Report Title: The Economic Impact of Coal Mining in New Mexico

Type of Report: Topical Report

Reporting Period Start Date: October 1, 2008

Reporting Period End Date: September 30, 2009

Principal Authors: James Peach and C. Meghan Starbuck

Date Issued: June 2009

DOE AWARD Number: DE-NT0004397

Name and Address of Submitting Organization:

Arrowhead Center
New Mexico State University
P. O. Box 30001/MSC 3CQ
Las Cruces, NM 88003-8001

Abstract

The economic impact of coal mining in New Mexico is examined in this report. The analysis is based on economic multipliers derived from an input-output model of the New Mexico economy. The direct, indirect, and induced impacts of coal mining in New Mexico are presented in terms of output, value added, employment, and labor income for calendar year 2007. Tax, rental, and royalty income to the State of New Mexico are also presented. Historical coal production, reserves, and price data are also presented and discussed. The impacts of coal-fired electricity generation will be examined in a separate report.

Table of Contents

Table of Figures

Table of Tables

Economic Impact of Coal Production in New Mexico

Executive Summary

This report provides an analysis of the impact on the New Mexico economy of coal mining in 2007. This report is one of a series of reports on the impact of fossil fuels in New Mexico. This report has been prepared as part of New Mexico State University's Arrowhead Center's PROSPER project funded by a U.S. Department of Energy Grant, National Energy Technology Laboratory (NETL), Award Number DE-NT0004397.

New Mexico has been producing coal for more than a century. By 1918 New Mexico coal production reached four million short tons but declined to a low of 123,000 tons in 1954. New Mexico coal production began to rise again in the early 1960s, but did not reach its 1918 production level of four million short tons until 1969. More than half of all coal mined in the state has been produced since 1990. Between 1882 and 2007, New Mexico produced 936.7 million short tons of coal. From 1990 to 2007, New Mexico produced 480.7 million short tons of coal (51.3 percent of all coal mined ever mined in the state).

The US contains 27 percent of the world's recoverable reserves of coal (Energy Information Administration 2009). New Mexico has an estimated 483 million short tons of economically recoverable coal, which represents 2.6 percent of the total estimated US coal reserves in 2007. The majority of the coal resources in New Mexico are in the San Juan Basin (SJB) which contains large areas of alternating sandstone and shale beds. The basin contains two main coal bearing deposits, the Fruitland and the Mesa Verde.

In 2007 New Mexico's four active coal mines produced 24.4 million short tons of coal. The average price of New Mexico's coal in 2007 was $27.69 per short ton. The value of coal produced in New Mexico in 2007 was $673.9 million. In 2007, New Mexico had four active coal mines (1 underground mine and 3 surface mines). New Mexico coal production has remained relatively stable in the early years of the 21st century –with production averaging about 25 million short tons and with the price of a short ton between $25 and $30.

During the last several decades, the number of active coal mines in New Mexico has steadily decreased, while production from the remaining active mines has increased dramatically. In 1952 there were 27 active coal mines in the state with a total production of 759 thousand short tons of coal (U.S. Bureau of Mines 1952). The decrease in the number of active mines and the simultaneous increase in production during the last half century reflect a shift from underground mining to surface mining in the state.

In 2007 the coal mining industry in New Mexico contributed $1.039 billion in output (direct, indirect and induced) to the state economy. Value added was $588 million. Direct employment in coal mining in New Mexico was 1,390 jobs. Total employment (direct, indirect, and induced) associated with coal mining was 3,293 jobs. The coal mining industry accounted for $83.5 million in state revenue in 2007.

The economic impact of coal fired electricity generation in New Mexico will be the subject of a separate report.

Introduction

This report provides an analysis of the impact of coal mining on the New Mexico economy in 2007. This report is one of a series of reports on the impact of energy in New Mexico. This report has been prepared as part of fossil fuel energy in New Mexico. This report has been prepared as part of New Mexico State University's Arrowhead Center's PROSPER project funded by U.S. Department of Energy Grant Award Number DE-NT0004397.

The base year of the study (2007) is the most recent year for which complete coal production, price, and tax data are available. The report will be updated as new data become available.

New Mexico is a state rich in natural resources including timber, agricultural resources, oil, natural gas, coal, and uranium. The extraction and use of these resources provides important economic benefits in the form of employment, income, and tax revenues for New Mexicans.

The history of New Mexico is intertwined with resource based industries. Settlers sought gold and silver, lured by the tales of immense quantities of precious metals. Reports written in the late 1800s describe the main occupation of the population in the New Mexico Territory as gold and silver mining—the pursuit of the famed treasures of El Dorado (Chafee 1893). The prospectors that sought the riches of Eldorado eventually settled into communities. Agriculture in the fertile valleys, open range cattle on the vast grassy slopes, mining in the ravines and mountainous areas –all laid the foundation for the modern cities and economies of the west and New Mexico. As the railroads expanded westward, forests and coal deposits became vital components of western economic activity. The Southern Pacific Railroad had ownership of a 300 mile long coal field in New Mexico, which was instrumental to successful operation (Andrews 1874). The use of coal as a transportation, heating, and industrial fuel was critical to the development of the United States and New Mexico.

Professor E.B. Andrews described coal resources in the United States in 1874, "Fire was the great civilizer and introduced the golden age, which afterward degenerated in to the iron age [sic]. The fable of the ancients becomes the veritable history of today, for now fire is the prime factor in our highest material civilization, and our iron age is a golden age" (Andrews 1874, pp. 1).[1] This quote, true in 1874, is still so today—as coal fired electricity is a prime source of the 'fire' of our modern economy.

The economic activity generated by the mining of coal and the generation of coal-fired electricity for domestic consumption and export to other states is discussed in this report. This report is organized as follows: (1) a brief Introduction to coal; (2) coal in New Mexico; (3) coal Prices; (4) economic impacts of coal mining; (4) tax impacts; and (5) conclusion. Appendix A contains a discussion of contemporary coal production and price data. Appendix B contains the data and data sources used in all figures in the text. Appendix C contains background material on the IMPLAN software used in the analysis.

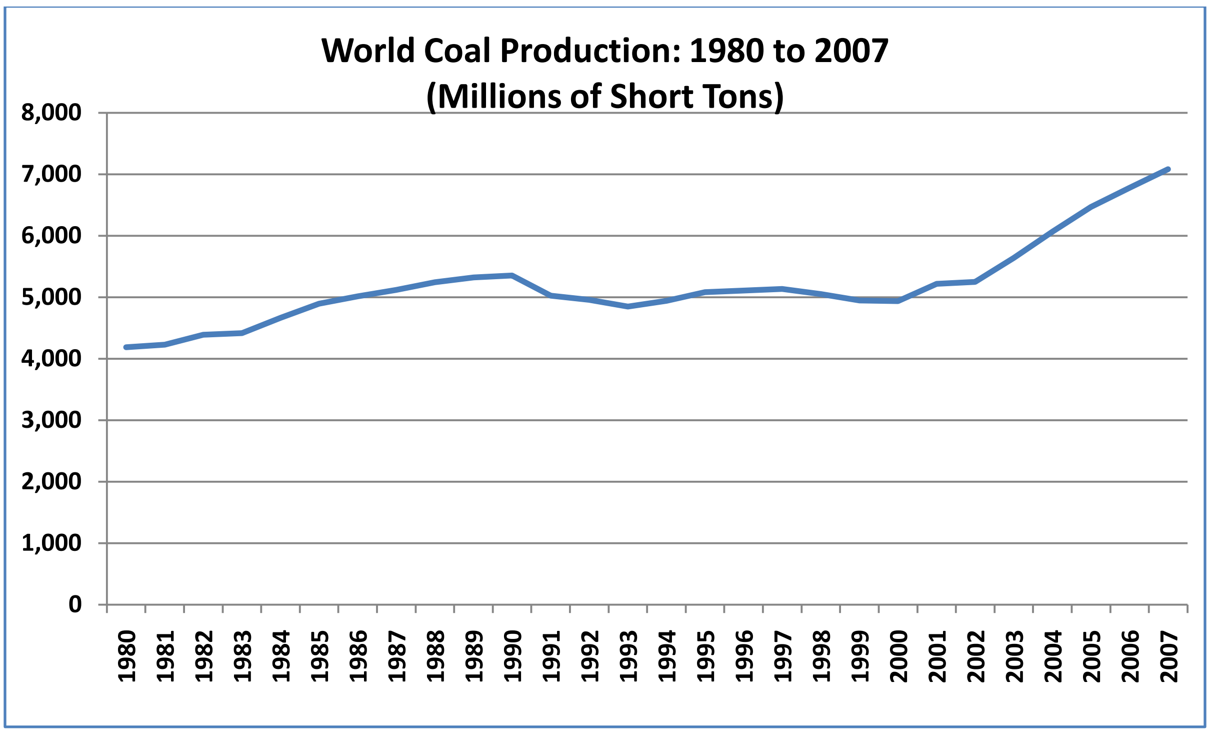
[1] This statement refers to the Greek myth of Prometheus bringing fire from the Gods.

A Brief Introduction to Coal

Coal has been a major source of energy in much of the world since the industrial revolution and has been an integral part of the economic prosperity of the United States. In 2007, the world produced and consumed seven billion short tons of coal (EIA International Energy Outlook, 2008). In 2007 coal provided 26 percent of the world's primary energy supply and was used to generate 41 percent of electricity (World Coal Institute 2009).

World coal production increased by 69.1 percent between 1980 (4.2 billion short tons) and 2007 (7.1 billion tons (Energy Information Administration 2009). As Figure 1 illustrates, the world-wide increase in coal production has accelerated in the 1990s and early 2000s. This trend reflects rapid increases in coal production in China and India.

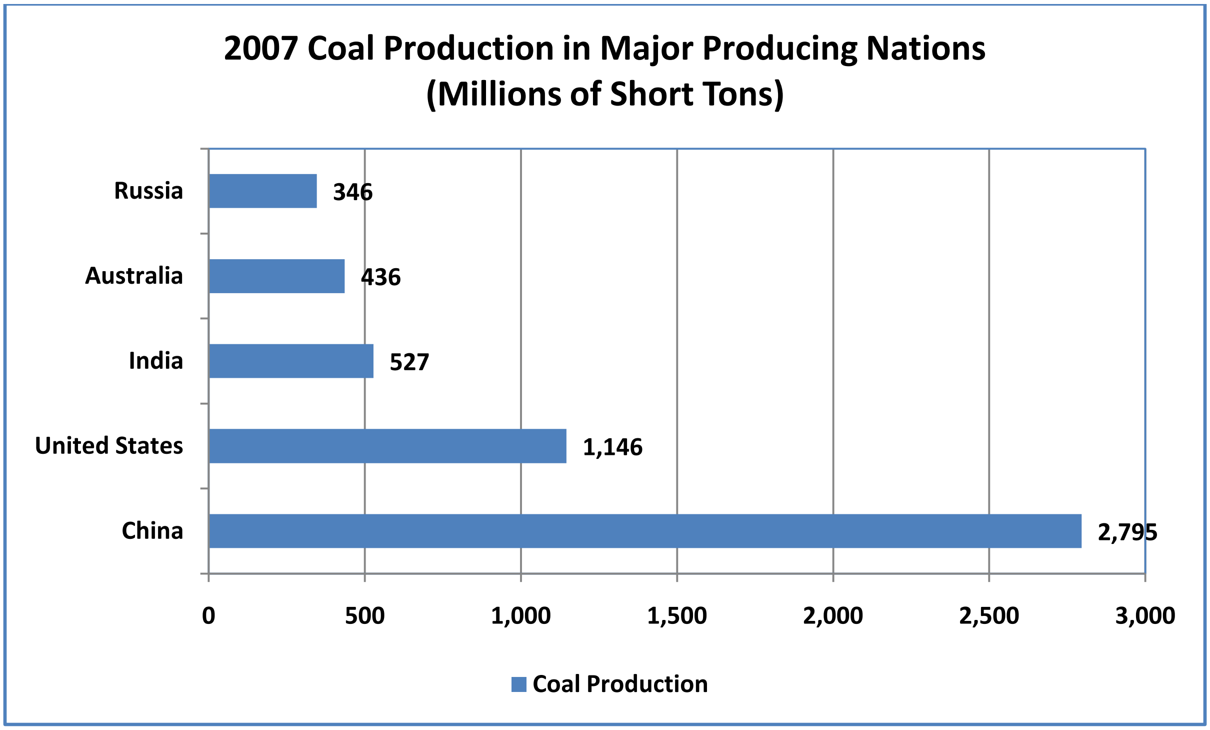
Figure 1 World Coal Production 1980-2007



Source: Appendix B contains data tables and data sources for all figures.

World coal production is highly concentrated geographically. Nearly three-fourths (74.1 percent) of world coal production in 2007 occurred in five nations. Figure 2 displays 2007 coal production for the leading producing nations (Energy Information Administration 2009).

