Economic Impact Analysis of Physicians' Offices in New Jersey

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EXECUTIVE SUMMARY

This study estimates the contribution of physicians' offices to the state economy in New Jersey. The study draws on information from the U.S. Census Bureau, the U.S. Bureau of Labor Statistics, the U.S. Bureau of Economic Analysis, the American Medical Association, and interviews with staff and membership of the Medical Society of New Jersey, which commissioned the report. The study provides estimates of the economic and fiscal impacts of the business expenditures made by medical practices in the state, but does not attempt to quantify the economic benefits of the medical care that the practices provide. Such benefits are undoubtedly enormous, and include the (monetary) value of the reductions in morbidity and premature mortality, the decrease in pain and suffering, improvements in quality of life, savings in work time lost due to illness and injury, increased worker productivity, lessened burdens on families, spouses, and caregivers, and reduced future health care costs of those effectively treated.

The report estimates that there were approximately 9,100 physicians' offices employing nearly 70,000 medical professionals and other staff in New Jersey as of 2009. In addition to the vital health care services provided by these facilities, the ongoing annual expenditures associated with their operations generates a significant contribution to the state economy, both directly through their employment of staff and purchases of materials, equipment and services, and indirectly, through the multiplier or "ripple" effects of these initial expenditures. This study's estimates of the *direct and indirect* contributions of physicians' practices in New Jersey to the state economy include:

- Nearly 113,000 jobs
- $7.3 billion in annual income
- $10.7 billion in annual gross domestic product for the state
- $334 million in annual state tax revenue
- $353 million in annual local tax revenue.

In addition, the study finds that the industry directly employs more people than comparable professional and other industries including offices of lawyers, the accounting sector, the engineering services sector, and the amusement and recreation sector.

INTRODUCTION

This study provides an analysis of the economic impacts of the operations of private practice physicians' offices in New Jersey. According to the American Medical Association's annual statistical review, *Physician Characteristics and Distribution in the US*, in 2008 there were 20,681 physicians with office-based practices in New Jersey. In addition to the vital health care services provided by these doctors, the ongoing annual expenditures associated with operating their private practices constitute a significant contribution to the state economy. This report estimates the size of this contribution. The report begins with a general overview of private physicians' practices in the state, including the economic data that underlie the impact analysis and the growth rate of the industry over time. This is followed by a description of the methodology and the economic impact model used in the analysis. The estimates of the economic and fiscal benefits are then provided and discussed.

A Note on the Economic Benefits Provided by Physicians' Offices

While this study provides estimates of the economic impacts of the business expenditures made by medical practices in the state, it does not attempt to quantify the broader economic and social benefits of the improvements in health outcomes that result from the health care and treatment provided by the physicians and their offices. Such benefits are undoubtedly enormous, and when measured in annual economic values, would likely dwarf the impact estimates provided in this report. These benefits would include the (monetary) value of the reductions in morbidity and premature mortality, the decrease in pain and suffering, improvements in quality of life, savings in work time lost due to illness and injury, increased worker productivity, lessened burdens on families, spouses, and caregivers, and reduced future health care costs of those effectively treated.[1] These benefits, the very purpose and goal of physician care and practice, are the central core "output" of the medical industry. A comprehensive study of all the economic and fiscal impacts of physicians' offices in New Jersey, inclusive of the above benefits, would properly reveal the full and extensive contribution of these activities to the health and well-being of the state and its citizens.

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[1] A large economic and health literature exists that attempts to measure the monetary value of premature deaths avoided by medical treatment (or health, environmental, and safety policies). See, e.g., W.Kip Viscusi and Joseph E. Aldy, "The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World" *Journal of Risk and Uncertainty*, Vol. 27, No. 1, August, 2003.

OVERVIEW OF OFFICE-BASED PHYSICIANS IN NEW JERSEY

This section presents a broad overview of the private physicians' practices industry in New Jersey based on the most recent available data from several sources. It begins with data on the distribution of office-based physicians in the state by demographic parameters and medical specializations. This is followed by an overview of economic data on the size and growth patterns of the industry in recent years. The demographic and specialization data are for calendar year 2008 and are drawn from the 2010 edition of the American Medical Association's *Physician Characteristics and Distribution in the US.*[2] Economic data are from the U.S. Bureau of Labor Statistics (BLS) and the U.S. Census Bureau.

Distribution of Physicians by Demographic Characteristics and Medical Specialties

Physicians with an M.D. (Allopathic)

There were a total of 30,700 allopathic physicians in New Jersey in 2008. Table I-1 provides the age and gender distribution of these physicians. Over two-thirds (20,808) of these physicians were male, and over 40% were age 55 or older. At the other end of the age spectrum, only 12.9% were under 35 years old. Male physicians tended to be somewhat older than their female counterparts, with 48.1% of male physicians over the age of 55, compared to only 26.5% of female physicians. Nearly 50% of female physicians are under forty-five years old, compared to 27.3% of males in the same age range.

Table I-1
Age and Gender Distribution of Allopathic Physicians in New Jersey

		Age as a Percentage of the Category					
		Physicians	<35	35 – 44	45 - 54	55 - 64	≥ 65
Category	State Total	30,700	12.9%	21.3%	24.7%	20.3%	20.8%
Category	Male Physicians	20,808	9.9%	17.4%	24.6%	22.5%	25.6%
Category	Female Physicians	9,892	19.2%	29.4%	25.0%	15.6%	10.9%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

[2] Smart, Derek R., *Physician Characteristics and Distribution in the US, 2010 Edition*, American Medical Association, 2010.

Of the 30,700 total physicians in the state in 2008, 18,538, or 60.4%, worked in office-based practices. Among these physicians, approximately 70% were male (Table I-2).

Table I-2
Office-Based Allopathic Physicians in New Jersey (Gender Distribution)

Office-Based Allopathic Physicians	Office-Based Share of Total	Share of Office-Based (%)	
		Male	Female
18,538	60.4%	69.2%	30.8%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

Table I-3 provides the distribution of allopathic office-based physicians in New Jersey by specialty and gender.[3] Nearly half of all office-based allopathic physicians (45.2%) in New Jersey practice medical specialties that include allergy and immunology, cardiovascular disease, dermatology, gastroenterology, internal medicine, pediatric cardiology, pediatrics, or pulmonary disease. Of those in a medical specialty office-based practice, 34.8% were female. Female allopathic physicians also comprised comparable percentages of family medicine/general practice and other specialties, but only 19.6% of office-based allopathic physicians practicing a surgical specialty.

