of Army spending on procurement, personnel (including Regular Army, USAR, ARNG, and civilians), and retirees within a region. The figure reported in the tables includes all reported Army spending within a congressional district, adjusted for outgoing and ingoing subcontracts. As discussed in Chapter Two, however, it is possible that a positive level of spending for a particular NAICS industry in a given district corresponds with an IMPLAN model sector with zero output for that sector. In such cases, we assumed that the contract was passed directly out of the district as a subcontract.[2] This created a gap between *all Army direct spending* and the change in final demand within a district.

Additional economic output is the estimated amount of economic activity that Army-generated demand supports in a region, as measured by the value of production in all sectors of the economy that is supported within a region as a result of all Army final demand (*all Army direct spending* minus assumed subcontracting for zero economic activity sectors). This includes changes in final demand as a result of Army spending within the district and intermediate demand generated from outside the district.

Functionally, this term is calculated as the difference between total economic output supported by Army spending and *all Army direct spending*. In the case of a high degree of pass-

[1] Appendix B is presented in two separate volumes: Schnaubelt et al., 2015a; Schnaubelt et al., 2015b.

[2] This spending will, however, be captured by the national model estimates.

through direct spending or deobligations within a district for a given fiscal year, it is possible for this term to be negative.[3]

For example, assume that total direct Army spending is $500 million in a given district. This spending is assumed to be final demand and will stimulate intermediate demand for inputs used to satisfy this contract within the region. The total value of this supplying activity is *additional economic output*. *Army-driven economic output* is the total value of production in a region that results from all Army direct spending nationwide, including all supplying activity.[4] This measures the estimated direct, indirect, and induced effects of all Army spending within a region. By construction, this equals the sum of *all Army direct spending* and *additional economic output.* Maintaining the example above, if the total intermediate demand is $250 million (*additional economic output*), from the $500 million that remains in district, *Army-driven economic output* is equal to $500 million + $250 million = $750 million.

All Army direct employment is an estimate of the total number of persons employed by the Army in a region at any time during the fiscal year, including Regular Army, USAR, ARNG, and civilians. It is measured as the number of unique individuals paid by the Army in each fiscal year. Because the DMDC data reports soldiers in the Active Guard/Reserve program within the active pay files, the number of soldiers assigned to ARNG and USAR units in a district and state was undercounted (all else equal) while Regular Army soldiers were equally overcounted. Dual-status technicians are counted twice because they have two jobs. However, these disparities do not influence the reported estimates of economic effects. Individuals who have claimed multiple addresses in multiple regions during a fiscal year are counted in each region. As such, sums of personnel across regions may not be accurate reflections of the number of individuals employed in a given year. In addition, the counts are of individuals employed at any time during the fiscal year by the Army. As such, these numbers cannot be aggregated to obtain overall force size.

Additional employment is an estimate of the non-Army employment associated with additional economic output, using region-specific ratios of output to employment by sector contained within IMPLAN. It includes estimated employment related to direct spending on contracting and procurement, as well as indirect employment generated by the backward-linkages in the district-level economy. If, for example, the average number of jobs per million dollars of output associated with the direct spending for procurement and acquisitions plus generated intermediate demand is 7.3, the total estimated additional employment in our example is approximately 68.5.

All Army personnel and additional employment is the total employment supported by Army direct spending nationwide, including all supplying activity. It measures the estimated direct, indirect, and induced jobs supported by all Army spending within a region, and is equal to the sum of *all Army direct employment* and *additional employment*. If direct Army employment in the region were equal to 50, the total *Army personnel and additional employment* would be 108.5 for the maintained example.

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[3] In reporting these results, the choices were to (a) report Army direct spending in a district as the actual estimated change in final demand, in which case the sum across all districts would not equal the national-level total of Army direct spending; (b) retain the Army direct spending as reported and calculate additional economic output from the assumed change in final demand, in which case the sum of direct and additional economic output would not equal the total economic output; or (c) calculate additional economic output as the residual, as we did here. We opted for option (c) as the choice easiest to interpret.

[4] *Output* is distinct from value-added, or gross regional product, in that the former includes the total value of all production (including intermediate inputs), while the latter excludes the value of intermediate inputs.

The reader is reminded that multipliers calculated from the ratio of *Army-driven economic output* to *all Army direct spending* should not be used to predict the effects of a change in direct spending because (a) direct spending does not necessarily equal changes in final demand in a district, and (b) the *Army-driven economic output* figures include economic activity generated from both changes in final demand in a district and from intermediate demands generated from Army spending outside the district.

State-Level Tables

In addition to the terms defined above, the state-level tables in Appendix B include economic effects calculated on a component-specific basis. In particular, we assigned direct spending, where possible, to components according to an aggregation of appropriation categories that results in the following categories:

- Regular Army
- USAR
- ARNG
- Civilian/retiree/survivor.

All appropriations categories that could not be mapped explicitly to a component, including all procurement and RDTE spending, were assigned to Regular Army. Appendix A provides additional details about the appropriations subcategories that are used in the analysis.

The economic activity associated with each direct spending subcategory was estimated using the methodology described in Chapter Two.

Key Insights and Observations

In this subsection, we provide a basic summary of the results of the analysis. For more detailed estimates, see Appendix B.