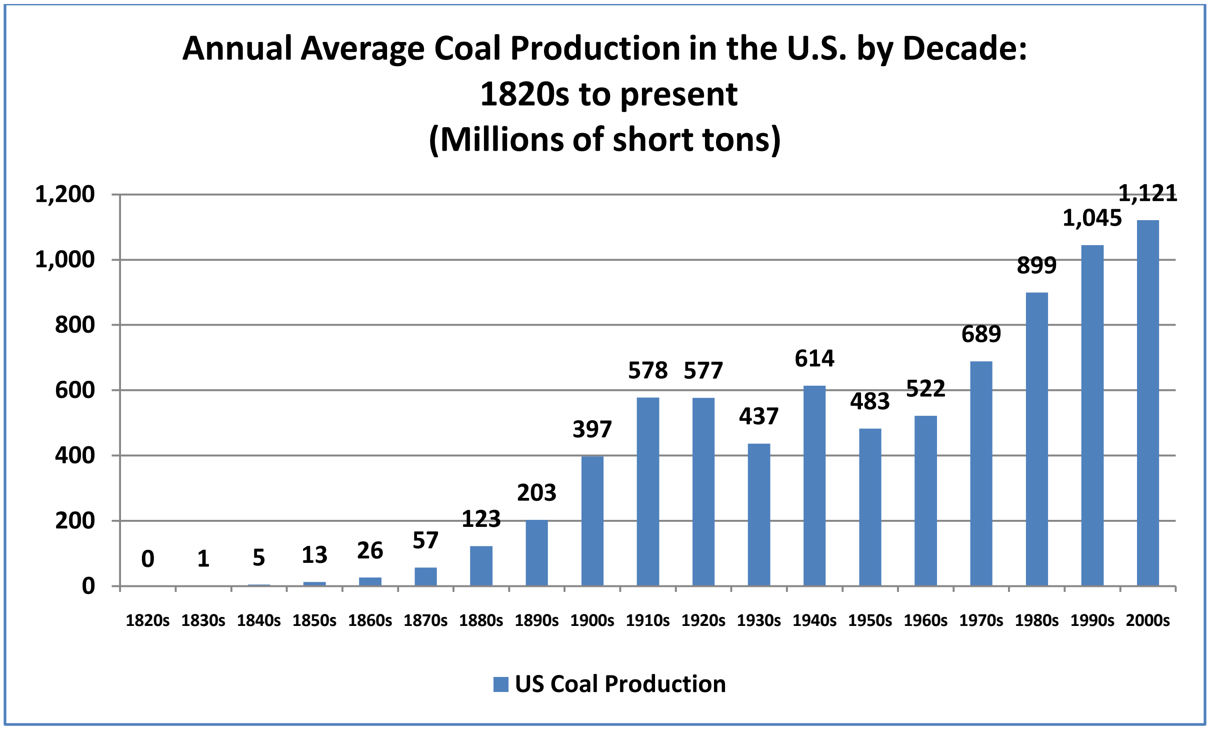
Figure 2 2007 Coal Production in Major Producing Nations



Great Britain was the world's largest producer of coal in the 19th century but ranked 25th in coal production in 2007 (18.2 million short tons). New Mexico's coal production in 2007 of 24.4 million short tons (only a small part of the US total) is now larger than Great Britain's production. The United States displaced Great Britain as the world's largest coal producer in about 1900, an event that symbolized the nation's rise as an industrial power (Zimmerman 1951, Table 27.4, p. 471). In 1985, China surpassed the U.S. in coal production and has remained the world's largest producer since then (Energy Information Administration 2009).

Coal began supplying the energy for a growing U.S. economy beginning with the colonial era, was instrumental in fueling the industrial revolution, and provided the fuel for two world wars. Coal is used for domestic heating, cooking, transportation, industrial power, and electricity generation. Figure 3 displays annual average US coal production by decade from the 1820s to the present. Between the 1890s and World War I, coal production in the US increased rapidly then decreased substantially in the 1930s and then increased briefly during World War II. US Coal production did not reach its World War I era peak again until the 1970s but has increased in each decade since the 1970s.

Figure 3 Average Annual Coal Production in the U.S. by Decade: 1820s to 2000s



Coal Reserves

Coal is formed by the burial of vegetation in low oxygen environments. Ancient marshlands and swamps that were prolific during the oxygen rich and wet carboniferous period generated massive quantities of vegetation. Over the long span of geologic time this organic material was buried and subjected to intense heat and pressure which created coal (Speer, Beaumont and Shoemaker 1977). Professor Andrews has a more artful description of coal (Andrews 1874, pp. 4-5):

> *"A careful observer will often see the distinct remains of leaf, trunk, root, and fiber of the old flora in the very coal itself, all changed to perfect coal. We may sometimes see in a seam of coal large numbers of the trunks of Sigillaria, with distinct bark-markings, lying in all directions like enormous jack-straw, each contributing a flattened layer of coal to the common stock…we find in beautiful preservation, all the forms of leaves, fronds, trunks, and fruit that belonged to the old-time vegetation."*

There are four main types of coal that are used as an energy source: (1) lignite; (2) sub-bituminous coal; (3) bituminous coal; and (4) anthracite. Different coal deposits have differing energy and sulfur contents (New Mexico Institute of Mining and Technology 2008). The US contains five major coal producing regions: (1) Appalachian basin; (2) Illinois basin; (3) Gulf Coast; (4) Northern Rocky Mountain and Great Plains; and the (5) Colorado Plateau (US Geological Survey 2001).

The Coal Reserves Database (CRD) of the Energy Information Administration (EIA) publishes regular estimates of the quantity of coal available in the United States. EIA lists 489 billion short tons of coal reserves. These reserves are classified as Demonstrated Reserves Base (DRB), and are comprised of coal reserves that have been identified within adequate levels of accuracy and are deemed able to support mining of coal using current technology. These reserves are larger than the known reserves of natural gas and oil (in terms of BTU). Of the 489 billion short tons of DRB coal reserves (Energy Information Administration 2008):

1. 53 percent is bituminous coal, with most seams occurring east of the Mississippi in Illinois, Kentucky, and West Virginia;
2. 37 percent is sub-bituminous coal, and occur west of the Mississippi in Montana and Wyoming;
3. 9 percent is lignite, and occur in Montana, Texas, and North Dakota; and
4. 1.5 percent is anthracite, and occurs mostly in northeastern Pennsylvania.

The US Geological Survey (USGS) defines the amount of coal that is readily available for energy production. Available Coal Resources (ACR) are the fraction of the DRB that are accessible for mine development after subtracting that quantity of coal resource that is restricted by environmental, societal, and technological constraints. The Recoverable Coal Resource (RCR) is the fraction of the ACR that remains after losses from mining and cleaning. The RCR is the actual amount of coal that can be used from the initial Demonstrated Reserve Base (Krischbaum, Roberts and Biewick 2000, pp. 8).

Of the 489 billion short tons of DRB coal, the EIA estimates that in 2008 the recoverable coal reserves were 262 billion short tons of coal. EIA estimates that in the US only about 50 percent of the DRB is available due to land use conflicts, property rights, physical restrictions, and environmental restrictions. Worldwide it is estimated that there are 998 billion short tons of recoverable coal. The US contains 27 percent of these recoverable reserves; Russia has 17 percent; China has 13 percent, and Australia has 9 percent (Energy Information Administration 2009).

The recoverable reserves (RCR) are further reduced by economic considerations. The Economically Extractable Resource (EER) is that part of the RCR that can be mined, cleaned, and marketed at a profit. The EER takes into account the marketability of the processed coal product; coal quality, cost to produce, deliver, and transport the coal to market (Krischbaum, Roberts and Biewick 2000, pp. 8). The US currently has an estimated 262 billion short tons of RCR, and the EER would be a smaller fraction of this quantity. The USGS has estimated the EER for major coalfields in the US under the National Coal Resource Assessment (NRCA) project. The EER varies dramatically by coalfield.

The use of coal over the years has changed dramatically, and is strongly influenced by technological change and regulatory frameworks. Three significant changes have occurred in the coal industry since the end of World War II: (1) the change in the uses of coal; (2) technological change; and (3) environmental/cultural preservation legislation.

The combination of these three factors created a structural shift in the coal industry in the US. Coal began to be used in electricity generation in the 1950s in response to the dramatic increase in electricity consumption in the post World War II era. The adoption of diesel engines for transportation, both in the railroad and trucking industries, also changed the demand for coal. In the 1970s, increased environmental awareness resulted in key legislative changes which restricted sulfur emissions from power plants. The Environmental Protection Agency (EPA) was created by President Nixon in 1970.[2] The passage of the Clean Air Act of 1970 and the subsequent rules and regulations implemented and enforced by the EPA began to significantly influence how coal was used (Environmental Protection Agency 2009).

Most mines in the 1950s were underground Eastern mines producing anthracite coal. By 2003, production of bituminous, sub-bituminous, and lignite coal-types increased to 1,069 million short tons from only 516 million short tons of bituminous and no sub-bituminous or lignite. Anthracite production was 44.1 million short tons in 1950, and in 2003, was only 1.3 million short tons. Over this same time period the number of subsurface mines in the US decreased from 421 in 1950, to 352 in 2003. Surface mines increased from 139 in 1950 to 719 in 2003 (Energy Information Administration 2006, pp. 3). Total employment in the coal industry in the United States in 1973 was 152,204. In 1983, employment had risen to 175,642. However, by 1993 the number had fallen to 101,322; and by 2003 had declined to only 71,023 (Energy Information Administration 2006, pp. 11). The peak of employment in the coal industry was a result of the increased use of relatively inefficient mining technology in many of the western surface mining operations and coal prices sufficient to sustain the lower productivity mines. However, the long term decline in coal prices between the late 1980s and the early 2000s led to steep decreases in the number of operating mines and the number of people employed in the industry (Energy Information Administration 2006, pp. 11).

Coal and New Mexico

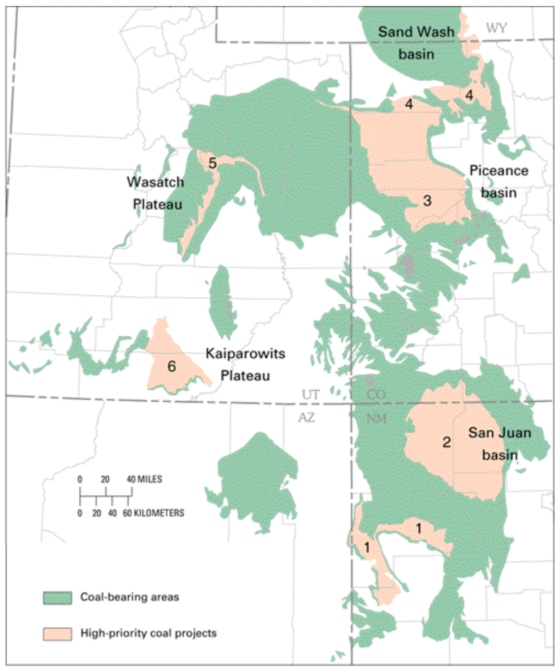
Coal Resources in New Mexico

The majority of the coal resources in New Mexico are in the San Juan Basin (SJB). The San Juan basin is in an arid to semi-arid climate with intermittent streams, sparse vegetation, mesas, canyons, plateaus, and broad dry-washes. There are large areas of alternating sandstone and shale beds. The basin contains two main coal bearing deposits, the Fruitland and the Mesa Verde. These were formed during the late cretaceous period when a broad, shallow inland sea covered the area. The depositional environment was highly variable which resulted in a widely varying pattern of coal deposits. The area was subject to influxes of mud and silts which created the discrete carbonaceous shale and siltstone inter-bedded with the coal in the SJB coal seams. This influx of mud and silt also created the impurities found in the coal deposits. The thickness of the deposits is dependent upon the length of time the shoreline remained stable. Generally, the deposits in the SJB are less than 10 feet thick, and tend to occur in sequence separated by layers of shale. The deposits exploited by commercial interests are typically between 25-35 feet thick. Deposits less than 3 feet are not considered economic extractable deposits (Speer, Beaumont and Shoemaker 1977, pp. 7-14).

[2] "During this period a great many new environmental laws were passed and some old ones resurrected and refurbished as well as energy legislation that impacted on the environment. Other environmental type laws were enacted, such as the Coastal Zone Management Act (1972), the Marine Protection Research and Sanctuaries Act (1972), the Endangered Species Act (1973), the Wild and Scenic Rivers Act (1976), the Marine Mammal Protection Act (1972), the Deepwater Ports and Waterways Safety Act (1974), the Fish and Wildlife Coordination Act (1974), the Water Resources Planning Act (1977), the Water Resources Research Act (1977), the Environmental Quality Improvement Act (1970), several amendments to the Food Drug and Cosmetics Act, and the Environmental Education Act. There was renewed enforcement of the Rivers and Harbors Act of 1899." (Wisman 1985)EPA History, 1970-1985.

New Mexico is a producer of energy for in-state production and for export to the rest of the United States. In the early 1960's New Mexico began producing coal for consumption in power generating facilities. Most of the coal mined in New Mexico is used for electricity generation. In 2007, 76.7 percent of all electricity generated in the state was from coal fired plants (27,603,647 megawatt hours) (Energy Information Administration 2009). New Mexico has an estimated 483 million short tons of economically recoverable coal, which represents 2.6 percent of the total estimated US coal reserves in 2007. New Mexico is ranked 11th in recoverable reserves (Energy Information Administration 2009, Table 14, p. 33).

Figure 4 Coal Resources in the Western US (USGS)



Source: (US Geological Survey 2009, Figure 12) Reproduced with permission.