Table I-3
Office-Based Allopathic Physicians in New Jersey by Specialty and Gender

	Office-Based Physicians	Specialty Share of Total (%)	Female Share of Specialty (%)
Total	18,538	-	-
Family Medicine/General Practice	1,197	6.5%	38.8%
Medical Specialties	8,382	45.2%	34.8%
Surgical Specialties[4]	4,240	22.9%	19.6%
Other Specialties[5]	4,719	25.5%	31.6%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

[3] Table 1 in Appendix I provides the distribution of allopathic physicians by specialty by county.
[4] Surgical specialties include: colon and rectal surgery, general surgery, neurological surgery, obstetrics & gynecology, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, thoracic surgery, urology.
[5] Other specialties include: aerospace medicine, anatomic/clinical pathology, anesthesiology, child and adolescent psychiatry, diagnostic radiology, emergency medicine, forensic pathology, general preventative medicine, medical genetics, neurology, nuclear medicine, occupational medicine, other specialty, physical medicine and rehabilitation, psychiatry, public health and general preventative medicine, radiation oncology, radiology and transplant surgery.

Physicians with a D.O. (Osteopathic)

In 2008, there were a total of 3,027 osteopathic physicians in New Jersey. Table I-4 provides their distribution by age and gender. Compared to allopathic physicians, they are younger, with only 13.5% aged sixty-five or older. Nearly 60% of all osteopathic physicians are between the ages of 35 and 54. Males comprise over two-thirds of osteopathic physicians, with an age distribution similar to the total osteopathic population. Female osteopathic physicians, like their allopathic counterparts, are younger than male physicians. Over a quarter of all female osteopathic physicians are under the age of 35, compared to only 12.1% of males.

Table I-4
Age and Gender Distribution of Osteopathic Physicians in New Jersey

		Age as a Percentage of the Category					
		Physicians	<35 (%)	35 - 44 (%)	45 - 54 (%)	55 - 64 (%)	≥ 65
Category	State Total	3,027	15.9%	29.6%	27.9%	13.1%	13.5%
	Male Physicians	2,148	12.1%	26.0%	27.8%	16.4%	17.7%
	Female Physicians	879	25.1%	38.5%	28.1%	5.0%	3.3%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

There were 2,143 office-based osteopathic physicians in New Jersey in 2008 (Table I-5). This represents 70.8% of total osteopathic physicians. Of these office-based physicians, 72.4% are male and 27.6% are female.

Table I-5
Office-Based Osteopathic Physicians in New Jersey (Gender Distribution)

Office-Based Osteopathic Physicians	Office-Based Share of Total	Share of Office-Based (%)	
		Male	Female
2,143	70.8%	72.4%	27.6%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

As indicated in Table I-6, osteopathic physicians are less likely to specialize than allopathic physicians, with only 72.7% reporting a medical, surgical or other specialization, vs. 93.6% for M.D. physicians.

Table I-6
Office-Based Osteopathic Physicians in New Jersey by Specialty and Gender

	Office-Based Physicians	Specialty Share of Total (%)
Total	2,143	-
Family Medicine/General Practice	584	27.3%
Medical Specialties	648	30.2%
Surgical Specialties	259	12.1%
Other Specialties	652	30.4%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

M.D. and D.O. Combined

In total, there were 33,727 physicians in New Jersey in 2008, including those with either an M.D. or a D.O. degree. Table I-7 provides their distribution by age and gender.

Table I-7
Age and Gender Distribution of All Physicians in New Jersey

		Age as a Percentage of the Category					
		Physicians	<35 (%)	35 - 44 (%)	45 - 54 (%)	55 - 64 (%)	≥ 65
Category	State Total	33,727	13.2%	22.0%	25.0%	19.6%	20.2%
	Male Physicians	22,956	10.1%	18.2%	24.9%	21.9%	24.8%
	Female Physicians	10,771	19.7%	30.1%	25.2%	14.7%	10.3%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

Female physicians account for just under one-third of the state total, with their age distribution skewed significantly younger than that of their male counterparts.

There were a total of 20,681 office-based physicians (both M.D. and D.O.) in New Jersey in 2008, representing 61.3% of all physicians (Table I-8).

Table I-8
Office-Based Physicians in New Jersey (Gender Distribution)

Total Office-Based Physicians	Office-Based Share of Total	Share of Office-Based (%)	
		Male	Female
20,681	61.3%	69.6%	30.4%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

Table I-9 provides the distribution by specialty for all office-based physicians in the state. Overall, these percentages indicate a high level of specialization, with fewer than 9% of the total office-based physicians classified as family doctors or general practitioners.

Table I-9
Office-Based Physicians in New Jersey by Specialty

	Office-Based Physicians	Specialty Share of Total (%)
Total	20,681	-
Family Medicine/General Practice	1,781	8.6%
Medical Specialties	9,030	43.7%
Surgical Specialties	4,499	21.8%
Other Specialties	5,371	26.0%

Source: Physician Characteristics and Distribution in the US (2010 Edition).

Economic Profile of Physicians' Practices in New Jersey

This section reviews the most recent available information on the physicians' offices sector from key sources of economic data. These data provide a sense of the economic magnitude and growth trends of physicians' offices in the state over the last several years, and are the underlying data for the analysis of the industry's contribution to the state economy presented in the next section of the report. Unless otherwise indicated, the economic data are reported primarily for Sector 62111 of the North American Industry Classification System (NAICS) – Offices of Physicians. NAICS, established by the U.S. Office of Management and Budget, defines the industry as follows:

> This industry comprises establishments of health practitioners having the degree of M.D. (Doctor of medicine) or D.O. (Doctor of osteopathy) primarily engaged in the independent practice of general or specialized medicine (e.g., anesthesiology, oncology, ophthalmology, psychiatry) or surgery. These practitioners operate private or group practices in their own offices (e.g., centers, clinics) or in the facilities of others, such as hospitals or HMO medical centers.

Table I-10 provides the growth rates in key economic variables for the industry from 2001 through 2009, as reported by the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages.