To provide context, Table 4.1 provides statistics related to total estimated population, employment, and total personal income across the 435 congressional districts for the year

Table 4.1
Population, Employment, and Total Personal Income, Congressional District Statistics, 2012

	Total Population	Employed Persons, Population over 16	Total Personal Income ($2012)
Average	693,065	570,270	$19.0 billion
Median	693,344	573,404	$17.7 billion
Minimum	509,019	428,216	$8.3 billion
25th percentile	676,176	554,199	$15.4 billion
75th percentile	710,175	588,355	$21.3 billion
Maximum	975,529	809,850	$50.9 billion

SOURCE: : U.S. Census Bureau, *American Community Survey*, 2012.
NOTES: Total Personal Income includes wage and salary income, net self-employment income, interest, dividends, net rental or royalty income or income from estates and trusts, Social Security or Railroad Retirement income, Supplemental Security Income, public assistance or welfare payments, retirement, survivor, or disability pensions, and all other income. Average, minimum, maximum, and other percentiles calculated independently for each column.

2012.[5] Total personal income as measured by the American Community Survey is a measure of general economic well-being akin to gross district product, which is unavailable at the district level.[6]

Table 4.2 reports statistics about direct Army spending, Army-driven economic output, and Army personnel and additional employment across the 435 congressional districts for FY 2014, reported in 2012 dollars.

As seen in the table, the Army spent approximately $121 million (2012 dollars) in the median district, with a corresponding economic effect of approximately $375 million (2012 dollars) from direct and intermediate demand. This translates into about 4,200 jobs, including all service member and civilian employees of the Army and the private-sector employment supported by Army spending. The range of district-level Army direct spending and impacts is large, with the distributions skewed toward a greater number of smaller-impact districts and a small number of high-spending districts.

Figure 4.1 provides an additional view of the relationship between district-level Army direct spending and Army-driven economic output in each district. This figure provides further visual evidence of a skewed distribution of direct spending and economic effect, with large spending amounts concentrated in a small number of districts. The straight line in the figure represents two times the direct district-level Army spending, which is often viewed as an upper bound on output multipliers associated with local spending, as opposed to national-level spending, as is the case here. The inclusion of intermediate demand generated from Army spending outside a district paints a more comprehensive picture of the effect of nationwide Army spending on individual districts.

Table 4.3 provides statistics related to total estimated population, employment, and total personal income across the 50 states for the year 2012. Results are reported in 2012 dollars.

Table 4.4 presents statistics related to Army-supported economic activity across the 50 states for FY 2014, reported in 2012 dollars.

At the state level, the Army spent approximately $1.7 billion in the median state (in 2012 dollars), with a corresponding economic effect of approximately $5.5 billion, including the

Table 4.2
Army-Supported Economic Output and All Army Personnel and Additional Employment Congressional District Statistics, 2014

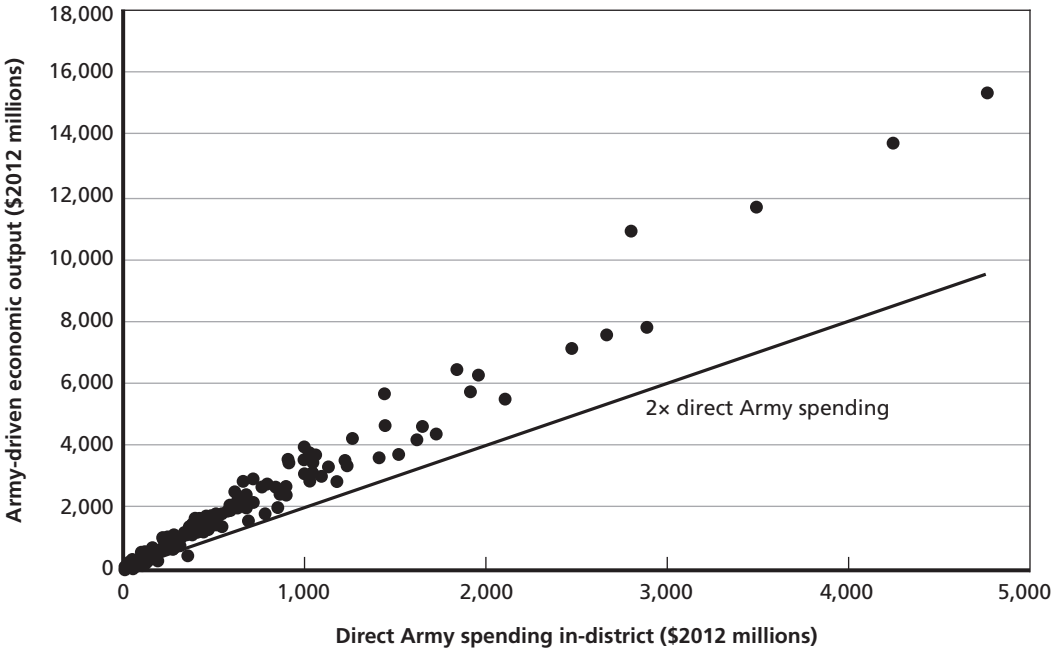
	All Army Direct Spending ($2012)	Army-Driven Economic Output ($2012)	All Army Personnel and Additional Employment
Average	$290.2 million	$913.6 million	9,171
Median	$120.8 million	$374.5million	4,178
Minimum	$14.6 million	$22.4 million	786
25th percentile	$66.6 million	$205.1 million	2,541
75th percentile	$246.9 million	$771.7 million	7,758
Maximum	$4.8 billion	$15.3 billion	111,303

NOTE: Average, minimum, maximum, and other percentiles calculated independently for each column.

[5] We report 2012 figures because this coincides with the baseline IMPLAN model.