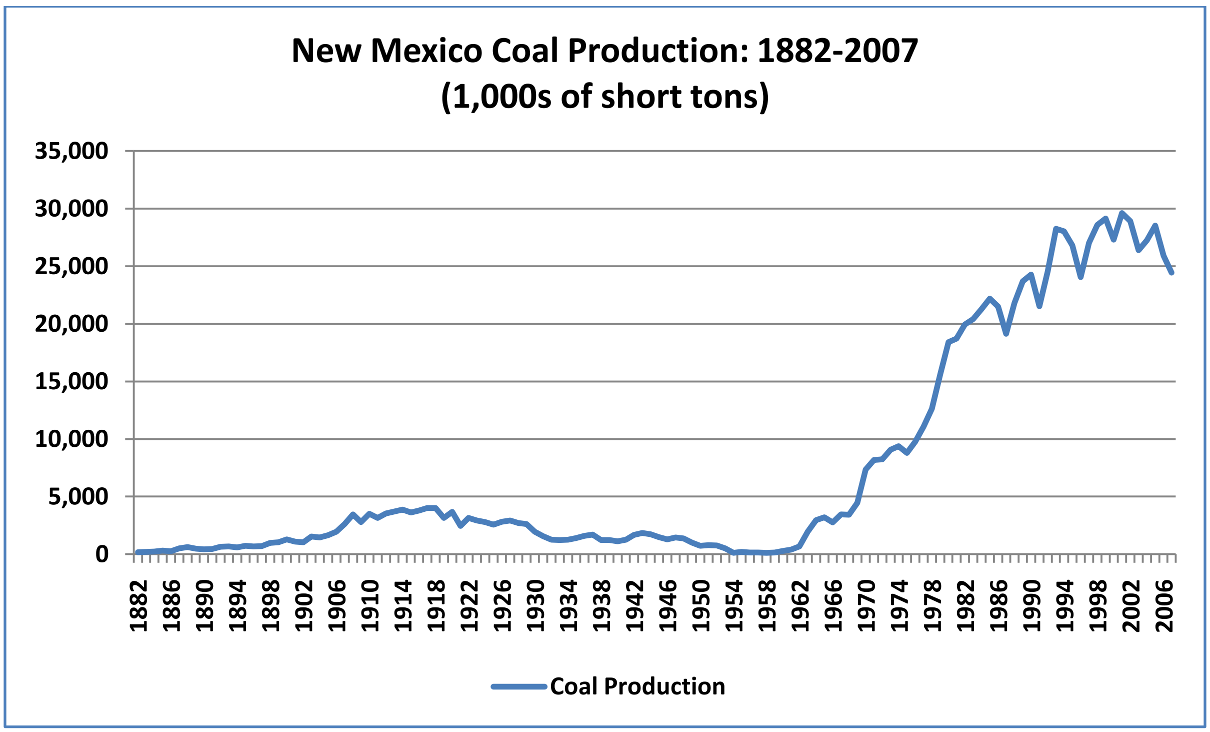
Figure 4 shows the main coal deposits in New Mexico. The San Juan Basin in Northern New Mexico and Southern Colorado contains large quantities of natural gas and coal deposits that formed during the late cretaceous period in swampy conditions. Coal deposits underlie 12 percent of the state's land area, with an estimated 14.6 million acres of the state containing coal reserves (New Mexico Institute of Mining and Technology 2008).

In New Mexico, the main mining methods used are: (1) contour strip; (2) area; (3) auger; (4) truck/shovel; and (5) dragline. Two underground methods are also used: (1) long wall; and (2) room and pillar. Each method has different recovery rates and cost structures. For coal seams that are less than 36 inches thick the recovery rate is only 78 percent, but a coal seam with a depth greater than 36 inches has an estimated recovery rate of 93 percent. Area mining and auger mining have the lowest recovery rates at 30 percent. Truck shovel mining and dragline methods range in recovery from 78 percent to 95 percent depending on the scale of the equipment. The underground methods have generally lower recovery rates of 57 percent to 84 percent. All but one of the New Mexico mines uses surface methods due to the nature of the coal seams in New Mexico (Krischbaum, Roberts and Biewick 2000, pp. 15). The coal mined in New Mexico is found in seams that are at least 2.5 feet thick and contain a minimum of 1,770 short tons of coal per acre foot. The current operations are mining sub-bituminous coal (Krischbaum, Roberts and Biewick 2000, pp. 42).

Coal Production in New Mexico

Coal was used in fire-pits by the Hopi Indians in New Mexico as early as AD 1300 (Kottlowski 1964, p. 3). By 1835, coal was being mined near Madrid, New Mexico about 14 miles from Santa Fe but far from currently producing coal mines. By 1861, federal troops at Fort Craig in the south central part of the state were mining coal on a "significant scale" (Kottlowski 1964, 3-4). By the early 1880s, coal production in New Mexico exceeded 150,000 short tons (Figure 5). By 1918 New Mexico coal production reached four million short tons but declined to a low of 123,000 tons in 1954. The decline in state production in the early 1950s was largely due to the replacement of steam-fired locomotives by diesel powered locomotives. New Mexico coal production began to rise again in the early 1960s, but did not reach its 1918 peak of four million short tons until 1969.

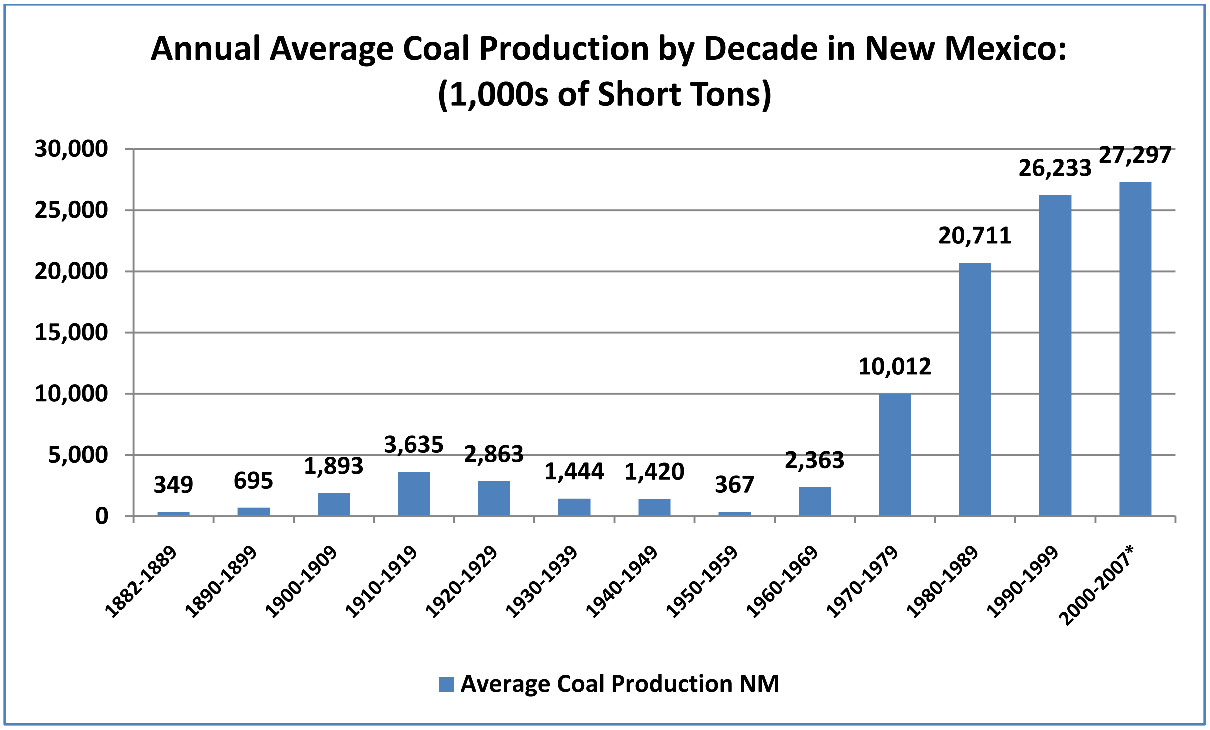
Figure 5 Coal Production in New Mexico 1882-2007



Prior to 1970 New Mexico coal production never exceeded five million short tons or approximately one-fifth of average annual production in the early 2000s. Although commercial coal mining in New Mexico on a relatively large scale began in the 1880s, half of New Mexico's total coal production took place after 1990.

Figure 6 displays New Mexico coal production by decade from the 1880s to the early 2000s. Production data for 1880, 1881, 2008 and 2009 are not available, but this omission will have little effect on the general pattern.

Figure 6 Annual Average Coal Production in New Mexico by Decade



The coal mined in New Mexico prior to the 1950s was anthracite from coal seams in proximity to the railroads (Andrews 1874). Gallup grew around the mines adjacent to the Atchison, Topeka, and Santa Fe Railroads standard gauge rail lines. The Monero and Lumberton leases provided coal to the narrow gauge lines of the Denver and Rio Grande Western Railroad. Some bituminous coal was used for mining smelters and low grade slack was used for boiler fuel. Coal from Gallup was used in El Paso, TX and Arizona by copper smelters until the 1920s. The first era of mining which ended in the late 1950s was typically conducted in underground mines and was comprised of drift mines that entered horizontal coal beds and followed the seam. In 1962 the introduction of large scale strip mines transformed the New Mexico coal industry (Speer, Beaumont and Shoemaker 1977, pp. 16-17).

The Pittsburg and Midway Coal Company began strip mining (surface mining) in the San Juan Basin (SJB) in 1962 at the McKinley mine about fourteen miles northwest of Gallup, New Mexico. The coal removed from the McKinley mine was a bituminous coal that was shipped by train to the Arizona Public Service Company (Speer, Beaumont and Shoemaker 1977, pp. 17). The 1970s saw a period of intense activity in coal mining in New Mexico as a result of the combined effects of the OPEC induced oil price shocks and the Clean Air Act of 1970 which triggered interest in developing coal gasification technology to generate electricity. El Paso Electric and Consolidated Electric planned a coal-gasification project which would have needed 454 million tons of coal over a 30 year period (Speer, Beaumont and Shoemaker 1977, pp. 28). This project was canceled after the collapse of oil prices in the 1980s.

Despite the decrease in coal prices during the 1980s, New Mexico’s coal production in that decade was double what it had been in the 1970s (see Figure 6). In the 1990s, coal production in the state was about 30 percent higher than it had been in the 1980s. In the early 2000s, coal production in New Mexico has remained at approximately the same levels as in the 1990s. The discussion of active coal mines in New Mexico (below) provides additional information on conditions in the New Mexico coal mining industry in the early 2000s.

Active Coal Mines in New Mexico

During the last several decades, the number of active coal mines in New Mexico has steadily decreased, while production from the remaining active mines has increased dramatically. In 1952 there were 27 active coal mines in the state with a total production of 759 thousand short tons of coal (U.S. Bureau of Mines 1952). In 2007, there were only four active mines in New Mexico, but these mines produced 24.4 million short tons of coal. The decrease in the number of active mines and the simultaneous increase in production during the last half century reflect a shift from underground mining to surface mining in the state.

In 2007 (the base year for this study) there were four active coal mines in New Mexico: San Juan (underground); Navajo (underground); Lee Ranch (surface); and McKinley Mine (Surface). BHP Billiton operates the San Juan and the Navajo mines. They have 1,009 full-time employees, of which 65 percent are Native American from the Navajo Tribe. The mines are located on the Navajo reservation near Farmington, NM in the San Juan Basin of northern New Mexico (BHP Billiton 2009). The San Juan mine is a single long wall operation which has 576 employees. The coal produced at the San Juan mine is used by the San Juan Generating Station (BHP Billiton 2009). The San Juan mine is a subsurface mine that produced 6,898,040 short tons of coal in 2007 and was the 27th largest coal mine in the US (Energy Information Administration 2009b). The subsurface Navajo Mine uses two drag lines and sends coal to the Four Corners Power Plant and has 433 employees (BHP Billiton 2009). The Navajo Mine produced 8,529,955 short tons of coal in 2007 and is the 18th largest coal mine in the United States (Energy Information Administration 2009b). The Lee Ranch Mine is operated by the Lee Ranch Coal Co. (a subsidiary of Peabody) and is the 37th largest coal mine in the US and produced 5,358,749 short tons in 2007 (Energy Information Administration 2009b). The McKinley mine, operated by Chevron Mining was closed in 2008 and is now under-going reclamation. The McKinley mine was a subsurface bituminous/lignite mine that produced 175 million short tons of coal before the mine was closed (NM Energy Minerals and Natural Resources Department 2008). The reclamation process will continue for two more years and currently has 58 employees. The McKinley mine was the first strip mine in New Mexico and was opened in 1962 (Chevron Mining 2009).

The Navajo Nation and a private firm, Sithe Global Power LLC, are attempting to build and construct a new 1,500 MW coal-fired plant in northern New Mexico (the Desert Rock Plant). The plant is estimated to produce 80 percent fewer emissions than current generation power plants, and will use an innovative air cooling process to reduce water use (Helman 2009). Desert Rock Energy Company LLC and Sithe Global Power LLC began the permitting process in 2004, and were granted a Prevention of Significant Deterioration Permit in July 2008 by the Environmental Protection Agency (EPA). However, the permit was partially repealed in January of 2009 and is currently under review by the EPA. The EPA ruled that the agency failed to properly consider carbon dioxide emissions in the permit and repealed a “portion” of the permit. This means that construction on the plant has halted and cannot restart until further notice (Environmental Protection Agency 2009). The Desert Rock facility has been highly controversial. The State of New Mexico, under Governor Richardson’s direction, appealed the permit approval by EPA. The EPA notes that the agency has received over 20,000 comments regarding the Desert Rock power plant. The future of this facility and the coal mine that will support it are uncertain. The EPA has provided no timeline for a final decision (Environmental Protection Agency 2009). Numerous environmental and social justice organizations in addition to many individuals are filing motions with the EPA and the time to process and adjudicate these issues will be lengthy.

