

**THE ECONOMIC IMPACT OF
THE MINING INDUSTRY
ON THE STATE OF ARIZONA
2014**



September 2015

Prepared for the Arizona Mining Association

by

**L. William Seidman Research Institute
W. P. Carey School of Business
Arizona State University
Tempe, AZ 85287-4011**

CONTENTS

Executive Summary 3
 Introduction..... 5
 I. Overview of the Arizona Mining Industry 5
 II. Trends in Copper Production and Copper Prices 7
 III. Economic Impact of the Arizona Mining Industry 10
 IV. Impacts by County 15
 V. State and Local Government Revenues 17
 Appendix A: Glossary of Terms 20
 Appendix B: Mining as an Important Economic Base Activity in Arizona 21
 Appendix C: Economic Impact Methodology 24
 Appendix D: Survey Questionnaire 28

Figures and Tables

Figure 1: Value of Arizona Mining Outputs, 2014..... 6
 Figure 2: Copper Production in Arizona and the United States, 1970-2014 7
 Figure 3: Top 10 Copper-Producing Countries in 2014 8
 Figure 4: History of U.S. Copper Prices 9
 Figure 5: Purchases by Mining Companies from other Arizona Businesses, 2014..... 11
 Figure 6: Comparing Labor Income per Worker 14
 Figure 7: Arizona Mining Employment by County of Residence, 2014 16
 Figure 8: Total Employment Impacts by County, 2014 16
 Figure 9: Comparing Taxes per Worker 18

Table 1: Economic Impact of Mining on the State of Arizona, 2014..... 12
 Table 2: Total Economic Impact of Mining by County, 2014..... 15
 Table 3: Impact of Mining on Arizona State and Local Government Revenues, 2014..... 17

Table B 1: Economic Base Industries in Arizona..... 22

Table C 1: Arizona Mining Companies Surveyed for Operations in 2014..... 24

Executive Summary

The purpose of this report is to measure the economic impact of the mining industry on employment, income and tax revenues in the state of Arizona. The estimated impacts include both the direct effects of mining operations and indirect multiplier effects that arise through interindustry purchases and the recycling of income within the state economy. The analysis indicates that mining activity in 2014 provided a total of 43,800 Arizona jobs and generated \$4.29 billion in total income for workers, business and property owners, and governments in Arizona.¹

The impacts reported are based on primary data collected in a survey of Arizona mining companies for the calendar year 2014. Companies completing surveys include all but one of the major copper producers in the state, as well as companies that made significant equipment purchases and other capital investments in 2014 and expect to be producing copper in the near future, a coal producer, a uranium producer, a gold and silver producer, and an exploration company. Companies involved in sand, gravel and rock products were not included in the analysis.

Economic impact variables taken directly from information reported in the survey include mining company employment, the total payrolls of mining companies, and business taxes and royalties paid by mining companies to state and local governments. The IMPLAN input-output model was used to estimate all other economic impacts, including the effects on Arizona employment and income of supplier purchases reported by mining companies.

There were approximately 12,000 employees of mining companies residing in Arizona in 2014. Mining employment is widely distributed across state counties. Each of five counties is home to at least 10 percent of the state's mining employees: Gila, Graham, Greenlee, Pima and Pinal. Two other counties—Maricopa and Yavapai—each have more than 800 mining employees as residents.

The total payroll of Arizona mining companies in 2014 was \$1.23 billion. This includes wages, salaries, and fringe benefits such as employer contributions to health insurance and retirement plans. Overall, income per worker in the mining industry was \$102,860 in 2014. This is over twice the average income of \$49,820 per worker across all industries in Arizona.

Arizona mining companies spent a total of \$2.77 billion in 2014 purchasing goods and services from other Arizona businesses. This includes wholesale purchases of mining equipment, payments to construction firms, payments for outside services, and purchases of fuels, electricity and supplies. Expenditures on products from other Arizona businesses are estimated to have generated 6,200 jobs and income of \$0.91 billion just among first-tier suppliers.

¹See Appendix A for a glossary of the terms used in this report, including definitions of all economic impact variables.

The economic impact of an industry is not limited to its own employees and the employees of its immediate suppliers. There are indirect effects associated with upstream purchases by first-tier suppliers, the consumer spending of all workers connected with the industry, and the spending of state and local governments out of new tax revenues. For the Arizona mining industry, these indirect effects amounted to an additional 25,700 jobs and income of \$1.95 billion in 2014.