[6] Gross district product is equal to total district output minus intermediate inputs. It is a measure of the value added by production within a district.

Figure 4.1
Scatterplot of Army-Driven Economic Output Against Direct Army Spending ($2012 millions)



RAND *RR1119-4.1*

effects from direct spending within the state and intermediate demand from outside the state. This translates into just over 62,000 Army and non-Army jobs. The range of state-level Army direct spending and impacts is not quite as large, proportionally, as it is in congressional districts, with more symmetric (though still skewed) distributions.

Figure 4.2 shows the cumulative percentage of the economic activity supported by all Army spending across states for FY 2014, sorted from highest to lowest effect by state, from left to right.

Table 4.3
Population, Employment, and Total Personal Income, State Statistics, 2012

	Total Population	Employed Persons, Population over 16	Total Personal Income ($2012)
Average	6,041,416	4,961,353	$164.9 billion
Median	4,331,550	3,537,470	$105.1 billion
Minimum	548,219	453,994	$15.2 billion
25th percentile	1,725,514	1,386,154	$41.3 billion
75th percentile	6,998,876	5,750,136	$226.5 billion
Maximum	36,389,464	29,884,983	$1,031.3 billion

SOURCE: U.S. Census Bureau, 2012.
NOTES: Total Personal Income includes wage and salary income, net self-employment income, interest, dividends, net rental or royalty income or income from estates and trusts, Social Security or Railroad Retirement income, Supplemental Security Income, public assistance or welfare payments, retirement, survivor, or disability pensions, and all other income. Average, minimum, maximum, and other percentiles calculated independently for each column.

Table 4.4
Army-Supported Economic Output and All Army Personnel and Additional Employment State Statistics, 2014

	All Army Direct Spending ($2012)	Army-Driven Economic Output ($2012)	All Army Personnel and Additional Employment
Average	$2.5 billion	$8.0 billion	79,786
Median	$1.7 billion	$5.5 billion	62,222
Minimum	$85.5 million	$245.7 million	3,549
25th percentile	$513.8 million	$1.5 billion	17,113
75th percentile	$3.1 billion	$10.1 billion	108,690
Maximum	$14.0 billion	$45.0 billion	419,119

NOTE: Average, minimum, maximum, and other percentiles calculated independently for each column.

The figure confirms the skew of the total impact distribution, with the top five states (Virginia, Texas, Maryland, Alabama, and Arizona) accounting for 37 percent of total Army-supported economic output, and the bottom five states (Maine, South Dakota, Vermont, Rhode Island, and Wyoming) constituting 0.5 percent of total Army-supported economic output across all states.

Because states have a much larger variation in economic activity and population than do congressional districts, we present the Army-supported economic output per capita in Figure 4.3. The range is quite large, with the greatest per-capita effect in Alaska, at just over than $6,200 per person (2012 dollars), while the smallest is Rhode Island, at $320 per person. Once again, the results are skewed, with a mean per-capita effect of $1,400 and a median (Arkansas and New Jersey) of $870 per person.

Finally, Tables 4.5 and 4.6 present the results of the economic effects of total Army spending by state for 2014. Table 4.3 presents results alphabetically, while Table 4.4 presents results sorted from largest to smallest economic impact in terms of total Army-driven economic output.

Figure 4.2
Cumulative Percentage of Economic Activity Supported by Army Spending by State, Army-Driven Economic Output and All Army Personnel and Employment, FY 2014

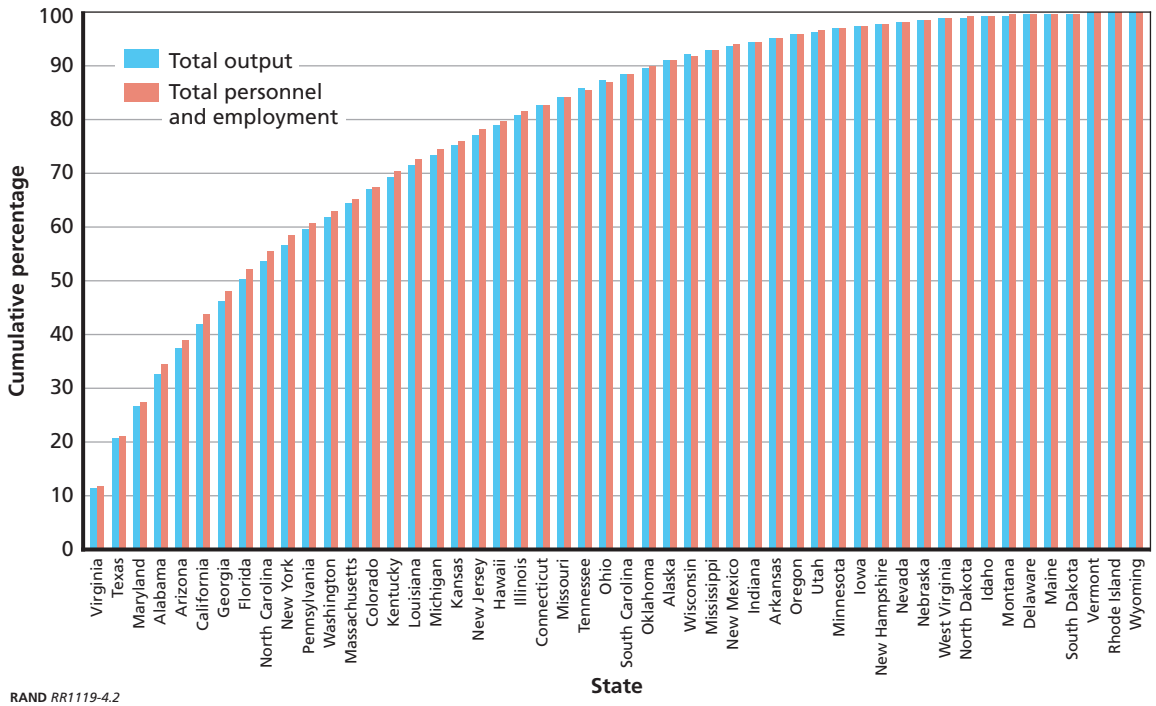


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Figure 4.3
Army-Supported Economic Output per Capita ($2012)