Table I-10
Growth of Physicians Practices in New Jersey, 2001-2009

Year	Employees	Establishments	Total Wages (Thousands)	Average Weekly Wage	Average Annual Pay
2001	57,639	7,402	$3,697,031	$1,233	$64,142
2007	67,681	8,417	$5,020,750	$1,427	$74,182
2009	69,698	8,493	$5,500,472	$1,518	$78,919
Percent Change 2001 - 2009	20.9%	14.7%	48.8%	23.1%	23.0%
Percent Change 2001-2009 All NJ Industries	-2.7%	3.5%	21.1%	24.5%	24.5%

Source: U.S. Bureau of Labor Statistics.

The combined growth rates for all industries in the state (last row in Table I-10) are provided for purposes of comparison. The data show that the sector's economic growth has been significantly stronger than that of the state as a whole, and that the industry was not strongly affected by the deep job losses of the 2007-2009 recession. In fact, while total state employment declined by almost 3% compared to its 2001 level, employment by physicians' offices grew by over 20%, and total annual wages in the industry grew by almost 50%. This is consistent with the private healthcare sector as a whole, which saw employment growth of approximately 23% at both the state and national levels over the same period. As of 2009, Offices of Physicians in New Jersey directly employed nearly 70,000 people, with a total payroll of $5.5 billion. This employment total includes *all* medical practice employees, both clinical (doctors, nurses, physicians' assistants, etc.) and non-clinical (bookkeepers, coders, practice managers, administrative support staff, etc.). Unless otherwise noted, references to employment by medical practices throughout the remainder of this report refer to total clinical and non-clinical staff.

In addition to the Bureau of Labor Statistics, the U.S. Census Bureau's Economic Census, conducted every five years, provides comprehensive economic data on the office-based physicians industry. The most recent Economic Census in 2007 reported 8,770 employer establishments[6] employing 67,178 people (Table I-11). These numbers are largely consistent with those reported by the U.S. Bureau of Labor Statistics (Table I-10). The 2007 Economic Census also reported annual employee payroll of $4.7 billion and $10.95 billion in revenues. Data from the Economic Census and BLS, adjusted to reflect 2009 levels, form the basis of the economic impact analysis presented later in the report.

Table I-11
Economic Profile of Physicians' Offices in New Jersey, 2007

Number of employer establishments	Employer sales, shipments, receipts, revenue, or business done ($1,000)	Annual payroll ($1,000)	Number of paid employees for pay period including March 12	Number of non-employer establishments	Non-employer sales, shipments, receipts, revenue, or business done ($1,000)
8,770	10,950,040	4,736,112	67,178	7,273	721,705

Source: U.S. Census Bureau, 2007 Economic Census.

[6] Employer establishments are those that have payroll employees. Non-employer establishments are reported here, but are not included in the impact analysis. These businesses reported less than $100,000 in revenues per establishment, and do not employ staff.

INDUSTRY EXPENDITURE DATA AND METHODOLOGY

This section draws on economic data from the U.S. Census Bureau and the U.S. Bureau of Economic Analysis (BEA), and uses the R/ECON™ Input-Output Model of the New Jersey economy to estimate the contribution of physicians' offices to the state economy.

Industry Expenditure Data

Magnitude of Industry Expenditures

In order to assess the contribution of an entire industry's operating expenditures to the state economy, it is necessary to understand the magnitude of those expenditures, the type of expenditures made, and the distribution of these expenditures across industries. As noted in the preceding section, data on the size of the physicians' practices industry in New Jersey vary somewhat across sources, but are generally consistent. The 2007 Economic Census provides estimates of total revenues and payroll for the industry. These estimates serve as the starting point for measuring the economic mass of the industry in New Jersey for the most recent yea available. Table II-1 provides estimates of industry revenues, payroll, and employment for 2009, based on growth rates and compensation estimates from the 2007 Economic Census and the BLS data for the period from 2007 to 2009.

Table II-1
Economic Profile of Physicians' Offices in New Jersey, 2009

Number of employer establishments	Employer sales, shipments, receipts, revenue, or business done ($1,000)	Annual payroll ($1,000)	Employment
9,100	12,717,265	5,500,472	69,698

Source: U.S. Census Bureau, 2007 Economic Census; U.S. Bureau of Labor Statistics; Rutgers calculations.

The 2009 data thus derived from the U.S. Economic Census indicate total annual revenues (employer establishments only) of $12.7 billion, payroll of $5.5 billion, and employment of almost 69,700.

Distribution of Industry Expenditures

Having determined a range of estimates for the magnitude of the industry's revenues, payroll, and employment, the next step is to determine how these revenues are spent and how the expenditures are distributed across the various cost categories. This information is embodied in national economic input-output accounts maintained by the U.S. Bureau of Economic Analysis. At the national level, these accounts reflect the inter-relations between economic industries. That is, they embody the purchases that each industry in the economy makes from all other industries, as well as each industry's labor expenditures and profits.

The distribution of expenditures by physicians' offices in both national and regional input-output accounts is aggregated with the expenditure distributions of other health sector practices, including the offices of dentists, chiropractors, non-M.D. mental health professionals, and physical and speech therapists. The most recent *detailed* national expenditure distribution covering 430 economic industries comes from the BEA's 2002 Benchmark Input-Output accounts.[7] An aggregated distribution (into13 categories) of the expenditures made across these industries by the "Offices of physicians, dentists and other health practitioners" sector is provided in Table II-2.[8]

Table II-2
National Distribution of Expenditures

Expenditure Category	**% Share**
Compensation of employees	58.2
Pharmaceuticals and other chemical products	6.6
Real estate	4.6
Insurance carriers and agencies	2.8
Medical equipment and supplies	2.3
Banking and financial services	1.6
Medical and diagnostic labs and outpatient and other ambulatory care services	2.0
Dental equipment and supplies manufacturing	0.5
Dental laboratories	1.0
3rd Party Services (includes consulting, legal, accounting, janitorial, communications, administrative and other services)	12.2
Utilities	0.4
Miscellaneous Manufacturing	1.7
Other Expenditures	6.2
Total	**100.0%**

Source: U.S. Bureau of Economic Analysis.