Including both the direct and indirect economic impacts, mining activity in 2014 is estimated to have provided a total of 43,800 Arizona jobs and income of \$4.29 billion.

Mining activities not only increase the absolute size of the Arizona economy, but they raise the average standard of living of its residents. The average labor income of all employees directly and indirectly supported by the mining industry is \$67,370. This is significantly higher than \$49,820, the average labor income of all Arizona workers.

The mining industry also makes an important contribution to the Arizona economy through the revenues it generates for state and local governments. In 2014, the mining companies themselves paid \$206 million in business taxes and royalties to Arizona governments. Employees of mining companies are estimated to have paid \$100 million in individual taxes.

Because the provision of state and local government services is heavily tied to population, it is useful to compare the taxes paid per employee by an industry with the statewide ratio of total taxes to total employment. Industries with per employee tax contributions that exceed the statewide average are likely to be making a net fiscal contribution to the state. The companies and their employees pay in taxes an amount that exceeds the value of the services they receive, with the difference serving to subsidize the provision of public services to other residents of the state.

The business taxes paid by Arizona mining companies average \$17,200 per employee. This compares with an average of \$3,300 per worker paid in business taxes by all businesses in the state. Because of their relatively high compensation, the individual taxes paid by mining company employees are also higher than the statewide average. Individual taxes paid by mining employees are estimated to be \$8,400 per worker. This compares with a statewide figure of \$4,700 per worker.

In total, the mining companies and their employees pay to Arizona state and local governments \$25,600 per worker. This is more than 3 times as much as is paid by the average Arizona business and its workers.

The Economic Impact of the Mining Industry on the State of Arizona, 2014

Introduction

Mining has played a central role in the economy of Arizona since statehood. In 1910, one-quarter of wage earners in Arizona were employed in the mining industry. By 1970, after the state population had increased more than eightfold, copper mining was still touted as one of the Five Cs which formed the backbone of the Arizona economy. Over the past four decades, the Arizona population has more than tripled in size and the economy has continued to become more diverse, experiencing rapid growth in new high-technology industries such as semiconductors and aerospace. Because of the growth and diversification of the state's economy, the share of mining employment in total employment has declined in Arizona, as it has throughout the United States. Nevertheless, Arizona remains one of the top producers of copper in the world, and the mining industry continues to play a significant role in the state's economy and is one of its most important economic base industries.

The purpose of this report is to provide estimates of the economic impact of the mining industry on employment, income and tax revenues in Arizona. Estimated impacts include both the direct effects of mining operations in the state and indirect multiplier effects that arise through interindustry linkages and the recycling of income within the state economy. Section I of the report provides an overview of the Arizona mining industry. Section II provides information and perspective on production and prices of copper, which continues to be the most important segment of the state's mining sector. Section III presents estimates of the total impact of the mining industry on employment and income in Arizona. Section IV presents the impacts by county. Section V provides information on the importance of mining as a source of tax revenues for state and local governments in Arizona.

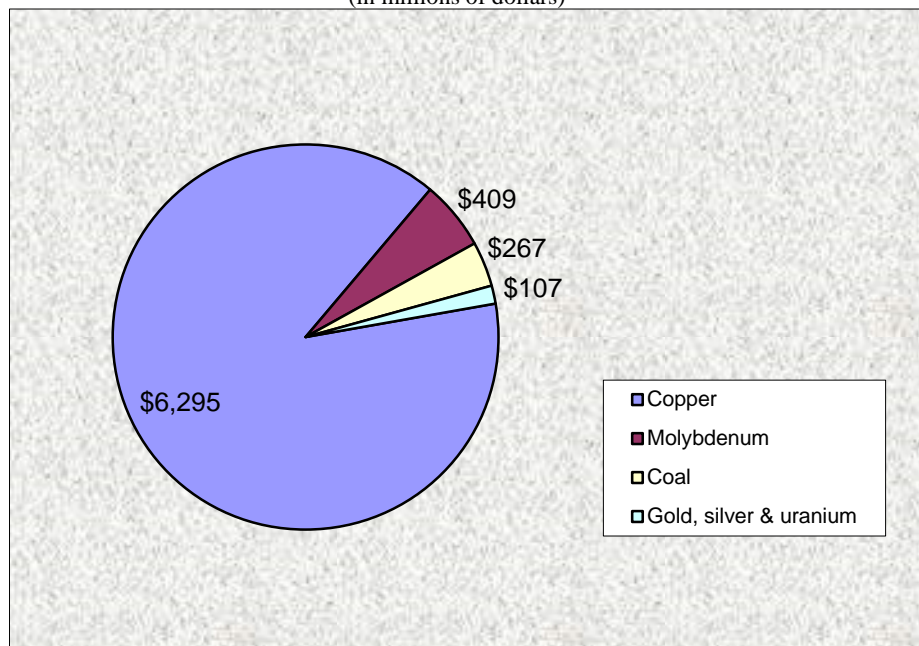
I. Overview of the Arizona Mining Industry