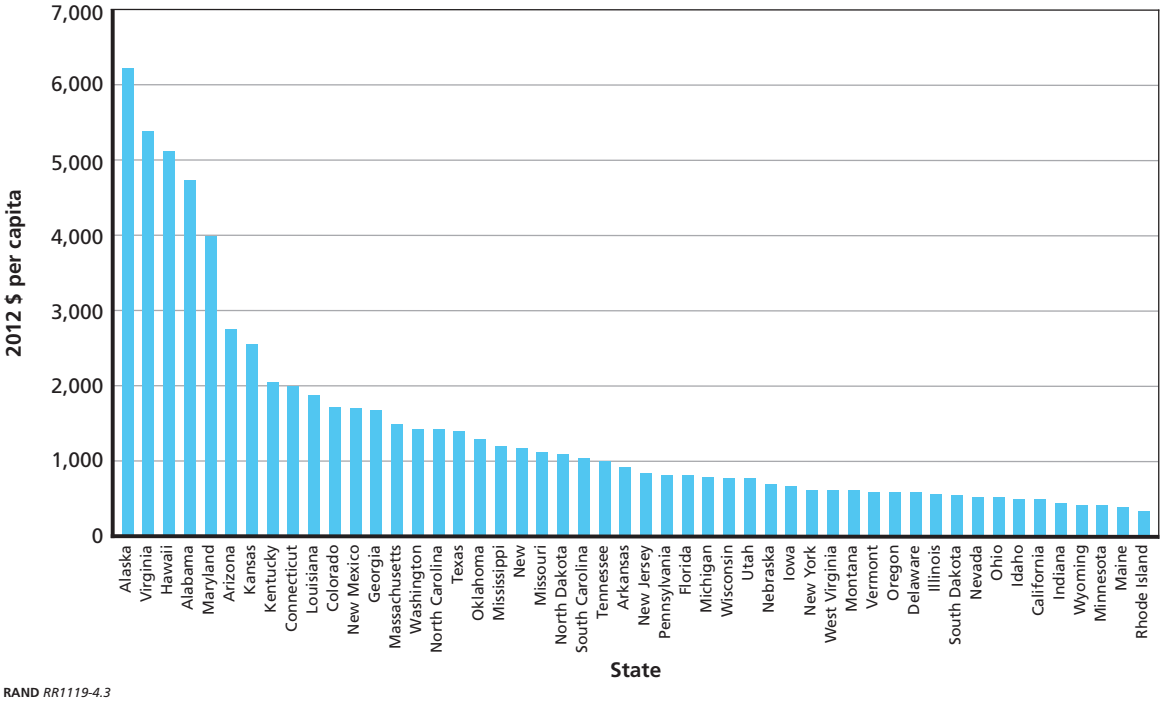

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Table 4.5
Economic Effects of Total Army Spending by State, Alphabetically Sorted, 2014 ($2012)

State	All Army Direct Spending[a] ($)	Additional Economic Output[b] ($)	Army-Driven Economic Output[c] ($)	Army-Driven Economic Output per Capita ($)	All Army Direct Employment[d]	Additional Employment[e]	All Army Personnel and Additional Employment[f]
Alabama	6,978,211,861	16,077,400,238	23,055,612,098	4,754	55,702	157,108	212,810
Alaska	1,648,850,998	2,946,364,778	4,595,215,776	6,237	24,348	23,623	47,971
Arizona	6,051,928,534	12,454,753,838	18,506,682,373	2,749	29,198	106,994	136,192
Arkansas	895,006,405	1,793,737,478	2,688,743,882	906	15,083	16,199	31,282
California	5,680,189,348	12,822,816,557	18,503,005,903	477	69,720	106,988	176,708
Colorado	3,112,018,020	6,080,890,259	9,192,908,282	1,716	60,778	52,759	113,537
Connecticut	2,282,199,849	4,903,495,039	7,185,694,887	1,998	7,192	29,255	36,447
Delaware	167,856,035	380,879,039	548,735,074	586	3,250	2,823	6,073
Florida	5,265,611,530	10,841,356,994	16,106,968,524	810	48,280	97,412	145,692
Georgia	5,818,318,260	11,074,504,885	16,892,823,147	1,673	110,884	102,003	212,887
Hawaii	2,919,095,117	4,344,537,701	7,263,632,819	5,117	46,500	40,319	86,819
Idaho	248,322,508	548,852,923	797,175,432	488	6,858	4,448	11,306
Illinois	1,984,985,107	5,216,894,982	7,201,880,086	559	27,299	36,670	63,969
Indiana	1,009,692,072	1,917,110,052	2,926,802,122	444	21,452	15,862	37,314
Iowa	654,402,380	1,367,515,026	2,021,917,405	651	14,915	11,689	26,604
Kansas	2,288,863,250	5,115,787,061	7,404,650,312	2,550	47,878	41,033	88,911
Kentucky	2,805,072,775	6,193,000,509	8,998,073,285	2,039	43,620	65,070	108,690
Louisiana	2,305,242,412	6,383,391,653	8,688,634,065	1,869	28,905	54,167	83,072
Maine	182,603,120	341,492,220	524,095,340	394	4,111	2,954	7,065
Maryland	6,650,540,011	17,193,411,371	23,843,951,383	3,990	46,680	147,959	194,639
Massachusetts	3,005,543,618	7,044,693,253	10,050,236,869	1,490	15,015	48,852	63,867
Michigan	2,482,724,153	5,241,091,382	7,723,815,534	779	23,975	39,695	63,670
Minnesota	777,580,997	1,433,425,253	2,211,006,250	405	17,685	10,248	27,933
Mississippi	1,026,484,218	2,573,782,292	3,600,266,509	1,202	18,323	23,630	41,953