[7] While the most recent input-output accounts available from the BEA are for 2009, those data are reported in aggregate, and further combine the offices of physicians, dentists, and other health practitioners, with medical and diagnostic laboratories, home health care services, blood banks, and other ambulatory healthcare establishments.
[8] This expenditures distribution is net of operating surpluses and taxes.

In order to refine the economic impact analysis performed for this study, a more detailed, amended version of this expenditure distribution was reviewed in consultation with several MSNJ staff and members. The purpose of that consultation was to determine whether the aggregate nature of this national distribution[9] over- or under-estimates expenditures in any particular category. Because of the disparate cost structures of firms even within the narrower physicians' industry, it was not possible to determine specific degrees of over- or under-estimation based on the distribution presented in Table II-2. While some individuals noted that their own outlays deviated somewhat from the national distribution, this was often due to the specialized nature of their practices, or was not of a significant magnitude to suggest the need for amending the national distribution.

However, based on the examination of the national distribution for the aggregate industry, it was determined that several key changes should be made when conducting the state-level analysis of the industry's economic contribution. First, expenditures made on dental equipment and labs were removed from the distribution. Second, the general consensus from discussions with MSNJ staff and membership indicate that the national distribution for the aggregate industry likely *underestimates* the narrower industry's (i.e., physicians' offices) outlays on pharmaceuticals and other chemical preparations. Based on data from the 2007 Economic Census, physicians' offices accounted for approximately 69% of the combined revenues of the offices of physicians, dentists, and other health practitioners in New Jersey. Offices of dentists accounted for an additional 20%, and offices of other health practitioners accounted for the remaining 11%. Thus, approximately 31% of the aggregate industry is likely to spend a significantly lower amount (and in many cases, nothing at all) on pharmaceuticals and other chemical preparations than physicians. For purposes of analysis, we assume a scenario wherein the share of total expenditures that dentists' offices spend on pharmaceuticals is half the share that physicians' offices spend, and that "other health practitioners" make no expenditures on pharmaceuticals and related chemical products. Based on these assumptions, the implied share of such expenditures for physicians' offices would be approximately 8.4% (compared to the 6.7% base case scenario). Finally, MSNJ members commented that their real estate (i.e.,

[9] The economic impact analysis conducted for this study uses a slightly different, more detailed regionalized expenditure distribution that reflects the regional purchase coefficients for New Jersey. However, the national expenditure distribution is more appropriate for examining the actual outlays made by firms in the industry, as it reflects industry expenditures regardless of whether they represent demand filled by local or out-of-region suppliers.

property rent and associated costs) expenditures are higher than those indicated in the distribution. In fact, office rents in New Jersey are, on average, approximately 20% higher than the national average.[10] This differential was also incorporated into the revised distribution.

A recalculated expenditure schedule taking into account both the higher implicit share of physicians' expenditures on pharmaceuticals and rent, and net of any expenditures on dental labs or equipment, is presented in Table II-3.[11]

Table II-3
National Distribution of Expenditures - Amended for New Jersey

Expenditure Category	% Share
Compensation of employees	57.1
Pharmaceuticals and other chemical products	8.7
Real estate	5.6
Insurance carriers and agencies	2.7
Medical equipment and supplies	2.3
Banking and financial services	1.6
Medical and diagnostic labs and outpatient and other ambulatory care services	2.0
3rd Party Services (includes consulting, legal, accounting, janitorial, communications, administrative and other services)	12.0
Utilities	0.4
Miscellaneous Manufacturing	1.7
Other Expenditures	6.1
Total	**100.0%**

Source: U.S. Bureau of Economic Analysis.

Having determined both the magnitude of industry expenditures and a range of distributions over which to allocate these expenditures, the cost distribution next must be regionalized. An assessment of state-level economic impacts of an industry's economic contribution considers not only the national expenditure distribution, but also the degree to which the local demand for the goods or services provided by each industry is filled by local (within New Jersey) firms and workers. This ratio is captured in regional economic input-output models. Economic impact assessment and the New Jersey input-output model used for this analysis are briefly described in the next section.

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11 Note that, because the majority of pharmaceuticals and other chemical products are manufactured outside of New Jersey, the allocation of a higher share to these products based on the assumption of a zero share for dentists and other health practitioners is in fact likely to render the economic impact estimates *more conservative* than they otherwise would be, as a larger share of the industry's expenditures is assumed to "leak" out of the state.

Economic Impact Analysis / R/ECON™ Input-Output Model

The annual expenditures of the office-based physicians industry in New Jersey constitute a significant *recurring* economic contribution to the New Jersey economy. Expenditures on staffing, equipment and medicines, third-party services and other requirements for the ongoing operation of medical practices have both direct economic effects as those expenditures become incomes and revenues for workers and businesses, and subsequent indirect "ripple" or "multiplier" effects, as those workers and businesses, in turn, spend those dollars on other consumer goods and business operations and investment expenditures, which, in turn, become income for other workers and businesses. This income gets further spent, and so on.

Economic input-output modeling focuses on the interrelationships of sales and purchases among sectors of the economy. This analytical method measures the effect of changes in expenditures in one industry on economic activity in all other industries, thus capturing both the direct and indirect impacts of any set of initial expenditures in the economy. Input-output models also embody the degree to which supply of locally produced goods and services meets local demand. These measures, known as regional purchase coefficients (RPCs), capture the economic "leakage," as some portion of any investment or expenditure flows out of the region.

The R/ECON™ Input-Output Model developed and maintained at Rutgers' Center for Urban Policy Research is designed to measure these direct and indirect impacts for New Jersey. The R/ECON™ model consists of 517 individual sectors of the New Jersey economy, and can measure the impacts of investments and expenditures in terms of employment, income, gross domestic product for the state, and state and local tax revenues. It has been used to estimate the economic impacts of a wide array of projects and activities, such as:

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

A comprehensive description of input-output modeling and the R/ECON™ Input-Output Model are presented in Appendix II.

ANALYSIS AND RESULTS

Total Industry Impacts

The R/ECON™ Input-Output Model was used to measure the contribution of physicians' offices to the New Jersey economy. Two estimates of the distribution of $12.7 billion in total 2009 expenditures were used. The first relies on the unadjusted, pre-existing distribution of expenditures for the aggregate industry comprising the offices of physicians, dentists and other health practitioners embodied in the R/ECON™ Model. This distribution is analogous to the national distribution reflected in Table II-2. The second distribution amends the first, similarly to the amendments reflected in Table II-3, to embody a higher share of expenditures on pharmaceuticals and real estate, and the removal of expenditures on dental equipment and laboratory services. Both distributions are regionalized and thus embody flows of expenditures out of the state.