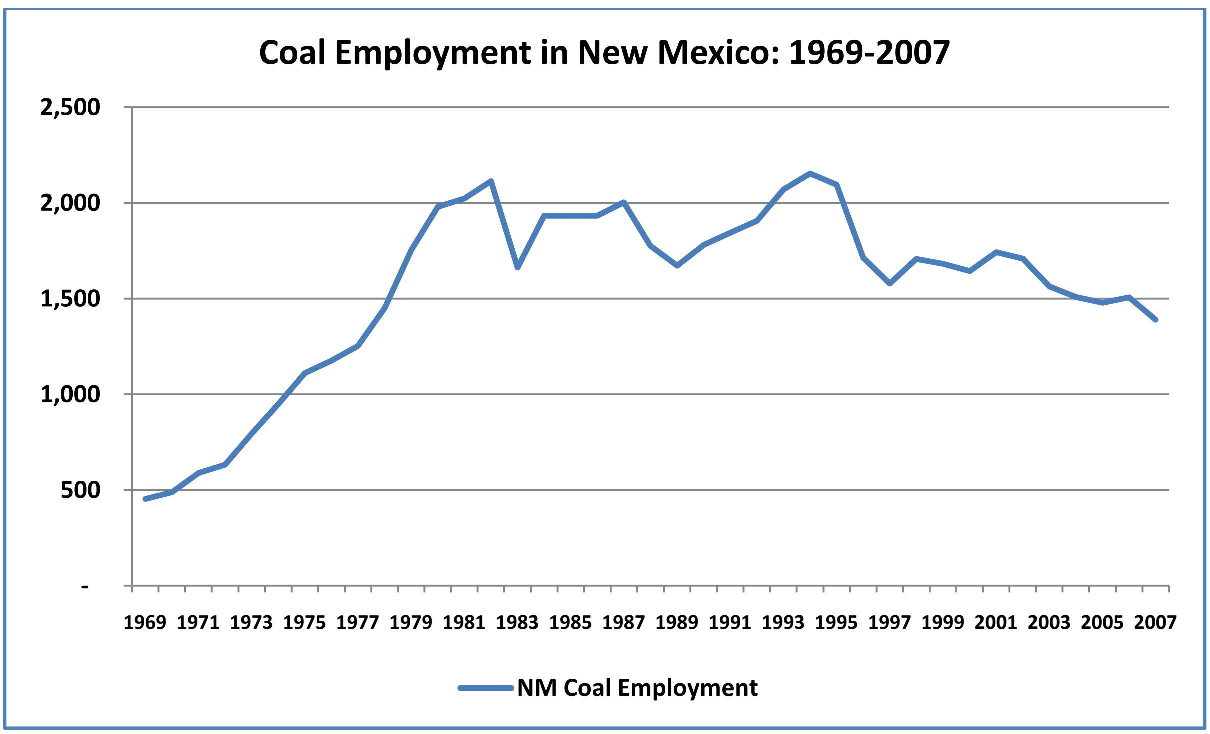
Employment in the New Mexico Coal Industry

Despite increases in coal production in New Mexico, employment in the state's coal mining industry has been declining –a pattern also seen at the national level. Employment in the coal industry reflects underlying changes in the industry, and shows the dual effects of changes in mining type and technology.

More specifically, there has been a long-term increase in productivity per worker in the coal mining industry. Labor productivity in the coal mining industry can be measured as tons per worker per year (or per day or per hour worked). For example, in 1934 New Mexico's 2,342 coal miners produced 1,150,825 short tons of coal or about 491 short tons per worker per year. In 2007, New Mexico's 1,390 coal miners produced 24.451 million tons of coal or 17,591 tons per worker per year. This is a 35 fold increase in output per worker since 1934 (United States Geological Survey 1932-2007, 1936 and 2007).

Given the dramatic increases in labor productivity, the long-term downward trend in coal mining employment is not surprising. In New Mexico, this trend has continued in recent years. Figure 7 displays employment in coal mining in New Mexico from 1994 to 2007. In 2001, there were 1,743 jobs directly associated with the coal-mining industry in New Mexico, but by 2007 that figure had declined to 1,390 (Bureau of Labor Statistics 2009).

Figure 7 Coal Industry Employment in New Mexico: 1969-2007



Coal Prices

Coal prices in the United States and New Mexico vary substantially by type of coal, location of coal deposits relative to markets, the technology used to mine the coal (e.g., surface versus underground mining), the nature of long-term contracts, and other market conditions. Figure 8 shows the price of coal by type from 1949 to 2007 in nominal (current) dollars per short ton. Figure 9 displays coal prices by type converted to constant 2007 dollars. The four types of coal are: bituminous, sub-bituminous, lignite, and anthracite. Prior to 1978, bituminous and sub-bituminous were reported together, since the sub-bituminous coal was not being mined except in small quantities. Sub-bituminous coal became an important energy source after 1970 and after 1978 is reported separately (Energy Information Administration 2008). As shown in Figures 8 and 9, the variability in the price of coal by type is obvious. Throughout the time period shown in the charts, anthracite has commanded a higher price than other types of coal.

In 1949, anthracite sold for an average price of $8.90 per short ton (the equivalent of $65.22 in 2007 dollars) while lignite sold for only $2.37 per short ton (the equivalent of $17.36 in 2007 dollars). Figure 10 displays the average price of coal in 2007 dollars from 1998 to 2007. Anthracite is still the highest price per short ton (averaging $49.23) while the decade long price of sub-bituminous coal was only $8.42.

Figure 8 U.S. Coal Price by Type of Coal: 1949-2009

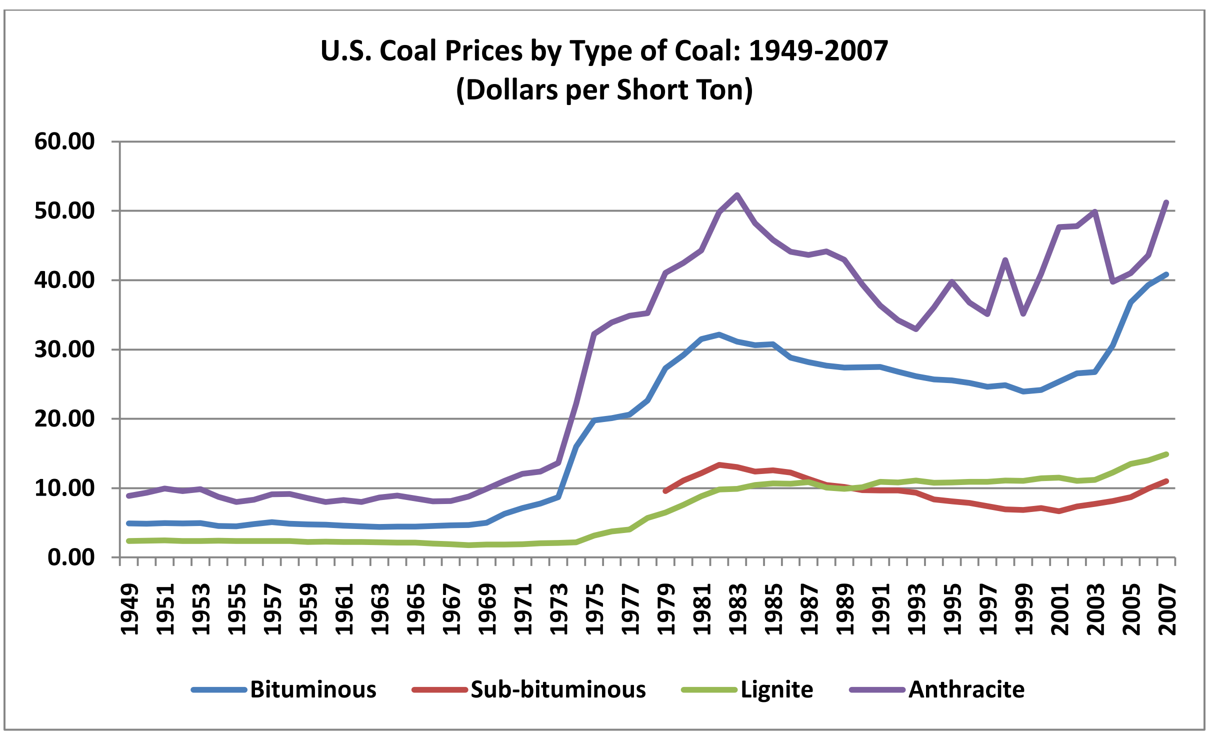


Figure 9 Real (2007 Dollars) Coal Prices in the United States by Type of Coal: 1949-2007

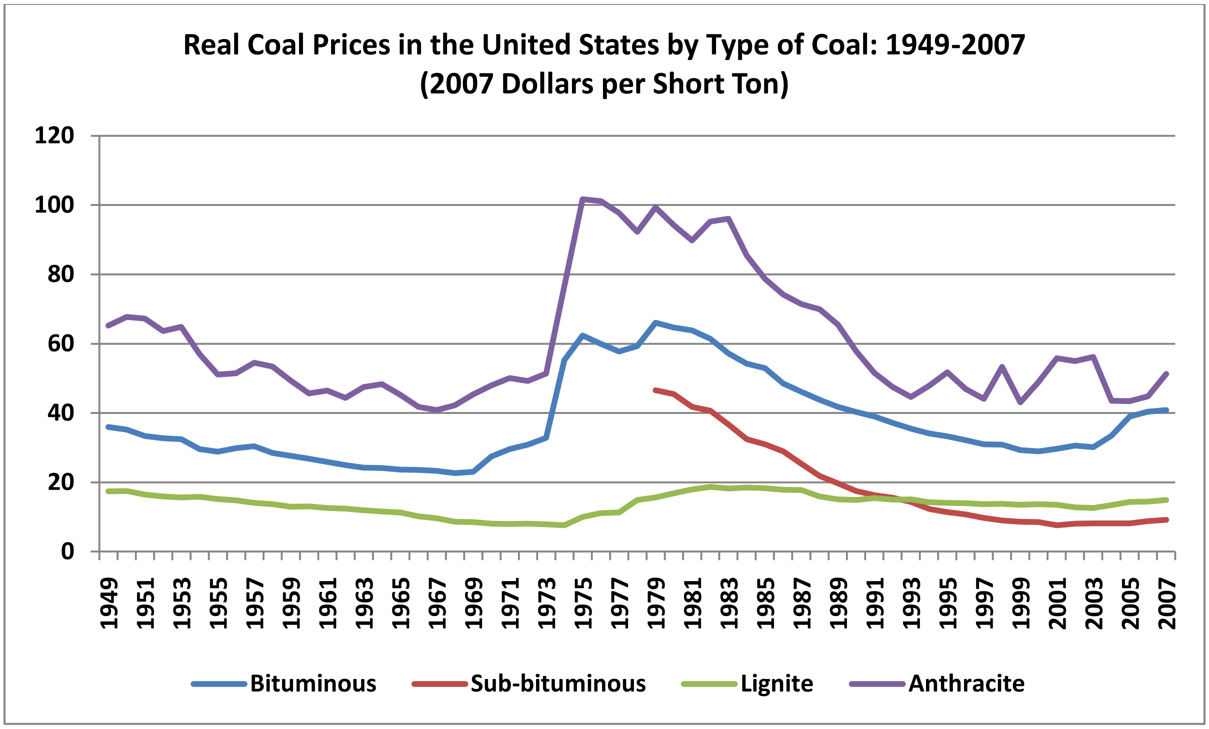
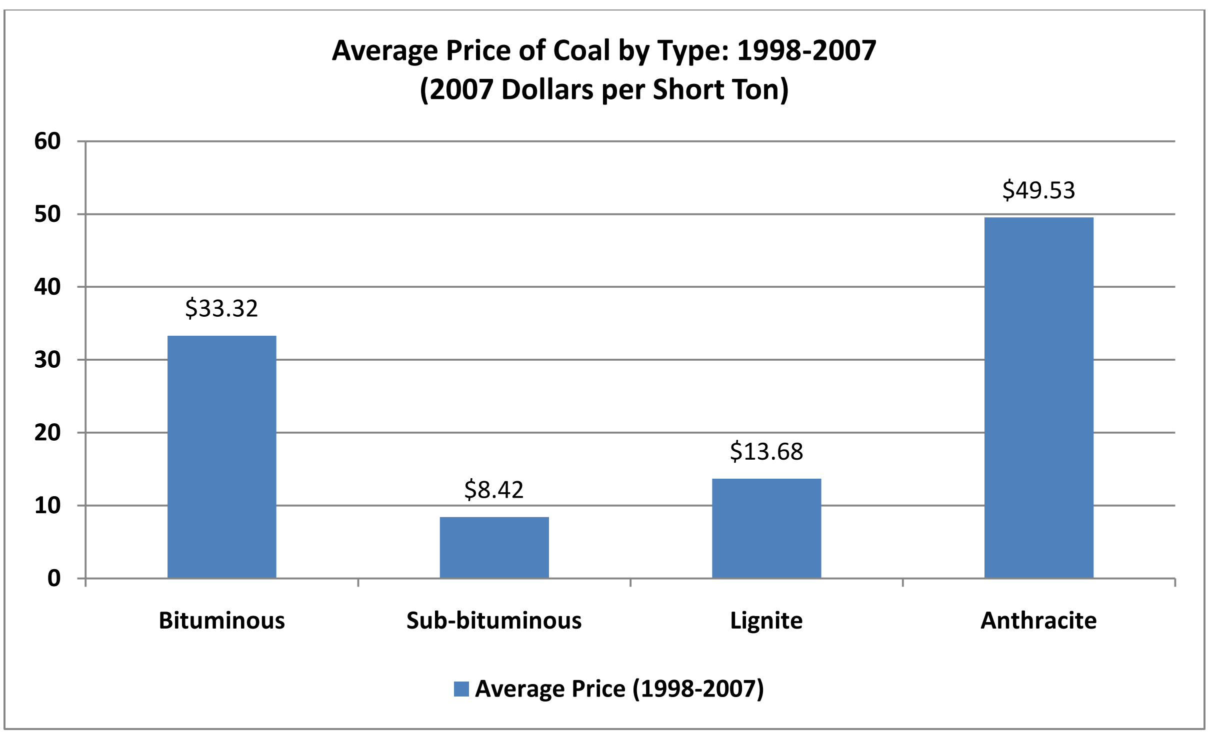


Figure 10 Average Price of Coal by Coal Type: 1998-2007 in 2007 Dollars



Coal prices in New Mexico differ from national averages. Figure 11 displays the average price per short ton of coal in New Mexico and the United States from 1949 to 2007. Figure 12 displays average coal prices in New Mexico and the nation in real (2007 dollars). From 1949 to 1969 the average price of coal in New Mexico and the nation hovered near $5 per short ton in nominal prices (Figure 11), while the real price of coal was decreasing (Figure 12). During the 1970s there was a dramatic increase in coal prices (real and nominal) in the state and nationally. From the early 1980s to the early 2000s, real and nominal coal prices declined in the nation and the state, but coal prices began to increase after 2003.