Table 4.5—Cont.

State	All Army Direct Spending[a] ($)	Additional Economic Output[b] ($)	Army-Driven Economic Output[c] ($)	Army-Driven Economic Output per Capita ($)	All Army Direct Employment[d]	Additional Employment[e]	All Army Personnel and Additional Employment[f]
Missouri	2,297,333,398	4,516,123,391	6,813,456,789	1,124	49,988	37,712	87,700
Montana	180,985,916	448,419,027	629,404,943	615	4,922	3,886	8,808
Nebraska	401,462,966	906,666,787	1,308,129,753	695	8,053	8,481	16,534
Nevada	513,886,968	969,603,687	1,483,490,654	523	8,466	8,647	17,113
New Hampshire	470,302,141	1,067,424,801	1,537,726,942	1,159	4,430	8,638	13,068
New Jersey	2,066,554,254	5,332,102,786	7,398,657,040	828	20,776	44,420	65,196
New Mexico	1,030,372,993	2,519,433,155	3,549,806,148	1,702	11,074	23,678	34,752
New York	3,749,866,861	8,531,907,729	12,281,774,588	622	63,503	63,405	126,908
North Carolina	5,155,454,914	8,879,130,825	14,034,585,739	1,411	103,115	78,386	181,501
North Dakota	255,988,227	553,608,613	809,596,840	1,095	4,727	4,416	9,143
Ohio	1,712,369,547	4,252,256,708	5,964,626,257	514	25,542	38,156	63,698
Oklahoma	1,609,305,594	3,395,055,553	5,004,361,149	1,290	35,250	31,180	66,430
Oregon	645,909,913	1,708,822,870	2,354,732,782	593	11,289	14,035	25,324
Pennsylvania	3,790,984,496	6,751,131,548	10,542,116,045	824	41,872	52,452	94,324
Rhode Island	120,583,584	220,231,956	340,815,540	323	3,474	1,761	5,235
South Carolina	1,745,952,856	3,282,937,771	5,028,890,629	1,041	29,473	31,300	60,773
South Dakota	141,300,234	306,405,558	447,705,792	525	5,165	2,593	7,758
Tennessee	2,335,458,488	4,093,728,379	6,429,186,867	982	55,780	30,134	85,914
Texas	11,729,317,286	25,735,206,088	37,464,523,376	1,390	201,688	217,431	419,119
Utah	622,032,818	1,604,087,285	2,226,120,102	756	12,605	13,388	25,993
Vermont	120,607,045	253,107,933	373,714,978	596	3,208	2,217	5,425
Virginia	13,988,485,779	31,029,215,553	45,017,701,336	5,407	87,144	269,332	356,476
Washington	3,666,041,841	6,404,095,299	10,070,137,140	1,426	75,277	54,155	129,432
West Virginia	382,704,838	755,633,514	1,138,338,353	615	7,086	7,298	14,384

Table 4.5—Cont.

State	All Army Direct Spending[a] ($)	Additional Economic Output[b] ($)	Army-Driven Economic Output[c] ($)	Army-Driven Economic Output per Capita ($)	All Army Direct Employment[d]	Additional Employment[e]	All Army Personnel and Additional Employment[f]
Wisconsin	1,169,540,212	3,210,812,239	4,380,352,452	761	17,364	21,976	39,340
Wyoming	85,546,170	160,142,531	245,688,701	421	2,243	1,306	3,549

[a] Includes military and government civilian payroll and retiree pay for Regular Army, ARNG, and USAR plus acquisition and services contracts in district. Direct spending in sectors with zero output in IMPLAN district model is assumed to be passed out of district. Does not include demand from Army spending from the rest of the country.

[b] Includes estimated indirect and induced effects of all Army direct spending within and outside of district.

[c] All Army direct spending assumed to stay in district plus estimated additional economic output. Does not include spending passed out of district. May not sum exactly due to rounding.

[d] Includes military and government civilian personnel for Regular Army, ARNG, and USAR, including soldiers not on active duty. Sum of unique individuals paid in each congressional district by state in each fiscal year.

[e] Estimated additional jobs resulting from additional economic output, including indirect and induced effects of all Army direct spending within and outside of district.

[f] All Army employment plus estimated additional employment. May not sum exactly due to rounding.