Table III-1 provides the estimated annual economic contribution, both direct and indirect, of physicians' offices to the New Jersey economy based on total annual industry expenditures of $12.7 billion. The left panel – "Unadjusted Distribution" – reflects the impacts of the base case scenario, assuming that the distribution of physicians' offices' expenditures is the same as that of dentists and other health practitioners. The panel on the right – "Adjusted for Physicians" – reflects the impacts of the distribution adjusted to more accurately reflect physicians' offices.

Table III-1
Contribution of Physicians' Offices to the New Jersey Economy
2009 Estimated Industry Expenditures of $12.7 Billion

	Unadjusted Distribution			Adjusted for Physicians		
Impacts	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Employment (job-years)	69,698	44,880	114,578	69,698	43,140	112,838
GDP ($ millions)	7,830.0	2,927.6	10,757.7	7,830.0	2,863.8	10,693.8
Compensation ($ millions)	5,500.5	1,868.7	7,369.2	5,500.5	1,793.7	7,294.3
Federal Tax Revenues ($ millions)	-	-	2,135.4	-	-	2,048.3
State Tax Revenues ($ millions)	-	-	341.1	-	-	333.9
Local Tax Revenues ($ millions)	-	-	357.6	-	-	352.8

For perspective, total employment in New Jersey in 2009 was 3,891,700, total wages in the state were $208.1 billion, and total GDP for the state was $478.3 billion. Thus, it is estimated that, based on the adjusted, more conservative estimates, physicians' offices accounted, either directly or indirectly, for approximately 2.9% of state employment, 3.5% of wages paid in the state, and approximately 2.2% of state GDP.

Table III-2 shows the estimated employment impacts by industry, and a brief explanation of the impacts for the adjusted expenditure distribution follows the table.

Table III-2
Distribution of Employment Impacts by Sector

	Employment (job-years)	
Sector	**Base Case**	**Adjusted**
Natural Resources & Mining	210	202
Construction	663	636
Manufacturing	1,646	1,578
Transportation & Public Utilities	3,342	3,194
Wholesale Trade	1,611	1,541
Retail Trade	15,893	15,193
Financial Activities	6,428	6,376
Services	84,567	83,910
Government	218	208
Total	**114,578**	**112,838**

- Employment

  Employment impacts are measured in job-years (i.e., one job lasting one year). However, as long as annual industry expenditures are maintained, these jobs are, in effect, permanent. The industry's 2009 expenditures of $12.7 billion are estimated to generate 112,838 job-years in New Jersey, including approximately 69,698 *direct* jobs in the industry. Significant additional *indirect* employment (43,140 job-years) is generated across various business sectors, including services (includes miscellaneous business services, education and health industries, and other service sectors), financial activities, and retail trade.

- Gross Domestic Product (GDP)

  Total GDP, a measure of the value of the output generated in the state based on the industry's 2009 expenditures is estimated at $10.7 billion. This is less than the $12.7 billion in 2009 total expenditures by the industry in the state. This is due primarily to economic "leakage," as some of these expenditures are made on products and services produced or provided by out-of state sources.

- <u>Compensation</u>

  Compensation (or income) represents the total wages, salaries and wage supplements (i.e., employer contributions to government and private pension funds) paid for all direct *and* indirect jobs generated as a result of the industry's annual expenditures *in New Jersey*.[12] The expenditures are estimated to generate $7.4 billion in compensation in New Jersey.

- <u>State Tax Revenues</u>

  State tax revenues include direct state taxes paid by physicians' practices, the indirect income taxes associated with the salaries paid to the workers in the direct *and* indirect jobs generated by the industry expenditures, and the indirect sales taxes associated with the economic output generated by those expenditures. These state taxes are estimated to total $333.9 million.[13]

- <u>Local Tax Revenues</u>

  The estimated increase in local tax revenues is for the entire state. It includes both direct property and other local taxes paid by physicians' practices, and a *long-run estimate* of property tax revenues resulting from increased property values associated with improvements to existing, or construction of new, property using the new and/or increased personal and business incomes generated directly and indirectly by the industry's annual expenditures. These tax revenues are estimated to total $352.8 billion. Following is a more detailed description of how the estimated *indirect* local tax revenues are generated.

[12] In more familiar terms, compensation as used in this and similar economic impact analyses is equivalent to income.

[13] Of a total of $224.65 million in *direct* industry taxes estimated to be paid by the industry to all levels of government, 18% were estimated to be paid to local governments, 20% to state government, and 62% to the federal government. These allocations are based on total tax collections from New Jersey to each level of government for 2009.

Local tax revenues increase because the additional economic activity resulting from the capital expenditures generates income for workers and revenues for business.[14] The increases in personal incomes and in business revenues are, in part, used to pay property taxes and to improve properties (both residential and commercial). Thus, households benefitting from the additional jobs and resulting incomes acquire and/or improve residential properties, and are able to pay rents and mortgages and the associated property taxes. Similarly, business income and profits also increase as a direct result of higher sales and output caused by the project. Businesses subsequently acquire and/or improve their properties.

Historical New Jersey fiscal and economic data are used to measure the relationship between business revenues and the amount of commercial property tax revenues collected, and between household incomes and the amount of residential property tax revenues collected.[15] Given the increases in both household income and business revenues associated with physicians' practices' expenditures, the R/ECON™ Input-Output Model invokes the known statistical relation of local property tax revenues to both household income and business revenues in order to estimate the addition to local tax revenues attributable to the capital expenditures. It is important to note that this additional tax revenue occurs over a period of time. It is not an immediately generated impact. The economic sequence is as follows. The additions/improvements to residential and commercial property financed by the higher household incomes and higher business revenues are, in time, captured by higher property assessments, which, in turn, generate higher local tax revenues. There are time lags between the increase in incomes and revenues, the improvements to property, and the increase in assessed values. Thus, the local tax revenue impacts estimated in this analysis are the outcome of a long-run adjustment process. This process occurs over the entire state based on the geographical dispersal within New Jersey of the households and businesses that benefit from the expenditures on the water infrastructure.