New Mexico coal prices have been higher than national coal prices for the last two decades (1988 to 2007), but this has not always been the case. During the 1960s and 1970s, New Mexico coal prices remained below national prices and the gap was particularly large during the 1970s (Figures 11 and 12). From 1988 to 2007 the relationship between New Mexico coal prices and national coal prices has been very strong. During this time (1988-2007) the simple correlation between New Mexico coal prices and national coal prices was 0.827 in nominal dollars and 0.938 in real (2007 dollars). A strong correlation in the past does not, of course, indicate that this relationship will hold in the future.

Figure 11 Coal Prices in the United States and New Mexico: 1949-2007

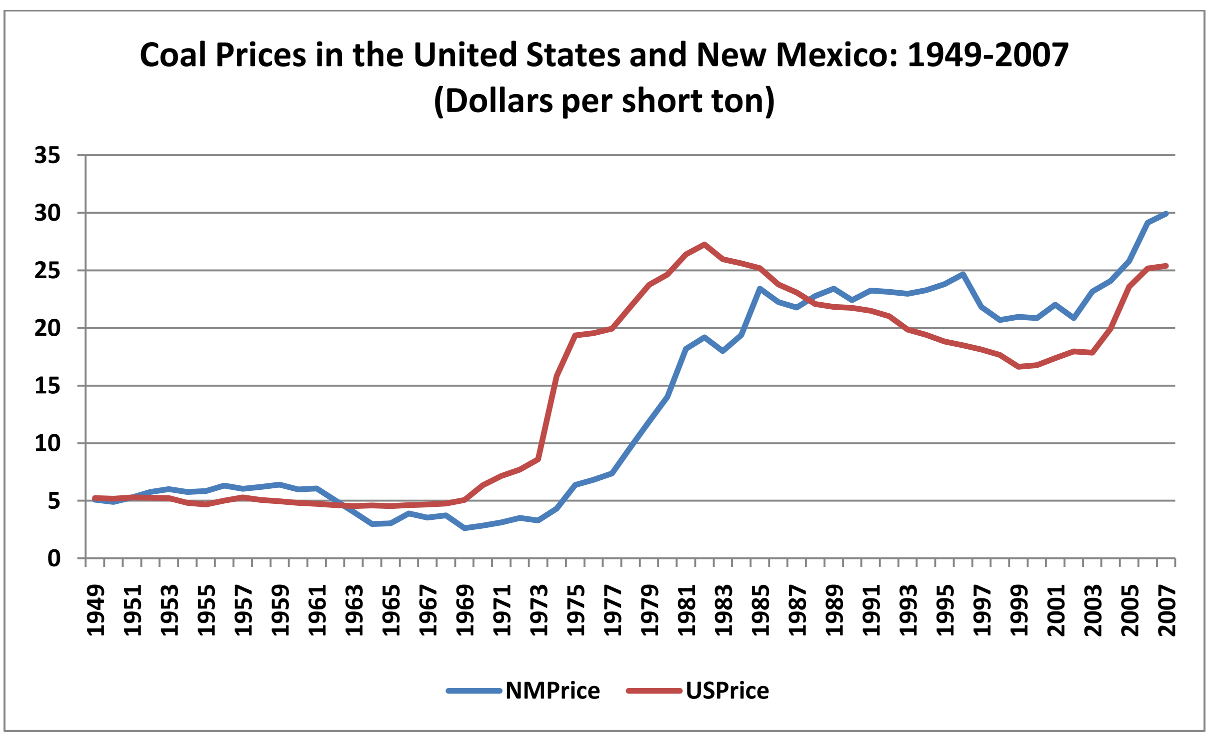
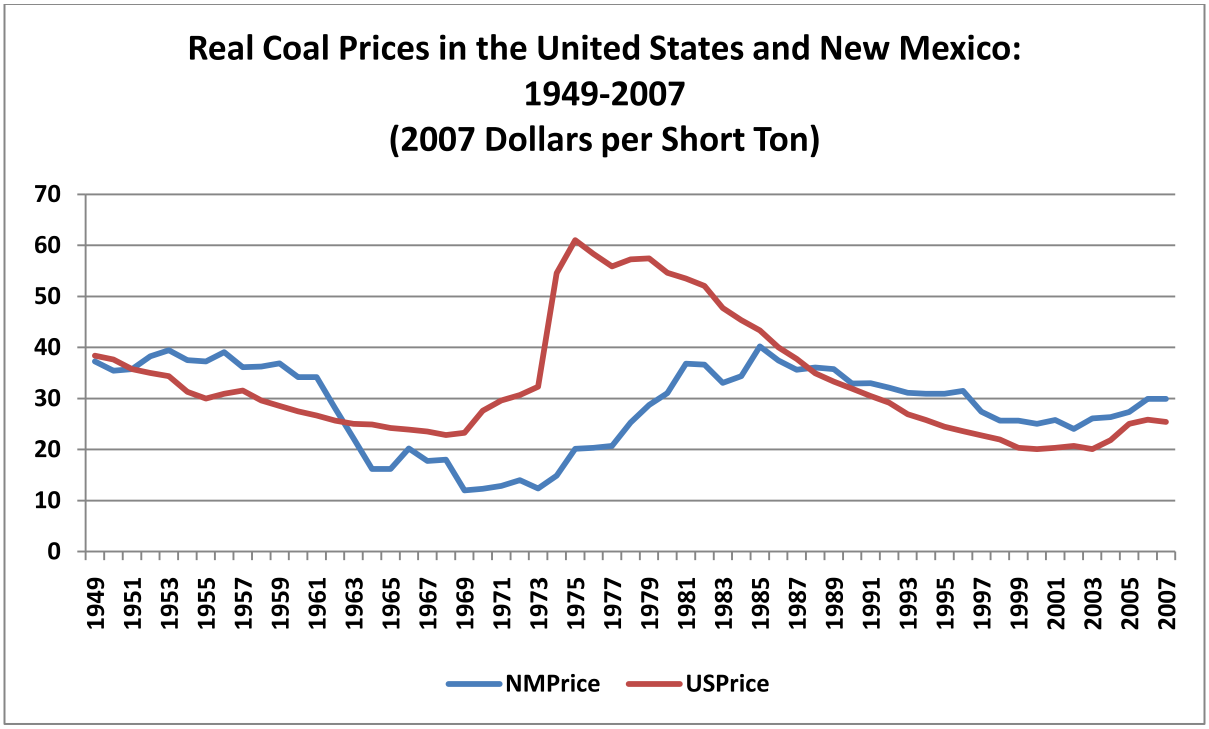


Figure 12 Real (2007 Dollars) Coal Prices in the United States and New Mexico: 1949-2007



Economic Impact of Coal in New Mexico

The economic impacts of coal mining in New Mexico were estimated using multipliers derived from an input-output model. Input-Output analysis was initially developed by Wassily W. Leontief in the 1930s. In the U.S., input-output models are available at the national, state, and county levels. Input-output analysis quantifies the inter-relationships between sectors of a complex economic system, detailing the movement of dollars between producers and consumers of goods and services within an economy. The input-output modeling software used in this analysis is IMPLAN PRO Version 2, produced by the Minnesota Implan Group (MIG, Inc).

Typical economic impact studies capture the direct, indirect, and induced effects of the economic activity being considered. Direct effects are estimates of dollar impacts to the economy resulting from production by businesses within the sector under consideration. That is, a particular sector's direct effect on the economy is the amount of money generated by the sector through sales of its products and/or services. Indirect effects are impacts to the economy as the result of industry businesses purchasing inputs from other industry sectors within the economy, that is, the production in other industries resulting from input demands generated by the primary industry. Induced effects are the value of increased spending by households resulting from the increase in income that was generated through the direct and indirect effects discussed above. The total economic impact of any initial change in the economy is the sum of the direct, indirect, and induced effects. The direct, indirect, and induced effects are measured in terms of output, value added, income and employment. Appendix C provides a more detailed description of Input-Output methods, and the IMPLAN modeling software.

In 2007, there were 24,402 thousand short tons of coal mined in New Mexico at an average price per short ton of $27.62 (See Appendix A for a discussion of New Mexico coal production and price data). As shown in Table 1, the direct output from coal mining in New Mexico in 2007 was $673.9 million (production multiplied by average price). The total output impact was $1.039 billion or 1.54 times the direct output.

In 2007, New Mexico's Gross State Product (GSP) was $75.192 billion (BEA 2009). Value added is the best measure from Table 1 to compare with GSP. The direct impact of coal mining on a value added basis was 0.49 percent of New Mexico's GSP and total value added including direct, indirect and induced effects ($588.5 million) was 0.78 percent of GSP.

The employment and labor income impacts in Table 2 have been calibrated to Bureau of Labor Statistics (BLS) employment data. That is, the direct employment figure of 1,390 in Table 2 matches the 2007 BLS figure. Direct labor income generated by employment in New Mexico's coal mining industry was $141.9 million or $102,116 per employee. Labor income includes employee compensation, employer contributions pension and insurance funds, and employer contributions for government social insurance programs. The total employment impact (direct, indirect and induced) was 3,293 jobs and $218.6 million in labor income.

Table 1 Coal Mining Industry Impacts in New Mexico 2007

Value	Direct	Indirect	Induced	Total
Output	$673,944,832	$200,289,241	$165,636,748	$1,039,870,811
Value Added	$370,295,392	$97,019,908	$91,238,499	$588,553,819
Employment	1,390	786	1,117	3,293
Labor Income	$141,941,298	$41,541,286	$35,149,868	$218,632,452

Tax Impacts of Mining in New Mexico

New Mexico coal production generates substantial tax revenues, rents and royalties for the state. Coal is subject to gross receipts tax, excise tax, conservation tax, and severance tax (New Mexico law Section 7-26-6). Coal mining properties are subject to a property tax. In addition, the State of New Mexico receives rental and royalty income from coal leases on state and Indian owned land. For 2007, the statutory tax rates were as follows: surtax on surface coal was ($.80) per short ton and ($0.77) per short ton for mined underground coal. The severance surtax on coal is indexed to inflation using the producer price index. In addition to the indexed surtax, the state collects a fixed severance tax of ($0.57) per short ton for surface coal and ($0.55) per short ton for underground coal. Taxes actually paid differ from these nominal or stated tax rates because of various deductions, exclusions, and special circumstances.

A summary of actual taxes, rents, and royalties is presented in Table 2. Tax data for fiscal years 2007 and 2008 have been presented. The New Mexico Fiscal Year is from July 1 to June 30. The average of FY07 and FY08 data provides an estimate for calendar year 2007, the base year for other impacts reported.

The direct taxes, rental and royalties paid to the State of New Mexico from coal mining are not estimates. Rather, the FY07 and FY08 totals are the actual tax receipts reported by the State Board of

Finance while the rental and royalty payments are reported by the State Land Office. The FY07 and FY08 average ($59.2 million) implies an effective tax rate per short ton of coal mined in the state of $2.43. Alternatively, the effective rate is 8.8 percent of the dollar value of production. If the state portion of federal rent and royalty payments is included, the effective tax rate is $2.66 or 9.6 percent of the total reported value of $673.9 million.