Table 4.6
Economic Effects of Total Army Spending by State, Sorted Largest to Smallest by Army-Supported Economic Output, 2014 ($2012)

State	All Army Direct Spending[a] ($)	Additional Economic Output[b] ($)	Army-Driven Economic Output[c] ($)	Army-Driven Economic Output per Capita	All Army Direct Employment[d]	Additional Employment[e]	All Army Personnel and Additional Employment[f]
Virginia	13,988,485,779	31,029,215,553	45,017,701,336	9,283	87,144	269,332	356,476
Texas	11,729,317,286	25,735,206,088	37,464,523,376	50,852	201,688	217,431	419,119
Maryland	6,650,540,011	17,193,411,371	23,843,951,383	3,542	46,680	147,959	194,639
Alabama	6,978,211,861	16,077,400,238	23,055,612,098	7,772	55,702	157,108	212,810
Arizona	6,051,928,534	12,454,753,838	18,506,682,373	477	29,198	106,994	136,192
California	5,680,189,348	12,822,816,557	18,503,005,903	3,455	69,720	106,988	176,708
Georgia	5,818,318,260	11,074,504,885	16,892,823,147	4,697	110,884	102,003	212,887
Florida	5,265,611,530	10,841,356,994	16,106,968,524	17,215	48,280	97,412	145,692
North Carolina	5,155,454,914	8,879,130,825	14,034,585,739	705	103,115	78,386	181,501
New York	3,749,866,861	8,531,907,729	12,281,774,588	1,216	63,503	63,405	126,908
Pennsylvania	3,790,984,496	6,751,131,548	10,542,116,045	7,426	41,872	52,452	94,324
Washington	3,666,041,841	6,404,095,299	10,070,137,140	6,161	75,277	54,155	129,432
Massachusetts	3,005,543,618	7,044,693,253	10,050,236,869	780	15,015	48,852	63,867
Colorado	3,112,018,020	6,080,890,259	9,192,908,282	1,394	60,778	52,759	113,537
Kentucky	2,805,072,775	6,193,000,509	8,998,073,285	2,896	43,620	65,070	108,690
Louisiana	2,305,242,412	6,383,391,653	8,688,634,065	2,992	28,905	54,167	83,072
Michigan	2,482,724,153	5,241,091,382	7,723,815,534	1,750	23,975	39,695	63,670
Kansas	2,288,863,250	5,115,787,061	7,404,650,312	1,593	47,878	41,033	88,911
New Jersey	2,066,554,254	5,332,102,786	7,398,657,040	5,563	20,776	44,420	65,196
Hawaii	2,919,095,117	4,344,537,701	7,263,632,819	1,215	46,500	40,319	86,819
Illinois	1,984,985,107	5,216,894,982	7,201,880,086	1,068	27,299	36,670	63,969
Connecticut	2,282,199,849	4,903,495,039	7,185,694,887	725	7,192	29,255	36,447
Missouri	2,297,333,398	4,516,123,391	6,813,456,789	1,249	49,988	37,712	87,700
Tennessee	2,335,458,488	4,093,728,379	6,429,186,867	2,147	55,780	30,134	85,914

Table 4.6—Cont.

State	All Army Direct Spending[a] ($)	Additional Economic Output[b] ($)	Army-Driven Economic Output[c] ($)	Army-Driven Economic Output per Capita	All Army Direct Employment[d]	Additional Employment[e]	All Army Personnel and Additional Employment[f]
Ohio	1,712,369,547	4,252,256,708	5,964,626,257	984	25,542	38,156	63,698
South Carolina	1,745,952,856	3,282,937,771	5,028,890,629	4,913	29,473	31,300	60,773
Oklahoma	1,609,305,594	3,395,055,553	5,004,361,149	2,660	35,250	31,180	66,430
Alaska	1,648,850,998	2,946,364,778	4,595,215,776	1,619	24,348	23,623	47,971
Wisconsin	1,169,540,212	3,210,812,239	4,380,352,452	3,301	17,364	21,976	39,340
Mississippi	1,026,484,218	2,573,782,292	3,600,266,509	403	18,323	23,630	41,953
New Mexico	1,030,372,993	2,519,433,155	3,549,806,148	1,702	11,074	23,678	34,752
Indiana	1,009,692,072	1,917,110,052	2,926,802,122	148	21,452	15,862	37,314
Arkansas	895,006,405	1,793,737,478	2,688,743,882	270	15,083	16,199	31,282
Oregon	645,909,913	1,708,822,870	2,354,732,782	3,184	11,289	14,035	25,324
Utah	622,032,818	1,604,087,285	2,226,120,102	192	12,605	13,388	25,993
Minnesota	777,580,997	1,433,425,253	2,211,006,250	570	17,685	10,248	27,933
Iowa	654,402,380	1,367,515,026	2,021,917,405	509	14,915	11,689	26,604
New Hampshire	470,302,141	1,067,424,801	1,537,726,942	120	4,430	8,638	13,068
Nevada	513,886,968	969,603,687	1,483,490,654	1,406	8,466	8,647	17,113
Nebraska	401,462,966	906,666,787	1,308,129,753	271	8,053	8,481	16,534
West Virginia	382,704,838	755,633,514	1,138,338,353	1,334	7,086	7,298	14,384
North Dakota	255,988,227	553,608,613	809,596,840	124	4,727	4,416	9,143
Idaho	248,322,508	548,852,923	797,175,432	30	6,858	4,448	11,306
Montana	180,985,916	448,419,027	629,404,943	214	4,922	3,886	8,808
Delaware	167,856,035	380,879,039	548,735,074	876	3,250	2,823	6,073
Maine	182,603,120	341,492,220	524,095,340	63	4,111	2,954	7,065
South Dakota	141,300,234	306,405,558	447,705,792	63	5,165	2,593	7,758

Table 4.6—Cont.