Copper has been the predominant product of mining activity in Arizona for more than a century. This continues to be the case today. There are two large employers and several medium-sized employers of workers involved in copper mining. Companies with the largest employment are Freeport-McMoRan, Inc. and ASARCO LLC. Freeport-McMoRan has its headquarters in Phoenix and operates mines in Gila, Graham, Greenlee, Pima, and Yavapai counties. ASARCO LLC has administrative offices in Tucson and mining operations in Gila, Pima and Pinal counties. Firms with smaller employment operating in the state are Carlota Copper Company, Capstone Mining, Florence Copper, Resolution Copper and Rosemont Copper. Carlota Copper and Capstone Mining operate mines in Gila County. Mercator Minerals operated a copper mine in Mohave County during 2014 but filed for bankruptcy in September of 2014. Florence Copper, Rosemont Copper and Resolution Copper are still in the developmental stage and are not yet producing copper.

Other notable outputs of the Arizona mining industry include molybdenum, coal, gold, silver and uranium. There is one large coal mine in the state, operated by Peabody Energy and located in Navajo County. The mine supplies coal to the Navajo Generating Station. Uranium is mined by Energy Fuels in Mohave County; another company, Uranium One is still in the developmental stage. Molybdenum, gold and silver are important co-products associated with the primary copper industry, i.e., mining, beneficiation, smelting and refining.

As reported by the companies who participated in the mining survey, Arizona in 2014 produced 2.0 billion pounds of copper, 34 million pounds of molybdenum, 7.6 million tons of coal, 4.0 million ounces of silver, 7,100 ounces of gold and approximately 520,000 pounds of uranium. When expressed in dollars, copper makes up 89 percent of the value of Arizona mining output, followed by molybdenum at 6 percent, coal at 4 percent, and gold, silver and uranium combining for 1 percent (see Figure 1).

Figure 1: Value of Arizona Mining Outputs, 2014
(in millions of dollars)



Source: Quantities of mining outputs are from the 2014 Survey of Arizona mining companies. Prices used to value the outputs are from the U.S. Geological Survey and the Energy Information Administration.

Mining as an important economic base activity in Arizona

In explaining the size of regional economies, economists find it useful to divide a region’s economic activities into two groups: *basic* and *nonbasic* activities. *Basic* activities satisfy demands from outside the region and generate export income that can be used to pay for the region’s imports. *Nonbasic* activities exist to supply goods and services to local residents. Basic activities are a region’s economic *raison d’etre*, i.e., its *economic base*. Nonbasic activities are derived from that base and grow or shrink depending on the performance of basic industries.

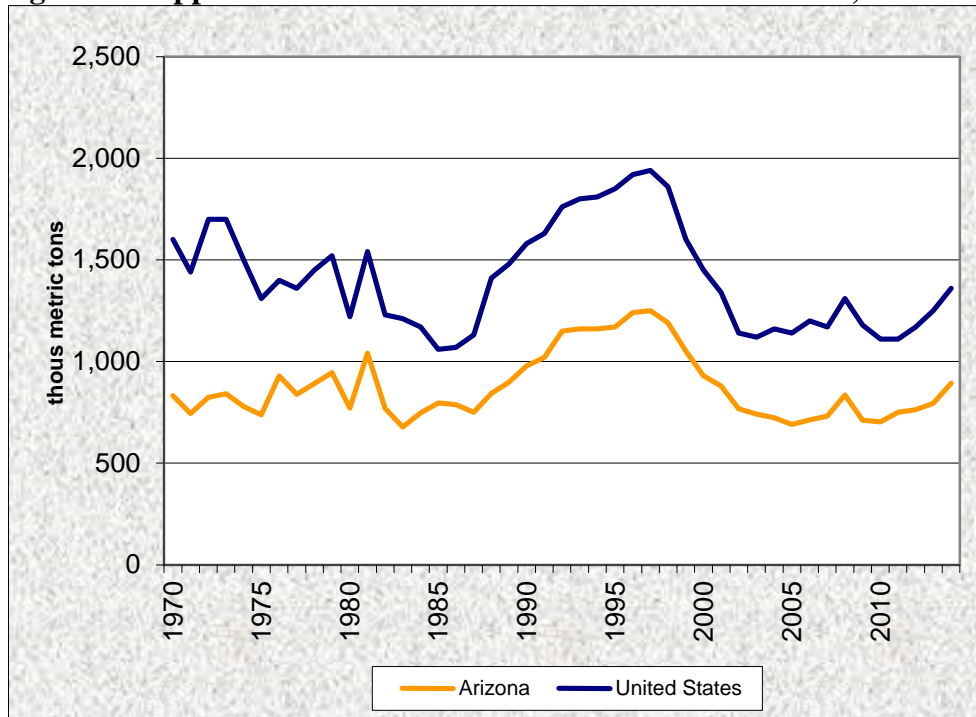
Because of a lack of hard information on trade flows at the subnational level, economists commonly use employment data, as a proxy, to identify the basic activities of a region.