[14] For businesses, the revenue increase is measured in terms of value-added, and it is the change in value added in the business sector that is the basis for the estimated change in property tax revenues.
[15] For the entire state, approximately 76% of total local property tax revenues are attributable to residential property; with approximately 21% derived primarily from commercial and industrial property.

Contribution of Surgeons' Offices

As part of this report, MSNJ requested that the analysis address, if possible, the specific contribution of surgeons' offices to the New Jersey economy. The U.S. Economic Census and the U.S. Bureau of Economic Analysis do not provide economic data specific to this group. However, an estimate can be made of their contribution using the data on office-based physicians from the AMA's *Physician Characteristics and Distribution in the U.S.* Including both M.D.s and D.O.s, approximately 21.8% of all office-based physicians in the state have surgical practices. Applying this percentage to the total state expenditures and their impacts gives an estimate of the contribution of surgical practices to the state economy. These impact estimates assume that surgical practices are of the same average size with similar average revenues as other medical practices, and that the distribution of their expenditures is the same as those of other medical practices. The impacts are given in Table III-3 and are based on estimated expenditures of $2.8 billion.

Table III-3
Contribution of Surgeons' Offices to the New Jersey Economy
2009 Estimated Industry Expenditures of $2.8 Billion

	Unadjusted Distribution			Adjusted for Physicians		
Impacts	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Employment (job-years)	15,162	9,763	24,925	15,162	9,385	24,547
GDP ($ millions)	1,703.4	636.9	2,340.3	1,703.4	623.0	2,326.4
Compensation ($ millions)	1,196.6	406.5	1,603.1	1,196.6	390.2	1,586.8
Federal Tax Revenues ($ millions)	-	-	464.5	-	-	445.6
State Tax Revenues ($ millions)	-	-	74.2	-	-	72.6
Local Tax Revenues ($ millions)	-	-	77.8	-	-	76.8

Table III-4
Distribution of Employment Impacts by Sector

	Employment (job-years)	
Sector	**Base Case**	**Adjusted**
Natural Resources & Mining	46	44
Construction	144	138
Manufacturing	358	343
Transportation & Public Utilities	727	695
Wholesale Trade	350	335
Retail Trade	3,458	3,305
Financial Activities	1,398	1,387
Services	18,397	18,254
Government	47	45
Total	**24,925**	**24,547**

CROSS-INDUSTRY COMPARISONS

In order to put into context the magnitude of the contribution of private practice physicians' offices to the New Jersey economy, it is helpful to compare the industry's size to that of other major industries in the state. Table IV-1 below provides a comparison of the *direct* output, payroll and employment for the physicians' offices sector and several other New Jersey industries, as reported in the 2007 Economic Census.[16] The industries are shown in descending order of total employment. As indicated in the table, the physicians' offices industry in New Jersey is larger in terms of employment, payroll and output than several other key professional industries, including lawyers' offices, the accounting sector and the engineering services sector.

Table IV-1
Comparison of Direct Impacts Across Industries, 2007

NAICS	Sectors	Output ($000)	Payroll ($000)	Employment	Payroll/Job ($)
722	Food services and drinking places	12,167,244	3,310,915	221,700	14,934
62211	General medical and surgical hospitals	17,705,470	7,201,528	132,402	54,391
522 & 523	Finance	N/A	11,157,378	129,039	86,465
524	Insurance carriers and related activities	N/A	7,347,596	83,941	87,533
7211	Traveler accommodation	7,710,796	1,887,478	68,648	27,495
62111	**Offices of physicians**	**10,950,040**	**4,736,112**	**67,178**	**70,501**
5412	Accounting, tax preparation, bookkeeping, and payroll services	5,083,023	2,299,627	45,727	50,290
713	Amusement, gambling, and recreation industries	2,555,289	832,612	42,769	19,468
531	Real estate	11,605,739	1,939,343	42,755	45,359
541110	Offices of lawyers	6,888,311	2,869,593	39,135	73,325
54133	Engineering services	7,031,136	2,385,954	31,133	76,637
32541	Pharmaceutical and medicine manufacturing	14,841,723	2,471,612	27,122	91,129
Source: 2007 Economic Census, U.S. Census Bureau.					

[16] This comparison is limited to the *direct* impacts for employer establishments in each industry. That is, the comparison is of the size of each industry's own output, payroll and employment, but does not reflect the further *indirect* multiplier effects of each industry's output. Non-employer establishments are not included in the comparison.

APPENDIX I

Table A-1
Office-Based Allopathic Physicians by Specialty by County

	Total Physicians	Total Office-Based	Family Practice/ General Practice	Medical Specialties	Surgical Specialties	Other Specialties
Atlantic	687	439	29	174	133	103
Bergen	5210	3,257	105	1,468	748	936
Burlington	1,299	859	90	345	174	250
Camden	1,868	1,071	105	457	238	271
Cape May	151	86	11	26	20	29
Cumberland	217	160	18	72	41	29
Essex	3,798	2,036	88	895	515	538
Gloucester	390	241	45	94	46	56
Hudson	1,278	672	61	330	147	134
Hunterdon	473	301	74	96	56	75
Mercer	1,573	954	56	425	220	253
Middlesex	3,098	1,746	112	878	355	401
Monmouth	2,596	1,775	81	807	408	479
Morris	2,179	1,303	70	582	297	354
Ocean	960	669	34	343	168	124
Passaic	1,142	713	42	373	164	134
Salem	70	43	10	13	12	8
Somerset	1,591	9,56	88	409	195	264
Sussex	234	154	11	62	37	44
Union	1,583	986	47	489	234	216
Warren	204	117	20	44	32	21

Source: Physician Characteristics and Distribution in the US (2010 Edition).