State	All Army Direct Spending[a] ($)	Additional Economic Output[b] ($)	Army-Driven Economic Output[c] ($)	Army-Driven Economic Output per Capita	All Army Direct Employment[d]	Additional Employment[e]	All Army Personnel and Additional Employment[f]
Vermont	120,607,045	253,107,933	373,714,978	202	3,208	2,217	5,425
Rhode Island	120,583,584	220,231,956	340,815,540	59	3,474	1,761	5,235
Wyoming	85,546,170	160,142,531	245,688,701	421	2,243	1,306	3,549

[a] Includes military and government civilian payroll and retiree pay for Regular Army, ARNG, and USAR plus acquisition and services contracts in district. Direct spending in sectors with zero output in IMPLAN district model is assumed to be passed out of district. Does not include demand from Army spending from the rest of the country.

[b] Includes estimated indirect and induced effects of all Army direct spending within and outside of district.

[c] All Army direct spending assumed to stay in district plus estimated additional economic output. Does not include spending passed out of district. May not sum exactly due to rounding.

[d] Includes military and government civilian personnel for Regular Army, ARNG, and USAR, including soldiers not on active duty. Sum of unique individuals paid in each congressional district by state in each fiscal year.

[e] Estimated additional jobs resulting from additional economic output, including indirect and induced effects of all Army direct spending within and outside of district.

[f] All Army employment plus estimated additional employment. May not sum exactly due to rounding.

CHAPTER FIVE

Conclusion

This report presents the findings from RAND Arroyo Center research on the economic activity supported by Army spending on state and local economies. Using a combination of congressional district and national-level I/O models, in conjunction with procurement and payroll data, we estimated the regional economic activity associated with Army-generated demand. Given the lack of feedback associated with the I/O methodology, the estimates should be interpreted as predictive maxima of economic activity associated with Army spending at the local level.

In addition, because we estimated the effects of both in-region and out-of-region total Army spending on the economic activity within each district and state, the results reported in the district- and state-level tables should not be used to calculate the per-dollar effect of increased or decreased Army spending in a district or state. Rather, for any given suite of cuts or spending increases that can be associated with a geographic area, the *methodologies* detailed in this report could be used to estimate impacts, but per-dollar results would likely vary due to differences in the distribution of demand changes across local and nonlocal sectors and the geographic distribution of the suite of cuts. In addition, only net demand changes should be included; that is, any spending changes by the Army should be offset by any spending changes made by other agencies as a result of decreased Army demand.

We found that the Army directly spent approximately $120.8 million in the median district (in 2012 dollars) and $1.7 billion in the median state in FY 2014, with considerable variance across the local economies. This direct spending and the intermediate demands generated by out-of-district/out-of-state spending contributed a total of $375 million of economic output to the median district and $5.5 billion to the median state. This translates into about 4,200 jobs for the median district and more than 62,000 for the median state, with a wide range across economies.

APPENDIX A

Preprocessing of Direct Army Spending Data

Mapping ZIP Code Data to Congressional Districts

Table A.1 summarizes the data we used in our economic impact models and the length of the corresponding ZIP code.

Table A.1
Model Data and Associated ZIP Code Length

Data	Length of ZIP Code (Digits)
First-tier awards (FPDS-NG)	9
First-tier sub awards (FSRS)	5
Regular Army payroll	5
USAR payroll	5
ARNG payroll	5
Civilian payroll	3
Retiree & survivor pay	3
All counts of personnel	3

Five-Digit ZIP Code to Congressional District

Out of 34, 902 ZIP codes, 6,310 are in at least two. Some five-digit ZIP codes cross congressional district boundaries. In these instances, IMPLAN apportions the economic activity in the ZIP code according to how many congressional district boundaries the ZIP code crosses; if the ZIP code lies in three congressional districts, each district is apportioned one-third of the ZIP code's economic activity. Also, there were 932 five-digit ZIP codes in the Regular Army, USAR, and ARNG pay files that did not map to congressional districts. DMDC did note that foreign postal codes are sometimes entered into the ZIP field. For instance, 06686 is a German postal code. Another possibility is that those 932 ZIP codes were erroneously entered by the user. If this is the case, the pay in these ZIP codes should be apportioned to the best alternative ZIP code that does exist within the United States. Additionally, some ZIP codes are in the United States but do not belong to a congressional district. ZIP code 80279, the Air Force Accounting and Finance Center in Denver, had a total pay of $14 million in FY 2013. Considering the two latter circumstances, we truncated the ZIP codes to three-digit numbers and apportioned the pay as outlined in the Three-Digit ZIP Code to Congressional District section.

Three-Digit ZIP Code to Congressional District

The following steps were taken to apportion the three-digit ZIP code payroll and employment counts to congressional districts:

1. Calculate the total population in the truncated three-digit ZIP code from the 2010 census population estimates by the five-digit ZIP Code Tabulation Areas (ZCTAs).
2. Divide the five-digit ZCTA population estimate by the three-digit ZCTA total. This gives the percentage of the total population of the three-digit ZCTA living in the five-digit ZCTA.
3. For each unique five-digit ZIP code in our crosswalk of ZIP code to congressional district, multiply the percentage in step 2 by the three-digit totals in our DMDC files, and apportion that amount (either payroll amounts or employee counts) to the five-digit ZIP code.
4. Apportion the five-digit ZIP code data from step 3 to congressional districts per IMPLAN's methodology, as described in the Five-Digit ZIP Code to Congressional District section of this appendix.