Industries with employment that is disproportionately large by national standards are presumed to be engaged in export activity. Such an economic base analysis was carried out for the state of Arizona (see Appendix B). Copper mining is identified as one of the top ten economic base industries in Arizona. Other industries shown to be important to the economic base of Arizona include call center and back-office operations, semiconductor manufacturing, and aerospace industries such as guided missile manufacturing and the manufacture of search and navigation instruments.

II. Trends in Copper Production and Copper Prices

According to information compiled by U.S. Geological Survey, production of copper at Arizona’s mines rose to 893,000 metric tons in 2014 from 795,000 metric tons in 2013. Because of mine closures and declining ore grades at mature sites, copper production in the state remains below the levels of the mid 1990s, despite high prices for refined copper. Arizona copper production in 2014 was 71 percent of its level in 1997 (see Figure 2).

Figure 2: Copper Production in Arizona and the United States, 1970-2014



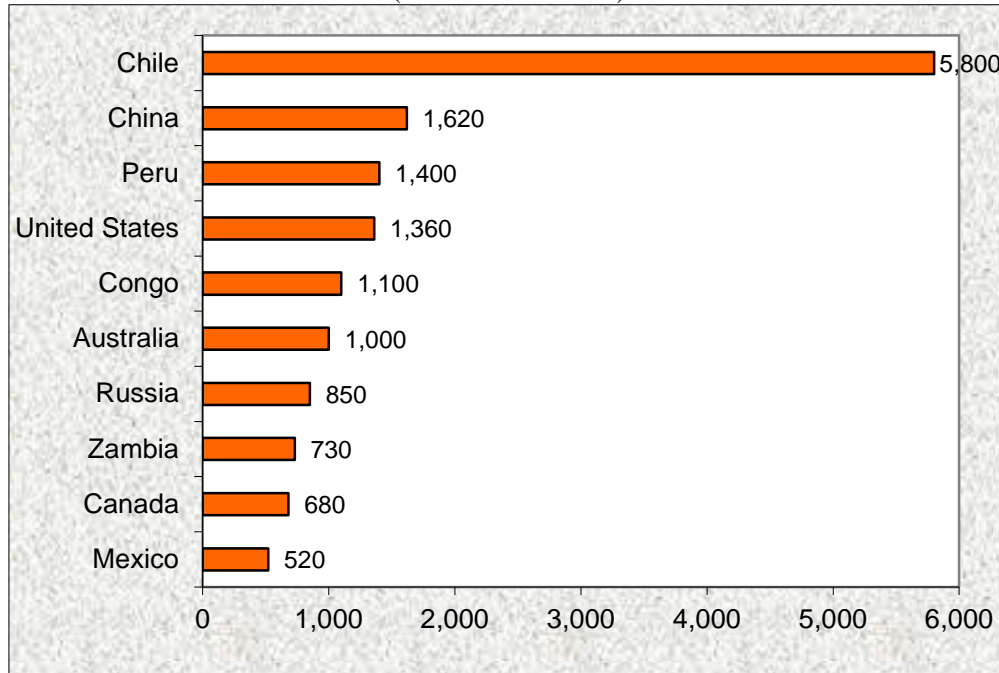
Source: U.S. Geological Survey

Arizona has been a top producer of copper in the United States for more than a century. In each year since 1973, Arizona has accounted for more than one-half of total U.S. copper production. In 2014, 66 percent of U.S. copper mining output came from mines in Arizona.