Table 2 Coal Taxes, Rents, and Royalties in New Mexico Fiscal Years 2007 and 2008

	FY07	FY08	Average FY07 FY08	Effective Tax Rate ($ per short ton)
Severance Tax and Surtax	$17,015,047	$17,145,895	$17,080,471	$0.70
Resources Excise Tax	$4,965,852	$4,432,200	$4,699,026	$0.19
Conservation Tax	$1,257,971	$1,133,085	$1,195,528	$0.05
Property Tax	$5,980,438	$6,071,098	$6,025,768	$0.25
Gross Receipts Tax	$18,201,471	$35,369,395	$26,785,433	$1.10
Sub-Total	$47,420,779	$64,151,673	$55,786,226	$2.29
Price per ton	$26.65	$28.72	$27.69	
Total Production (Tons)	26,002,101	22,801,290	24,401,696	
Total Value	$692,946,926	$654,942,711	$673,944,819	
Rental and Royalty Income on State Lands				
Rental Income	$22,695	$44,240	$33,468	$0.00
Royalty Income	$2,154,127	$4,631,632	$3,392,880	$0.14
Sub-Total	$2,176,822	$4,675,872	$3,426,347	$0.14
State Only Sub-Total	$49,597,601	$68,827,545	$59,212,573	$2.43
Rental and Royalty Income on Federal Lands Distributed to New Mexico (MMS Disbursements).				
MMS Disbursements	$4,502,057	$6,859,349	$5,681,004	$0.23
Direct Taxes, Rents, and Royalties Total	$54,099,658	$75,686,894	$64,893,276	$2.66

Sources: (1) Severance Tax, Resources Excise Tax, Conservation Tax, Property Tax and Gross Receipts Tax data along with price per ton, production and total value are from: (New Mexico State Board of Finance 2007, Table 19, p. 31) and (New Mexico State Board of Finance 2008, Table 19, p. 33). (2) Rental and Royalty Income on State Lands are from (New Mexico State Land Office 2007, p. 3)and (New Mexico State Land Office 2008, p. 4). (3) Rental and royalty income on Federal Lands are as reported by Mineral, Management Service (MMS) of the U.S. Department of Interior for FY07 and FY08. Federal Lands include Indian Lands. The federal fiscal year is from Oct 1 through September 30. These data are not directly comparable to the data reported by the New Mexico State Board of Finance or the New Mexico State Land Office for New Mexico Fiscal Years 2007 and 2008. The New Mexico Fiscal Year is from July 1 through June 30.

In addition to the direct taxes described above and displayed in Table 2, coal mining adds to state tax receipts indirectly. For example, the 1,390 coal mining workers received $141.9 million in labor income for the work they performed. This income is spent and taxed. The income coal mine workers receive is subject to the state Personal Income Tax. When a coal mine worker purchases goods or services, those purchases are subject to the Gross Receipts Tax (GRT). The GRT revenues generated in this fashion are distinct from the GRT on coal reported in Table 2 above. Incorporated businesses in the state that provide goods and services to coal workers are also subject to Corporate Income Tax (CIT).

Popp and Peach calculated effective tax rates for GRT, PIT and CIT in New Mexico over the last several years as a proportion of Total Personal Income (TPI) (Popp and Peach 2008). These effective tax rates have been adjusted to correspond to Labor Income as reported by IMPLAN. Calculating effective tax rates in this fashion is a common procedure among state revenue analysts. These effective tax rates are reported in Table 3 below and were used to estimate the indirect taxes generated by the coal mining industry[3]. No estimate of property taxes is reported in Table 2. There are simply too many unknown variables to provide a reasonable estimate of indirect property taxes.

The total tax, rental, and royalty revenue to the state of New Mexico from Tables 2 and 3 is $83.5 million from coal mining activities in 2007. Direct tax, rental and royalty payments accounted for $64.9 million (77.7 percent of the total). Indirect taxes (PIT, CIT, and GRT) contributed $18.6 million (22.3 percent of the total).

Table 3 Indirect Tax Revenue from Coal Mining

		Coal Mining Impacts			
	Tax Rate	Direct	Indirect	Induced	Total
Labor Income		$141,941,298	$41,541,286	$35,149,868	$218,632,452
PIT	0.02569	$3,645,875	$1,067,021	$902,852	$5,615,747
CIT	0.00558	$792,335	$231,889	$196,211	$1,220,435
GRT	0.05382	$7,638,637	$2,235,563	$1,891,606	$11,765,806
Totals	0.08508	$12,076,846	$3,534,473	$2,990,670	$18,601,989

[3] A reviewer commented that calculating effective tax rates in this fashion excludes spending associated with non-labor income. This problem does not occur here. Labor income simply serves as the basis for the effective tax rates. If all labor income (not just coal mining) for the state were included, the effective tax rates would produce total taxes in the categories listed.

Limitations of the Analysis

The economic impacts presented are static (single year) estimates and do not capture the dynamic long-run effects of coal mining on the economic development of New Mexico. These dynamic effects are likely to be important but are not captured in most economic impact studies.

The coal mining industry in New Mexico is particularly important in two counties (San Juan and McKinley). The economic impacts reported here are at the state level.

The analysis in this report does not address the economic impact of the production of coal-bed methane (CBM), which has become a major source of gas production in the state.

Tax, rental, and royalty income data are reported as the average of fiscal years 2007 and 2008, while the base year of the study is calendar year 2007. This data timing issue should not cause any major distortion of the results because New Mexico coal production and tax rates have been relatively stable in recent years. In any case, the data timing problem is unavoidable.

The report does not capture the full effects of the coal industry in New Mexico. In particular, the report does not contain an analysis of the effects of coal fired-generation of electricity in the state. In 2007, 15.6 million short tons of coal (63.9 percent) of total production in the state were used for electrical generation. A separate analysis of coal fired electrical generation will be necessary. A thorough analysis of coal-fired electrical generation would have required access to proprietary individual company data.

Summary and Conclusions

The economic impact analysis presented in this report suggests that coal mining is an important sector of the New Mexico economy. The analysis in this report is part of an on-going effort to examine the economic impact of fossil fuels on the New Mexico economy. The next report in this series will examine the economic impact of the oil and gas industry in New Mexico. Major findings of the analysis of the coal industry in New Mexico are summarized below.

New Mexico has been producing coal for more than a century but more than half of all coal mined in the state has been produced since 1990. Between 1882 and 2007, New Mexico produced 936.7 million short tons of coal. Between 1990 and 2007, New Mexico produced 480.7 million short tons of coal (51.3 percent of all coal mined in the state).

New Mexico's estimated economically recoverable reserves (483 million short tons) are substantial and should be sufficient for continued production at current rates for an extended period.

In 2007 New Mexico's four active coal mines produced 24.4 million short tons of coal. The average price of New Mexico's coal in 2007 was $27.69 per short ton. The value of coal produced in New Mexico in 2007 was $673.9 million.

In 2007 the coal mining industry in New Mexico contributed $1.039 billion in output (direct, indirect and induced) to the state economy. Value added was $588 million. Direct employment in coal mining in New Mexico was 1,390 jobs. Total employment (direct, indirect, and induced) associated with coal mining was 3,293 jobs.

The coal mining industry accounted for $83.5 million in state revenue in 2007.

Acknowledgements

Several individuals provided invaluable advice, assistance in obtaining data, and reviews of early drafts of this report. Any remaining errors in the report are the sole responsibility of the authors and should not be attributed to any of the individuals or their respective organizations mentioned. The authors thank: Dr. Anthony V. Popp (Professor of Economics at New Mexico State University), Leo Delgado (Policy Analyst, Arrowhead Center, New Mexico State University), Dr. Thomas Clifford (Research Director, New Mexico Tax Research Institute), Laird Graeser (New Mexico Department of Finance and Administration), Hector Aguirre (Graduate Assistant, Arrowhead Center, New Mexico State University), and Manuel Reyes (Graduate Assistant, Arrowhead Center, New Mexico State University).

Works Cited

Andrews, E.B. "Coal and its Supply: Article II." *The International Review*, July 1, 1874: 458.

BHP Billiton. *Home.* 2009. http://www.bhpbilliton.com/bb/ourBusinesses/energyCoal/newMexicoCoal.jsp (accessed March 15, 2009).

Bonskowski, Richard, William D. Watson, and Fred Freme. *Coal Production in the United States--An Historical Overview.* Adapted from an Entry in Encyclopedia of Engineering by Taylor&Francis, http://www.eia.doe.gov/cneaf/coal/page/coal_production_review.pdf, 2006, 19.

Bureau of Economic Analysis. *Regional Economic Information System.* June 10, 2009. http:/www./bea.gov/regional (accessed June 12, 2009).

Bureau of Labor Statistics. *Employment Data.* 2009. http://www.bls.gov (accessed March 16, 2009).

Chafee, E.A. "The Mineral Wealth of New Mexico." *The American Farmer*, July 15, 1893: 5.

Chevron Mining. "Chevron Mining." *Mining in New Mexico.* 2009. http://www.chevron.com/about/ourbusiness/otherbusinesses/mining/ (accessed June 1, 2009).

Energy Information Administration. "Annual Coal Report 2007." *EIA.* February 2009. http://www.eia.doe.gov/cneaf/coal/page/acr/acr.pdf (accessed March 12, 2009).

—. *Annual Energy Review 2007.* June 23, 2008. http://www.eia.doe.gov/emeu/aer/coal.html (accessed March 15, 1009).

—. "Coal." *Coal Production in the United States--An Historical Overview.* October 2006. http://www.eia.doe.gov/cneaf/coal/page/coal_production_review.pdf (accessed March 16, 2009).

Energy Information Administration. *Coal Industry Annual.* Annual Report, Washington, DC: EIA, 1990-1997.

—. "Coal Mining Productivity by State and Mine Type (Table 21)." *EIA.* June 2, 2009. http://www.eia.doe.gov/cneaf/coal/page/acr/table21.html (accessed June 2, 2009).

Energy Information Administration. *Coal Production.* Annual Report, Washington, DC: EIA, 1980-1984.

—. *Coal Reserves.* 2007. http://www.eia.doe.gov/cneaf/coal/reserves/reserves.html#_ftn1 (accessed March 16, 2009).

—. "Coal Reserves." *Coal Reserves Current and Back Issues.* February 3, 2009. http://www.eia.doe.gov/cneaf/coal/reserves/reserves.html (accessed March 15, 2009).

—. "Coal Reserves Database." *EIA.* April 2008. http://www.eia.doe.gov/cneaf/coal/page/special/feature.html (accessed March 14, 2009).

—. "International Energy Statistics Coal." *EIA.* May 30, 2009. http://tonto.eia.doe.gov/cfapps/ipdbproject/iedindex3.cfm?tid=1&pid=7&aid=1&cid=&syid=1980&eyid=2007&unit=TST (accessed June 2, 2009).

—. *International Energy Statistics Coal.* June 10, 2009. http://tonto.eia.doe.gov/cfapps/ipdbproject/iedindex3.cfm?tid=1&pid=7&aid=1&cid=&syid=1980&eyid=2007&unit=TST (accessed June 12, 2009).

—. "Large Coal Mines 2007." *Energy Information Administration.* 2009b. http://www.eia.doe.gov/cneaf/coal/page/acr/table9.html (accessed June 2, 2009). (accessed June 2, 2009).

—. *State Electricity Profile New Mexico 2007 Version.* April 2009. http://www.eia.doe.gov/cneaf/electricity/st_profiles/new_mexico.html (accessed April 16, 2009).

—. "State Energy Data System." *Coal.* 2006A. http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_all_btu.csv (accessed February 27, 2009).

—. *State Energy Profiles, New Mexico.* 2007. http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=NM (accessed May 11, 2009).

Environmental Protection Agency. "EPA." *Desert Rock.* 2009. http://www.epa.gov/region09/air/permit/desert-rock/ (accessed June 2, 2009).

—. *History of the Clean Air Act.* 2009. http://www.epa.gov/history/topics/caa70/11.html (accessed March 15, 2009).

Freese, Barbara. *Coal: A Human History.* Cambridge: Perseus, 2003.

Helman, Christopher. "Navajo Tribe Eyes Coal Plant As Economic Savior." *Forbes.* 2009. http://www.forbes.com/forbes/2009/0316/088_beyond_casinos.html (accessed March 2, 2009).

Kottlowski, Frank E. *The Economic Geology of Coal in New Mexico.* Circular 71, Socorro, NM: New Mexico Bureau of Mines, 1964.

Krischbaum, M. A., L.N. R. Roberts, and L.R. H. Biewick. "USGS National Coal Resource Assessment." *Coal Availability, Recoverability, and Economic Evaluations of Coal Resources in the Colorado Plateau: Colorado, New Mexico, and Utah.* 11 27, 2000. http://pubs.usgs.gov/pp/p1625b/Reports/Chapters/Chapter_F.pdf (accessed March 15, 2009).

Lillywhite, Jay M., and Cara M. Starbuck. *Economic Impact of Oil and Gas in New Mexico.* Consulting Report, Las Cruces, NM: Brothers and Company, 2008.

New Mexico Energy, Minerals, and Natural Resources Department. *An Economic Development Strategy for the Extractive Industries in New Mexico.* Santa Fe: NMEMNRD, 1990.

—. *Annual Report.* 2007. http://www.emnrd.state.nm.us/MAIN/documents/EMNRDAnnualReport07_WEB.pdf (accessed March 5, 2009).

New Mexico Institute of Mining and Technology. "Energy FAQ." *NM Tech Energy.* November 12, 2008. http://geoinfo.nmt.edu/faq/energy/coal/home.html (accessed March 1, 2009).

—. "Importance of Coal in New Mexico." *NMIMNT.* November 2008. http://geoinfo.nmt.edu/resources/coal/home.html (accessed March 1, 2009).

New Mexico State Board of Finance. "State of New Mexico Annual Continuing Disclosure FY2007." *SBOF.* 2007. http://www.board.nmdfa.state.nm.us/content.asp?CustComKey=293838&CategoryKey=293971&pn=Page&DomName=board.nmdfa.state.nm.us (accessed June 2, 2009).

—. "State of New Mexico Annual Continuing Disclosure FY2008." *SBOF.* 2008. http://board.nmdfa.state.nm.us/cms/kunde/rts/boardnmdfastatenmus/docs/215096855-05-08-2009-14-44-09.pdf (accessed June 2, 2009).

New Mexico State Land Office. "Annual Report 2007." *SLO.* 2007. htttp://www.nmstatelands.org/ (accessed June 2, 2009).

—. "Annual Report 2008." *SLO.* 2008. http://nmstatelands.org/ (accessed June 2, 2009).