Mapping NAICS Industries to IMPLAN Sectors

The 2012 IMPLAN models consolidate 2007 NAICS codes into the IMPLAN 440-sector classification. Consequently, some sectors contain multiple NAICS codes. The IMPLAN models impose the same regional multiplier on all NAICS codes contained in the same IMPLAN sector. IMPLAN provides a crosswalk from NAICS codes to the appropriate sector in the IMPLAN 440-sector classification. We used this crosswalk to map our procurement and payroll data to the IMPLAN sectors.

There were six congressional Districts in which 72–97 percent of direct Army spending occurred in sectors with multipliers equal to zero. In these instances, we chose the best alternative sector that had a nonzero multiplier in the district based on whether there was spending in the alternate sector in another FY and how similar the alternate sector was to the original sector. For instance, in California's 32nd Congressional District in FY 2012, 78 percent percent of total Army direct spending in the district ($82.7 million) occurred in IMPLAN sectors with a multiplier of zero. Of that, $82.3 million was apportioned to IMPLAN Sector 284 (aircraft manufacturing). IMPLAN sector 286 (other aircraft parts and auxiliary equipment manufacturing) had a nonzero multiplier and had positive direct Army spending. Spending from sector 284 was redirected to sector 286.

The NAICS codes in the FPDS-NG include 1997, 2002, 2007, and 2012 NAICS manuals. We cross-walked Census Bureau data from 1997 to 2002, 2002 to 2007, and 2007 to 2012 to map the FPDS-NG entries to the 2007 NAICS manual used by IMPLAN.

Component Direct Spending Categories Based on Appropriation Category

Regular Army includes the following appropriations categories:

- Military Personnel, Army
- Medicare-Eligible Retiree Health Fund Contribution, Army

- Operation And Maintenance, Army
- Military Construction, Army
- Family Housing Construction, Army
- Family Housing Operation And Maintenance, Army
- Homeowners Assistance Fund
- Aircraft Procurement, Army
- Missile Procurement, Army
- Procurement Of Weapons And Tracked Combat Vehicles, Army
- Procurement Of Ammunition, Army
- Other Procurement, Army
- Joint Improvised Explosive Device Defeat Fund (A Portion)
- Research, Development, Test And Evaluation, Army
- Chemical Agents And Munitions Destruction, Defense
- Chemical Demilitarization Construction, Defense-Wide
- Working Capital Fund, Army
- Environmental Restoration, Army
- Environmental Restoration, Formerly Used Defense Sites
- U. S. Army National Cemeteries Program
- Afghanistan Security Forces Fund
- Corps of Engineers—Civil Works
- Other Defense—Civil Programs.

USAR includes the following appropriations categories:

- Reserve Personnel, Army
- Medicare-Eligible Retiree Health Fund Contribution, Reserve Personnel, Army
- Operation And Maintenance, Army Reserve
- National Guard And Reserve Equipment (A Portion)
- Military Construction, Army Reserve

ARNG includes the following appropriations categories:

- National Guard Personnel, Army
- Medicare-Eligible Retiree Health Fund Contribution, National Guard Personnel, Army
- Operation And Maintenance, Army National Guard
- National Guard And Reserve Equipment (A Portion)
- Military Construction, Army National Guard

Regular Army direct spending on procurement and acquisition includes Regular Army military personnel, operations and maintenance, military construction, procurement, all RDTE, and spending not explicitly associated with other components. In FY 2014, Army procurement accounted for about 11 percent of the Regular Army direct spending, although both the Reserve and Guard also benefit from Army procurement. About 60 percent of Army procurement benefits the Regular Army, 10 percent benefits the Reserve, and 30 percent benefits the Guard based upon their proportionate shares of capital/materiel as calculated by the Army

G-8, although the distributions vary from year to year. Army RDT&E, which also benefits all components, accounted for about 5 percent, while several nonoperational Army responsibilities accounted for about 8 percent. These included civil works (Corps of Engineers), the Joint Improvised Explosive Device Defeat Organization, support to foreign militaries, chemical weapons demilitarization, and maintenance of military cemeteries, among others. These additional Army responsibilities are predominantly performed by Regular Army military and civilian personnel, but may include small percentages of Reserve and Guard contributions.

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This report presents findings on the economic activity supported by total Army spending in each of the 435 congressional districts in fiscal years 2012–2014. To estimate this activity, researchers used district-level input-output (I/O) models and a national-level I/O model known as IMPLAN. Each district-level model is used to estimate the direct, indirect, and induced effects of national-level Army spending that affects a particular district. In this context, direct effects are the total Army spending within a district; indirect and induced effects represent the local economic activity that supports both the direct spending and the in-district demand generated from Army spending outside the district. Indirect effects capture interindustry linkages, while induced effects capture the effects of household incomes.

For each congressional district, this report provides the following estimates:

- Direct Army spending (including military and government civilian payroll and retiree pay for Regular Army, Army National Guard, and U.S. Army Reserve, plus acquisition and services contracts)
- All Army employment (including military and government civilian personnel for Regular Army, Army National Guard, and U.S. Army Reserve, including soldiers not on active duty)
- Additional economic output generated by direct Army spending
- Additional jobs created by direct Army spending
- Army-driven economic output (direct plus indirect and induced spending)
- All Army employment plus estimated additional jobs resulting from total Army direct spending and indirect effects.

Results are aggregated by state and the economic activity associated with Army spending is separated by component where applicable.

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