Over the past two decades, as copper production has surged in Latin America and Asia, the share of world copper production accounted for by Arizona and the United States has declined. In 1995, the United States accounted for 19 percent of world copper production. In

2014 that share was 7 percent. Nevertheless, Arizona and the United States remain among the top producers of copper in the world (see Figure 3). In 2014, the U.S. was the fourth largest copper producing nation in the world. If Arizona was a country, it would be the seventh largest producer of mined copper.

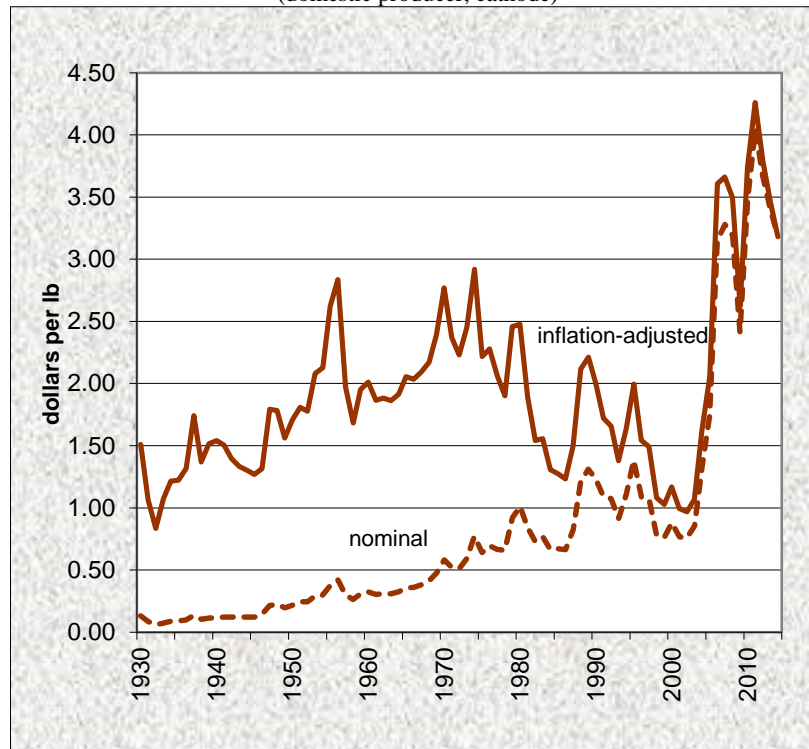
Figure 3: Top 10 Copper-Producing Countries in 2014
(in thous of metric tons)



Source: U.S. Geological Survey

Copper prices are an important underlying determinant of copper production and exploration. Figure 4 shows long-run trends in copper prices going back to 1930. Two series are shown: one nominal and the other adjusted for inflation. Over long periods of time, the inflation-adjusted series provides a more accurate measure of the relative financial rewards associated with using labor and capital in copper mining rather than other productive activities in the country. The inflation-adjusted series is in 2014 prices, and the adjustments are made using the U.S. GDP deflator.

Figure 4: History of U.S. Copper Prices
(domestic producer, cathode)



Source: U.S. Geological Survey

Note: The dashed line in Figure 4 shows the price of copper in current dollars, without an adjustment for inflation. The solid line shows the price of copper expressed in constant 2014 dollars, with an adjustment for inflation made using the U.S. GDP deflator.

Figure 4 reveals three distinct periods in copper prices. From the early 1930s through the early 1970s, U.S. producer prices of cathode increased 150 percent, from approximately \$1.00 per pound to \$2.50 per pound (when expressed in 2014 dollars). There were important short-run fluctuations in prices over this period, fluctuations associated with wars and business cycles. But there was a clear and significant upward trend in copper prices over this forty-year period.

Real copper prices then began to fall in the mid 1970s and continued a trend decline for the next twenty-five years. The inflation-adjusted price of copper fell from \$2.92 in 1974 to \$0.97 in 2002. The drop in prices was the result of both a significant increase in world copper production during the 1960s and early 1970s and a slowdown in economic growth that began in the 1970s and continued on into the 1990s. The rise in production is attributed to the development of new, high-yield mines and improvements in mining and refining technologies.