NM Energy Minerals and Natural Resources Department. "McKinley Mine Award." *NMEMNRD.* 2008. http://www.emnrd.state.nm.us/MMD/OFD/documents/2008McKinleyGeomorphic.pdf (accessed June 2, 2008).

Popp, Anthony V., and James T. Peach. *Impact of the Film Industry on New Mexico.* Policy Report for New Meixco Legislative Council, Las Cruces: Office of Policy Analysis, Arrowhead Center, NMSU, 2008.

Speer, William R., Edward C. Beaumont, and John W. Shoemaker. "Open File Report 84." *New Mexico Bureau of Mines and Mineral Resources.* December 1977. http://geoinfo.nmt.edu/publications/openfile/downloads/OFR014-99/76-99/84/ofr_84.pdf (accessed March 16, 2009).

U.S. Bureau of Economic Analysis. *Regional Economic INformation System.* June 12, 2009. http://www.bea.gov/regional/reis/ (accessed June 12, 2009).

U.S. Bureau of Labor Statistics. *Quarterly Census of Employment and Wages (QCEW).* June 2009. http://www.bls.gov/cew/#databases (accessed June 12, 2009).

U.S. Bureau of Mines. *Minerals Yearbook 1952, Volume II.* Washington DC: U.S. Department of the Interior, 1952.

—. *Minerals Yearbook 1960, Volume II.* Washington, DC: U.S. Department of the Interior, 1960.

United States Census Bureau . "Mineral Production, Coal." *Statistical Abstract of the United States*, December 29, 1889, 1310 ed.: 312.

United States Geological Survey . *Minerals Yearbook Archives.* 1932-2007. http://minerals.usgs.gov/minerals/pubs/commodity/myb/ (accessed March 17, 2009).

US Geological Survey. "The U.S. Geological Survey National Coal Resource Assessment." *USGS Energy Resources Program.* March 2001. http://pubs.usgs.gov/fs/fs020-01/fs020-01.pdf (accessed April 13, 2009).

—. "USGS Fact Sheet FS-157-96." *USGS.* 2009. http://energy.usgs.gov/factsheets/nca/12.html (accessed March 9, 2009).

Weil, David. *Economic Growth.* Pearson Addison Wesley, 2005.

Wisman, Phil. "EPA History (1970-1985)." *EPA.* November 1985.
http://www.epa.gov/history/topics/epa/15b.htm (accessed March 14, 2009).

World Coal Institute. "Coal Fact Sheets." *World Coal Institute.* June 5, 2009.
http://www.worldcoal.org/pages/content/index.asp?PageID=188 (accessed June 5, 2009).

Zimmerman, Erich W. *World Resources and Industries (Revised Edtion).* New York: Harper & Row, 1951.

Appendix A: Coal Data Sources and Issues

Contemporary New Mexico coal production and value (price) data are available from three sources:

(1) U.S. Department of Energy, Energy Information Administration's (EIA) *Annual Coal Report* (2008) (http://www.eia.doe.gov/cneaf/coal/page/acr/acr_sum.html);

(2) New Mexico Energy, Minerals and Natural Resources Department (NMEMNRD) , *Annual Report* (2008) http://www.emnrd.state.nm.us/main/documents/EMNRD-Annual-Report-2008.pdf ; and

(3) New Mexico State Board of Finance (NMSBOF) *Annual Continuing Disclosure Report* (FY2008) http://board.nmdfa.state.nm.us/cms/kunde/rts/boardnmdfastatenmus/docs/215096855-05-08-2009-14-44-09.pdf .

Table A-1 displays coal production, price and value data from these three sources for 2007. The NMSBOF data are presented for fiscal years 2007and 2008 and then averaged to obtain a calendar year figure (last column). Fiscal years in New Mexico are from July 1 to June 30. As can be seen in Table A-1, the production data for calendar year 2007 are similar by source –ranging from 24,402 thousand short tons (NMSBOF) to 24,451 thousand short tons (EIA). The price data vary substantially –ranging from $27.46 per short ton (NMEMNRD) to $29.91 per short ton (EIA). The reported price differences result in large differences in the value of coal produced in New Mexico –ranging from $670 million (NMEMNRD) to $731 million (EIA).

The differences in coal price data may be due to alternative price concepts. EIA reports three different prices of coal: (1) an open market spot price of coal sold to other coal companies or consumers, (2) a captive price of coal used by the producing coal company or sold to affiliated or parent organizations, and (3) a delivered price of coal to electric generating utilities. The EIA price reported in Table A-1 is an annual average open market price. The prices reported by NMEMNRD and NMSBOF are annual average prices related to taxable value.

Table A 1 New Mexico Coal Production, Price and Value Data 2007 by Source

Table A 1
New Mexico Coal Production, Price and Value Data 2007 by Source

	EIA	NMEMNRD	NMSBOF FY07	NMSBOF FY08	NMSBOF 2007***
Production*	24,451	24,408	26,002	22,801	24,402
Price**	$29.91	$27.46	$26.65	$28.72	$27.62
Value	$731,329,410	$670,316,349	$692,946,926	$654,942,711	$673,944,819

*Production measured in 1,000s of short tons
**Price in $ per short ton (see text)
***Average of NMSBOF FY2007 and FY2008 data

The economic impacts calculated in this report are based on the average production and value data from NMSBOF (last column of Table A 1) because the NMSBOF production and value data are consistent with reported taxes on coal in New Mexico. Detailed NM tax data on coal are available only from NM SBOF.

Appendix B: Data Tables and Sources for Figures

Table B 1 World Coal Production 1980-2007

World Coal Production: 1980-2007 (Millions of Short Tons)	
Year	Coal Production
1980	4,186.4
1981	4,226.0
1982	4,387.6
1983	4,417.8
1984	4,664.0
1985	4,894.8
1986	5,014.1
1987	5,120.9
1988	5,244.1
1989	5,320.2
1990	5,353.6
1991	5,023.4
1992	4,954.7
1993	4,849.6
1994	4,941.6
1995	5,084.2
1996	5,109.0
1997	5,135.7
1998	5,051.5
1999	4,944.4
2000	4,937.2
2001	5,219.6
2002	5,248.8
2003	5,638.6
2004	6,067.6
2005	6,465.4
2006	6,778.6
2007	7,080.1

Source: (Energy Information Administration 2009).
Note: The data in this table was used to produce Figure 1.

Table B 2 Coal Production in Major Producing Nations 2007

Coal Production in Major Producing Nations in 2007 (millions of Short Tons)		
1	China	2,795.5
2	United States	1,145.6
3	India	527.2
4	Australia	435.7
5	Russia	345.8
6	South Africa	268.5
7	Indonesia	254.8
8	Germany	225.5
9	Poland	162.0
10	Kazakhstan	95.2
11	Turkey	79.9
12	Colombia	79.0
13	Canada	76.5
14	Greece	71.0
15	Czech Republic	68.5
16	Ukraine	65.1
17	Vietnam	49.1
18	Korea, North	41.3
19	Former Serbia and Montenegro	39.3
20	Romania	39.2
21	Bulgaria	39.1
22	Thailand	20.1
23	Spain	18.9
24	Estonia	18.6
25	United Kingdom	18.2

Source: Same as Table B-1.
Note: The data in Table B-2 were used to create Figure 2.

Table B 3 Coal Production in the United States by Decade: 1820s to 2000s

Coal Production in the United States by Decade: 1820s to 2000s
(Millions of Short Tons)

Decade	Coal Production
1820s	0.140
1830s	1.032
1840s	4.535
1850s	12.513
1860s	26.122
1870s	57.220
1880s	122.844
1890s	202.972
1900s	396.956
1910s	577.788
1920s	577.222
1930s	436.984
1940s	614.291
1950s	483.006
1960s	521.985
1970s	688.976
1980s	899.268
1990s	1,045.080
2000s	1,120.805

Sources: (1)1820s-1840s (Zimmerman 1951, Table 27.4, p, 474); (2) (Energy Information Administration 2006A, Table 7.2).
Note: The data in Table B 3 were used to create Figure 3.

Table B 4 Coal Production in New Mexico: 1882-2007

Coal Production in New Mexico: 1882-2007 1,000S of Short Tons							
Year	Coal Production	Year	Coal Production	Year	Coal Production	Year	Coal Production
1882	164	1914	3,878	1946	1,280	1978	12,632
1883	211	1915	3,618	1947	1,443	1979	15,615
1884	221	1916	3,793	1948	1,364	1980	18,425
1885	306	1917	4,001	1949	1,004	1981	18,709
1886	271	1918	4,023	1950	727	1982	19,944
1887	508	1919	3,139	1951	783	1983	20,415
1888	627	1920	3,683	1952	760	1984	21,279
1889	487	1921	2,457	1953	514	1985	22,203
1890	420	1922	3,147	1954	123	1986	21,496
1891	462	1923	2,915	1955	201	1987	19,131
1892	661	1924	2,786	1956	158	1988	21,803
1893	665	1925	2,557	1957	137	1989	23,702
1894	597	1926	2,818	1958	117	1990	24,292
1895	721	1927	2,936	1959	148	1991	21,518
1896	663	1928	2,712	1960	295	1992	24,549
1897	717	1929	2,623	1961	412	1993	28,268
1898	992	1930	1,969	1962	677	1994	28,041
1899	1,051	1931	1,553	1963	1,945	1995	26,813
1900	1,299	1932	1,263	1964	2,969	1996	24,067
1901	1,087	1933	1,226	1965	3,212	1997	27,025
1902	1,049	1934	1,259	1966	2,755	1998	28,597
1903	1,542	1935	1,389	1967	3,463	1999	29,156
1904	1,452	1936	1,597	1968	3,429	2000	27,323
1905	1,650	1937	1,715	1969	4,471	2001	29,618
1906	1,965	1938	1,239	1970	7,361	2002	28,916
1907	2,620	1939	1,230	1971	8,175	2003	26,389
1908	3,468	1940	1,111	1972	8,248	2004	27,250
1909	2,801	1941	1,251	1973	9,069	2005	28,519
1910	3,508	1942	1,669	1974	9,392	2006	25,913
1911	3,148	1943	1,851	1975	8,785	2007	24,451
1912	3,537	1944	1,744	1976	9,760		
1913	3,709	1945	1,484	1977	11,083		

Sources: (1) 1882-1927: (Kottlowski 1964, Table 1, p. 3) (2) 1960-2007: (Energy Information Administration 2006A, Table P-6).
Note: The data in Table b 4 were used to create Figures 5 and 6.

Table B 5 New Mexico Average Annual Coal Production by Decade

New Mexico Average Annual Coal Production by Decade	
1882-1889	349
1890-1899	695
1900-1909	1,893
1910-1919	3,635
1920-1929	2,863
1930-1939	1,444
1940-1949	1,420
1950-1959	367
1960-1969	2,363
1970-1979	10,012
1980-1989	20,711
1990-1999	26,233
2000-2007	27,297

Source: Same as Table B 4
Note: Data in Table B 5 were used to create Figure 6

Table B 6 New Mexico Coal Mining Employment: 1969-2007

New Mexico Coal Mining Employment: 1969-2007

Year	Employment	Year	Employment
1969	453	1989	1,673
1970	489	1990	1,781
1971	589	1991	1,845
1972	632	1992	1,906
1973	795	1993	2,070
1974	949	1994	2,153
1975	1,110	1995	2,095
1976	1,176	1996	1,714
1977	1,252	1997	1,579
1978	1,451	1998	1,707
1979	1,755	1999	1,683
1980	1,980	2000	1,644
1981	2,024	2001	1,743
1982	2,113	2002	1,709
1983	1,662	2003	1,564
1984	1,933	2004	1,509
1985	1,933	2005	1,478
1986	1,933	2006	1,506
1987	2,003	2007	1,390
1988	1,776		

Sources: (1) 1969-2000 (Bureau of Economic Analysis 2009, Table SA25N); (2) 2001-2007 (Bureau of Labor Statistics 2009, Quarterly Census of Employment and Wages).
The data in Table B 6 were used to create Figure 7

Nominal

Table B 7 Nominal Coal Prices by Coal Type in the United States: 1949-2007

Nominal Coal Prices by Coal Type in the United States

Year	Bituminous	Sub-bituminous	Lignite	Anthracite	Total
1949	4.90		2.37	8.90	5.24
1950	4.86		2.41	9.34	5.19
1951	4.94		2.44	9.94	5.29
1952	4.92		2.39	9.58	5.27
1953	4.94		2.38	9.87	5.23
1954	4.54		2.43	8.76	4.81
1955	4.51		2.38	8.00	4.69
1956	4.83		2.39	8.33	5.01
1957	5.09		2.35	9.11	5.28
1958	4.87		2.35	9.14	5.07
1959	4.79		2.25	8.55	4.95
1960	4.71		2.29	8.01	4.83
1961	4.60		2.24	8.26	4.73
1962	4.50		2.23	7.99	4.62
1963	4.40		2.17	8.64	4.55
1964	4.46		2.14	8.93	4.60
1965	4.45		2.13	8.51	4.55
1966	4.56		1.98	8.08	4.62
1967	4.64		1.92	8.15	4.69
1968	4.70		1.79	8.78	4.75
1969	5.02		1.86	9.91	5.08
1970	6.30		1.86	11.03	6.34
1971	7.13		1.93	12.08	7.15
1972	7.78		2.04	12.40	7.72
1973	8.71		2.09	13.65	8.59
1974	16.01		2.19	22.19	15.82
1975	19.79		3.17	32.26	19.35
1976	20.11		3.74	33.92	19.56
1977	20.59		4.03	34.86	19.95
1978	22.64		5.68	35.25	21.86
1979	27.31	9.55	6.48	41.06	23.75
1980	29.17	11.08	7.60	42.51	24.65
1981	31.51	12.18	8.85	44.28	26.40
1982	32.15	13.37	9.79	49.85	27.25

Continued on Next Page

Table B 7. Continued From Previous Page

Year	Bituminous	Sub-bituminous	Lignite	Anthracite	Total
1983	31.11	13.03	9.91	52.29	25.98
1984	30.63	12.41	10.45	48.22	25.61
1985	30.78	12.57	10.68	45.80	25.20
1986	28.84	12.26	10.64	44.12	23.79
1987	28.19	11.32	10.85	43.65	23.07
1988	27.66	10.45	10.06	44.16	22.07
1989	27.40	10.16	9.91	42.93	21.82
1990	27.43	9.70	10.13	39.40	21.76
1991	27.49	9.68	10.89	36.34	21.49
1992	26.78	9.68	10.81	34.24	21.03
1993	26.15	9.33	11.11	32.94	19.85
1994	25.68	8.37	10.77	36.07	19.41
1995	25.56	8.10	10.83	39.78	18.83
1996	25.17	7.87	10.92	36.78	18.50
1997	24.64	7.42	10.91	35.12	18.14
1998	24.87	6.96	11.08	42.91	17.67
1999	23.92	6.87	11.04	35.13	16.63
2000	24.15	7.12	11.41	40.90	16.78
2001	25.36	6.67	11.52	47.67	17.38
2002	26.57	7.34	11.07	47.78	17.98
2003	26.73	7.73	11.20	49.87	17.85
2004	30.56	8.12	12.27	39.77	19.93
2005	36.80	8.68	13.49	41.00	23.59
2006	39.32	9.95	14.00	43.61	25.16
2007	40.83	11.01	14.89	51.23	25.40

Source: (Energy Information Administration 2008, Table 7.8).
Note: The data in Table B 7 were used to create Figure 8.