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

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

Estimating Multipliers

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

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

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

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

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

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

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

then substituting into the first equation, we obtain

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

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

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

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

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

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

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

The high level of industry aggregation and the rigidity of the economic assumptions that permit the application of the economic base multiplier have caused this approach to be subject to extensive criticism. Most of the discussion has focused on the estimation of the parameter **a**. Estimating this parameter requires that one be able to distinguish those parts of the economy that produce for local consumption from those that do not. Indeed, virtually all industries, even services, sell to customers both inside and outside the region. As a result, regional economists devised an approach by which to measure the *degree* to which each industry is involved in the nonbase activities of the region, better known as the industry's *regional purchase coefficient*. Thus, they expanded the above formulations by calculating for each i industry

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

and

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

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

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

Although accurate, this approach only facilitates the calculation of an aggregate multiplier for the entire region. That is, we cannot determine from this approach what the effects are on the various sectors of an economy. This is despite the fact that one must painstakingly calculate the regional demand as well as the degree to which they each industry is involved in nonbase activity in the region.

As a result, a different approach to multiplier estimation that takes advantage of the detailed demand and trade data was developed. This approach is called input-output analysis.

Regional Input-Output Analysis: A Brief History

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

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

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

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

Framework

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

Figure 1
Interindustry Transactions Matrix (Values)

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

For example, in figure 1, agriculture, as a producing industry sector, is depicted as selling $65 million of goods to manufacturing. Conversely, the table depicts that the manufacturing industry purchased $65 million of agricultural production. The sum across columns of the interindustry transaction matrix is called the *intermediate outputs vector*. The sum across rows is called the *intermediate inputs vector*.

A single *final demand* column is also included in Figure 1. Final demand, which is outside the square interindustry matrix, includes imports, exports, government purchases, changes in inventory, private investment, and sometimes household purchases.
The *value added* row, which is also outside the square interindustry matrix, includes wages and salaries, profit-type income, interest, dividends, rents, royalties, capital consumption allowances, and taxes. It is called value added because it is the difference between the total value of the industry's production and the value of the goods and nonlabor services that it requires to produce. Thus, it is the *value* that an industry *adds* to the goods and services it uses as inputs in order to produce output.

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

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

The next step in producing input-output multipliers is to calculate the *direct requirements matrix*, which is also called the technology matrix. The calculations are based entirely on data from figure 1. As shown in figure 2, the values of the cells in the direct requirements matrix are derived by dividing each cell in a column of figure 1, the interindustry transactions matrix, by its column total. For example, the cell for manufacturing’s purchases from agriculture is 65/200 = .33. Each cell in a column of the direct requirements matrix shows how many cents of each producing industry’s goods and/or services are required to produce one dollar of the consuming industry’s production and are called *technical coefficients*. The use of the terms “technology” and “technical” derive from the fact that a column of this matrix represents a recipe for a unit of an industry’s production. It, therefore, shows the needs of each industry’s production process or “technology.”

Figure 2
Direct Requirements Matrix

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

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

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

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

$$\mathbf{A} = \mathbf{ZX}^{-1}$$

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

$$\mathbf{Z} = \mathbf{AX}$$

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

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

or, alternatively,

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

solving this equation for **x** yields

$\mathbf{x} =$	$(\mathbf{I}\text{-}\mathbf{A})^{-1}$		$\mathbf{y}$
Total =	Total	*	Final
Output	Requirements		Demand

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

Because it does translate the direct economic effects of an event into the total economic effects on the modeled economy, the Leontief Inverse is also called the *total requirements matrix.* The total requirements matrix resulting from the direct requirements matrix in the example is shown in figure 3.

Figure 3
Total Requirements Matrix

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

In the direct or technical requirements matrix in Figure 2, the technical coefficient for the manufacturing sector's purchase from the agricultural sector was .33, indicating the 33 cents of agricultural products must be directly purchased to produce a dollar's worth of manufacturing products. The same "cell" in Figure 3 has a value of .6. This indicates that for every dollar's worth of product that manufacturing ships out of the economy (i.e., to the government or for export), agriculture will end up increasing its production by 60 cents. The sum of each column in the total requirements matrix is the *output multiplier* for that industry.

Multipliers

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

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

- A *direct effect* (the initial drop causing the ripple effects) is the change in purchases due to a change in economic activity.

- An *indirect effect* is the change in the purchases of suppliers to those economic activities directly experiencing change.

- An *induced effect* is the change in consumer spending that is generated by changes in labor income within the region as a result of the direct and indirect effects of the economic activity. Including households as a column and row in the interindustry matrix allows this effect to be captured.

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

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

Assuming that $\Delta \mathbf{y}$—the change in final demand—is the "drop in the pond," then succeeding terms are the ripples. Each "ripple" term is calculated as the previous "pond disturbance" multiplied by the direct requirements matrix. Thus, since each element in the direct requirements matrix is less than one, each ripple term is smaller than its predecessor. Indeed, it has been shown that after calculating about seven of these ripple terms that the power series approximation of impacts very closely estimates those produced by the Leontief Inverse directly.

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

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

One example of an industry multiplier is shown in figure 4. In this example, the activity is the preservation of a historic home. The *direct impact* component consists of purchases made specifically for the construction project from the producing industries. The *indirect impact* component consists of expenditures made by producing industries to support the purchases made for this project. Finally, the *induced impact* component focuses on the expenditures made by workers involved in the activity on-site and in the supplying industries.

Figure 4
Components of the Multiplier for the
Historic Rehabilitation of a Single-Family Residence

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

Regional Input-Output Analysis

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

In the regional setting, local technology matrices are not readily available. An accurate region-specific technology matrix requires a survey of a representative sample of organizations for each industry to be depicted in the model. Such surveys are extremely expensive.[17] Because of the expense, regional analysts have tended to use national technology as a surrogate for

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

regional technology. This substitution does not affect the accuracy of the model as long as local industry technology does not vary widely from the nation's average.[18]

Even when local technology varies widely from the nation's average for one or more industries, model accuracy may not be affected much. This is because interregional trade may mitigate the error that would be induced by the technology. That is, in estimating economic impacts via a regional input-output model, national technology must be regionalized by a vector of regional purchase coefficients,[19] **r**, in the following manner:

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

or

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

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

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

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

A Comparison of Three Major Regional Economic Impact Models

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

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

Model Accuracy

RIMS II, IMPLAN, and RECON™ I–O all employ input-output (I–O) models for estimating impacts. All three regionalized the U.S. national I–O technology coefficients table at the highest levels of disaggregation (more than 500 industries). Since aggregation of sectors has been shown to be an important source of error in the calculation of impact multipliers, the retention of maximum industrial detail in these regional systems is a positive feature that they share. The systems diverge in their regionalization approaches, however. The difference is in the manner that they estimate regional purchase coefficients (RPCs), which are used to regionalize the technology matrix. An RPC is the proportion of the region's demand for a good or service that is fulfilled by the region's own producers rather than by imports from producers in other areas. Thus, it expresses the proportion of the purchases of the good or service that do not leak out of the region, but rather feed back to its economy, with corresponding multiplier effects. Thus, the accuracy of the RPC is crucial to the accuracy of a regional I–O model, since the regional multiplier effects of a sector vary directly with its RPC.