Table B 8 Real Coal Prices (2007 Dollars) in the United States by Type of Coal

Real Coal Prices (2007 Dollars) in the United States by Type of Coal					
Year	Bituminous	Sub-bituminous	Lignite	Anthracite	Total
1949	35.91		17.36	65.22	38.40
1950	35.23		17.47	67.70	37.62
1951	33.40		16.50	67.22	35.78
1952	32.71		15.89	63.69	35.03
1953	32.45		15.64	64.82	34.35
1954	29.53		15.80	56.98	31.30
1955	28.83		15.22	51.14	29.98
1956	29.85		14.76	51.46	30.95
1957	30.43		14.05	54.47	31.57
1958	28.47		13.73	53.43	29.63
1959	27.65		12.99	49.36	28.58
1960	26.81		13.04	45.61	27.51
1961	25.90		12.62	46.51	26.64
1962	24.99		12.39	44.38	25.66
1963	24.19		11.93	47.50	25.01
1964	24.14		11.59	48.35	24.91
1965	23.66		11.32	45.24	24.19
1966	23.58		10.23	41.77	23.88
1967	23.27		9.63	40.87	23.52
1968	22.61		8.61	42.22	22.85
1969	23.00		8.52	45.41	23.28
1970	27.41		8.10	48.00	27.59
1971	29.55		8.00	50.06	29.63
1972	30.90		8.10	49.26	30.66
1973	32.77		7.86	51.35	32.31
1974	55.25		7.56	76.56	54.59
1975	62.40		9.99	101.71	61.01
1976	59.94		11.14	101.11	58.30
1977	57.70		11.30	97.70	55.91
1978	59.28		14.87	92.31	57.24
1979	66.04	46.60	15.67	99.29	57.43
1980	64.68	45.45	16.85	94.25	54.65
1981	63.86	41.75	17.94	89.74	53.51
1982	61.41	40.70	18.70	95.22	52.05
1983	57.16	36.71	18.21	96.08	47.73
1984	54.24	32.48	18.51	85.39	45.35
1985	52.90	30.99	18.36	78.72	43.31

Continued on Next Page

Table b 8 Continued from previous page

Year	Bituminous	Sub-bituminous	Lignite	Anthracite	Total
1986	48.50	28.94	17.89	74.19	40.01
1987	46.14	25.32	17.76	71.45	37.77
1988	43.78	21.86	15.92	69.90	34.94
1989	41.79	19.72	15.12	65.48	33.28
1990	40.28	17.46	14.88	57.86	31.95
1991	39.00	16.26	15.46	51.56	30.49
1992	37.14	15.55	14.99	47.50	29.16
1993	35.45	14.32	15.06	44.66	26.91
1994	34.09	12.31	14.29	47.88	25.76
1995	33.25	11.43	14.09	51.75	24.49
1996	32.13	10.71	13.95	46.96	23.62
1997	30.94	9.77	13.69	44.10	22.78
1998	30.89	8.95	13.77	53.29	21.95
1999	29.28	8.59	13.52	43.01	20.36
2000	28.94	8.53	13.67	49.00	20.11
2001	29.68	7.62	13.48	55.77	20.33
2002	30.55	8.11	12.74	54.95	20.68
2003	30.10	8.17	12.62	56.16	20.11
2004	33.45	8.12	13.43	43.53	21.82
2005	39.02	8.14	14.31	43.47	25.02
2006	40.41	8.78	14.39	44.82	25.86
2007	40.88	9.21	14.91	51.29	25.44

Source: Same as Table b 7 and author calculations. Real prices in 2000 dollars appearing in the original table converted to 2007 dollars. Conversion factor =1.9816 (the2007 implicit price deflator for GDP from Bureau of Economic Analysis, National Income and Product Accounts, Table 1.1.9 (www.bea.gov accessed on June 12, 2009. Note: the data in Table B 8 were used to create Figures 9 and 10.

Table B 9 Nominal Coal Prices in New Mexico and the United States: 1949-2007

Coal Prices in New Mexico and the United States: 1949 to 2007 (Dollars per Short Ton)					
Year	NMPrice	USPrice	Year	NMPrice	USPrice
1949	5.09	5.24	1979	11.88	23.75
1950	4.89	5.19	1980	14.01	24.65
1951	5.29	5.29	1981	18.18	26.4
1952	5.76	5.27	1982	19.19	27.25
1953	6.01	5.23	1983	18.00	25.98
1954	5.76	4.81	1984	19.40	25.61
1955	5.83	4.69	1985	23.41	25.2
1956	6.33	5.01	1986	22.26	23.79
1957	6.04	5.28	1987	21.78	23.07
1958	6.20	5.07	1988	22.78	22.07
1959	6.39	4.95	1989	23.42	21.82
1960	6.00	4.83	1990	22.43	21.76
1961	6.07	4.73	1991	23.25	21.49
1962	5.04	4.62	1992	23.14	21.03
1963	4.05	4.55	1993	22.96	19.85
1964	2.99	4.60	1994	23.29	19.41
1965	3.04	4.55	1995	23.80	18.83
1966	3.91	4.62	1996	24.66	18.5
1967	3.54	4.69	1997	21.83	18.14
1968	3.74	4.75	1998	20.68	17.67
1969	2.61	5.08	1999	20.97	16.63
1970	2.83	6.34	2000	20.87	16.78
1971	3.11	7.15	2001	22.02	17.38
1972	3.52	7.72	2002	20.87	17.98
1973	3.29	8.59	2003	23.18	17.85
1974	4.32	15.82	2004	24.09	19.93
1975	6.38	19.35	2005	25.82	23.59
1976	6.83	19.56	2006	29.15	25.16
1977	7.38	19.95	2007	29.91	25.4
1978	9.65	21.86			

Sources for New Mexico data: (1) 1949-1980: (New Mexico Energy, Minerals, and Natural Resources Department 1990, Table 2.2-2) and author calculations from production and gross sales; (2) 1980-1984, (Energy Information Administration 1980-1984), (3) 1985-1997 (Energy Information Administration 1990-1997); (4) (Energy Information Administration 2009). U.S. data source: see Table B 8. Note: The data in Table B 9 were used to create figure11.

Table B 10 Real Coal Prices (2007 Dollars) in New Mexico and the United States: 1949-2007

Real Coal Prices in New Mexico and the United States: 1949 to 2007 (Dollars per Short Ton)					
Year	NMPrice	USPrice	Year	NMPrice	USPrice
1949	37.27	38.40	1979	28.73	57.43
1950	35.44	37.62	1980	31.06	54.65
1951	35.75	35.78	1981	36.85	53.51
1952	38.26	35.03	1982	36.65	52.05
1953	39.48	34.35	1983	33.07	47.73
1954	37.48	31.30	1984	34.35	45.35
1955	37.29	29.98	1985	40.24	43.31
1956	39.08	30.95	1986	37.43	40.01
1957	36.13	31.57	1987	35.65	37.77
1958	36.23	29.63	1988	36.06	34.94
1959	36.90	28.58	1989	35.73	33.28
1960	34.16	27.51	1990	32.94	31.95
1961	34.16	26.64	1991	32.99	30.49
1962	28.02	25.66	1992	32.09	29.16
1963	22.24	25.01	1993	31.13	26.91
1964	16.22	24.91	1994	30.91	25.76
1965	16.17	24.19	1995	30.95	24.49
1966	20.22	23.88	1996	31.48	23.62
1967	17.77	23.52	1997	27.41	22.78
1968	18.01	22.85	1998	25.69	21.95
1969	11.97	23.28	1999	25.67	20.36
1970	12.34	27.59	2000	25.01	20.11
1971	12.90	29.63	2001	25.76	20.33
1972	13.99	30.66	2002	24.00	20.68
1973	12.38	32.31	2003	26.11	20.11
1974	14.89	54.59	2004	26.37	21.82
1975	20.13	61.01	2005	27.38	25.02
1976	20.36	58.30	2006	29.96	25.86
1977	20.69	55.91	2007	29.95	25.44
1978	25.27	57.24			

Sources: Tables B 8 and B 9. New Mexico real prices calculated by authors from original data sources.
Note: The data in Table B-10 were used to create Figure 12.

Appendix C: A Brief Review of Input-Output Analysis[4]

Input-Output analysis was initially developed by Wassily W. Leontief in the 1930s. Founded in general equilibrium analysis, input-output analysis was initially used as a tool to model national economies but is currently used extensively to examine economic impacts to regional economies as well. Input-output analysis quantifies the interrelationships between sectors of a complex economic system, detailing the movement of dollars between producers and consumers of goods and services within an economy. The approach uses structural coefficients that represent the relationship between inputs in the production process (factors of production) and the resulting outputs produced by each sector. The interdependence between sectors is modeled using a set of linear equations that balance a sector's total input use to the sector's total output. Assumptions commonly made in input-output analysis include: (1) each sector produces homogeneous outputs (e.g., underlying product value differences within a sector are not considered, rather the analysis examines total output and input usage in terms of dollar amounts); (2) linear production functions (factor substitution or economies of size are not considered); and (3) time is treated statically within the model and factors of production within the sectors are assumed to be fully used (Lillywhite and Starbuck 2008, Pg. 27).

Direct effects are estimates of dollar impacts to the economy resulting from production by businesses within the sector under consideration. That is, a particular sector's direct effect on the economy is the amount of money generated by the sector through sales of its products and/or services.

Indirect effects are impacts to the economy as the result of industry businesses purchasing inputs from other industry sectors within the economy, that is, the production in other industries resulting from input demands generated by the primary industry.

Induced effects are the value of increased spending by households resulting from the increase in income that was generated through the direct and indirect effects discussed above (Lillywhite and Starbuck 2008, Pg. 27-28).[5]

IMPLAN generates a large number of reports and information anytime an impact event is analyzed. The values usually reported are the: output, value added, labor income, and employment generated by the event. The following description is directly adapted from the IMPLAN website and user manual available at http://www.implan.com.

The output values reported in IMPLAN is the industry output valued in dollars generated by the event being analyzed. The output values reported in IMPLAN and their associated multipliers can be used to gauge the level of interdependence between the event sectors and the rest of the regional economy. Large output values related to the direct output values (which are equivalent to a large multiplier) indicate a high level of interdependence between the industries and will result in a larger impact of that sector on the regional economy (IMPLAN, 2008).

Value Added is comprised of four components: Employee Compensation; Proprietary Income, Other Property Type Income, and Indirect Business Taxes. The employee compensation includes benefits such as health and life insurance, retirement payments, and non-cash payments in addition to wages and

---

[4] This review is taken from Lillywhite and Starbuck (2008), and was originally written by Jay Lillywhite, Ph.D., New Mexico State University Department of Agriculture and Home Economics.

[5] Estimation of induced effects requires the economic system be treated as a closed system so that consumers are considered part of the production process. In the IMPLAN software used for this analysis, closing the system requires the use of the SAM (Social Accounting Matrix) multiplier.

cash payments. Proprietary income is defined as the income from self-employment as reported on Federal Tax Form 1040C, and includes any and all payments for self-employment. Indirect business taxes are excise and sales taxes paid by individuals to businesses. These taxes are collected during the normal operation of the businesses impacted by the event being analyzed, and do not include taxes on profit or income (IMPLAN, 2008).

The labor income values show the direct, indirect, and induced employee compensation plus proprietor income effects generated by the impact event (IMPLAN, 2008).

Employment is the total wage and salary and self employed jobs in a region. In this study the employment values reflect the total jobs created which includes both full-time and part-time labor to generate a total full-time equivalent number of jobs which allows for fractional values to be reported (IMPLAN, 2008).