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

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

Although both RECON™ I–O and IMPLAN use an RPC-estimating technique that is theoretically sound and update it using the most recent economic data, some practitioners question their accuracy. The reasons for doing so are three-fold. First, the observations currently used to estimate their implemented RPCs are based on 20-years old trade relationships—the Commodity Transportation Survey (CTS) from the 1977 Census of Transportation. Second, the CTS observations are at the state level. Therefore, RPC's estimated for substate areas are extrapolated. Hence, there is the potential that RPCs for counties and metropolitan areas are not as accurate as might be expected. Third, the observed CTS RPCs are only for shipments of goods. The interstate provision of services is unmeasured by the CTS. IMPLAN replies on relationships from the 1977 U.S. Multiregional Input-Output Model that are not clearly documented. RECON™ I–O relies on the same econometric relationships that it does for manufacturing industries but employs expert judgment to construct weight/value ratios (a critical variable in the RPC-estimating equation) for the nonmanufacturing industries.

The fact that BEA creates the RIMS II multipliers gives it the advantage of being constructed from the full set of the most recent regional earnings data available. BEA is the main federal government purveyor of employment and earnings data by detailed industry. It therefore has access to the fully disclosed and disaggregated versions of these data. The other two model systems rely on older data from *County Business Patterns* and Bureau of Labor Statistic's ES202 forms, which have been "improved" by filling-in for any industries that have disclosure problems (this occurs when three or fewer firms exist in an industry or a region).

Model Flexibility

For the typical user, the most apparent differences among the three modeling systems are the level of flexibility they enable and the type of results that they yield. R/Econ™ I–O allows the user to make changes in individual cells of the 515-by-515 technology matrix as well as in the 11 515-sector vectors of region-specific data that are used to produce the regionalized model. The 11 sectors are: output, demand, employment per unit output, labor income per unit output, total value added per unit of output, taxes per unit of output (state and local), nontax value added per unit output, administrative and auxiliary output per unit output, household consumption per unit of labor income, and the RPCs. Te PC I–O model tends to be simple to use. Its User's Guide is straightforward and concise, providing instruction about the proper implementation of the model as well as the interpretation of the model's results.

The software for IMPLAN Pro is Windows-based, and its User's Guide is more formalized. Of the three modeling systems, it is the most user-friendly. The Windows orientation has enabled MIG to provide many more options in IMPLAN without increasing the complexity of use. Like R/Econ™ I–O, IMPLAN's regional data on RPCs, output, labor compensation, industry average margins, and employment can be revised. It does not have complete information on tax revenues other than those from indirect business taxes (excise and sales taxes), and those cannot be altered. Also like R/Econ™, IMPLAN allows users to modify the cells of the 538-by-538 technology matrix. It also permits the user to change and apply price deflators so that dollar figures can be updated from the default year, which may be as many as four years prior to the current year. The plethora of options, which are advantageous to the advanced user, can be extremely confusing to the novice. Although default values are provided for most of the options, the accompanying documentation does not clearly point out which items should get the most attention. Further, the calculations needed to make any requisite changes can be more complex than those needed for the R/Econ™ I–O model. Much of the documentation for the model dwells on technical issues regarding the guts of the model. For example, while one can aggregate the 538-sector impacts to the one- and two-digit SIC level, the current documentation does not discuss that possibility. Instead, the user is advised by the Users Guide to produce an aggregate model to achieve this end. Such a model, as was discussed earlier, is likely to be error ridden.

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

Model Results

Detailed total economic impacts for about 500 industries can be calculated for jobs, labor income, and output from R/Econ™ I–O and IMPLAN only. These two modeling systems can also provide total impacts as well as impacts at the one- and two-digit industry levels. RIMS II provides total impacts and impacts on only 38 industries for these same three measures. Only the manual for R/Econ™ I–O warns about the problems of interpreting and comparing multipliers and any measures of output, also known as the value of shipments.

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

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

In terms of the format of the results, both R/Econ™ I–O and IMPLAN are flexible. On request, they print the results directly or into a file (Excel® 4.0, Lotus 123®, Word® 6.0, tab delimited, or ASCII text). It can also permit previewing of the results on the computer's monitor. Both now offer the option of printing out the job impacts in either or both levels of occupational detail.

RSRC Equation

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

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

and where for a given industry

$x = k\, Z_1^{a1} Z_2^{a2}\, P_j\, Z_j^{aj}$ and D is its total local demand.

Since for a given industry RPC = LS/D then

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

which was the equation that was estimated for each industry.

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

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

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

Advantages and Limitations of Input-Output Analysis

Input-output modeling is one of the most accepted means for estimating economic impacts. This is because it provides a concise and accurate means for articulating the interrelationships among industries. The models can be quite detailed. For example, the current U.S. model currently has more than 500 industries representing many six-digit North American Industrial Classification System (NAICS) codes. The CUPR's model used in this study has 517 sectors. Further, the industry detail of input-output models provides not only a consistent and systematic approach but also more accurately assesses multiplier effects of changes in economic activity. Research has shown that results from more aggregated economic models can have as much as 50 percent error inherent in them. Such large errors are generally attributed to poor estimation of regional trade flows resulting from the aggregation process.

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

The limitations of input-output modeling should also be recognized. The approach makes several key assumptions. First, the input-output model approach assumes that there are no economies of scale to production in an industry; that is, the proportion of inputs used in an industry's production process does not change regardless of the level of production. This assumption will not work if the technology matrix depicts an economy of a recessional economy (e.g., 1982) and the analyst is attempting to model activity in a peak economic year (e.g., 1989).

In a recession year, the labor-to-output ratio tends to be excessive because firms are generally reluctant to lay off workers when they believe an economic turnaround is about to occur.

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

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