The most striking development apparent in Figure 4, however, is the surge in copper prices that began in the early 2000s. Over the past twelve years, U.S. producer prices for cathode copper have more than tripled, going from \$0.97 per pound in 2002 to \$3.18 in 2014. Propelling the rise in prices of copper and other industrial raw materials during the first half of this period was strong economic growth in China, India, Brazil and other highly-populated developing countries. These countries made large investments in construction and electricity

infrastructure. The demand for copper was also boosted by increased purchases of consumer electronic equipment throughout the world. Because of the global economic slowdown, copper prices have fallen from their peak in 2007. They remain higher, however, than at any time during the period 1930-2005.

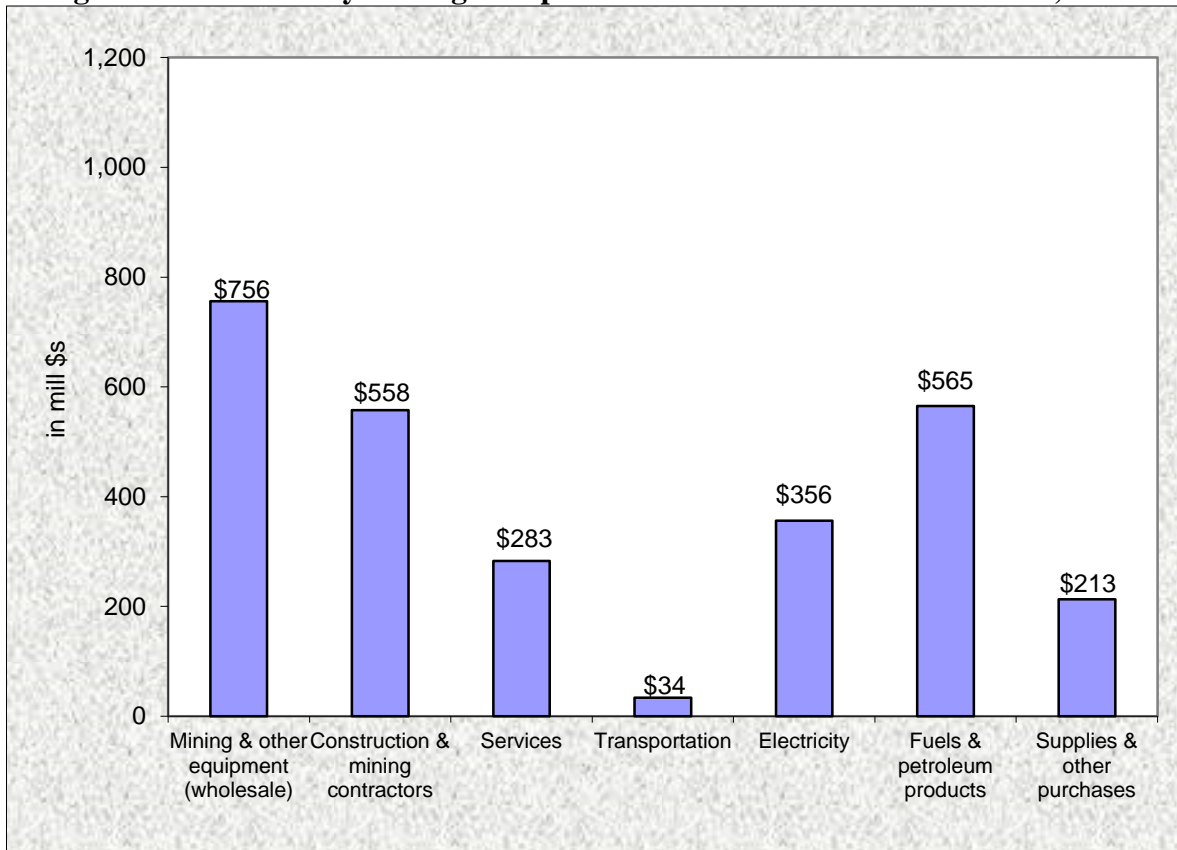
III. Economic Impact of the Arizona Mining Industry

This section of the report presents estimates of the economic impact of mining and exploration on the state of Arizona. The estimated impacts are based on two sources of information: (1) a survey of mining companies operating in Arizona and (2) the IMPLAN input-output model. Surveys sent to mining companies collected information on employment, payrolls, state and local taxes, and purchases from local suppliers. IMPLAN was used to estimate the consequences for Arizona employment and income of the supplier purchases reported by mining companies, as well as all of the indirect multiplier effects associated with the operations of mining companies. Impacts are for the year 2014. Appendix C provides a complete account of the economic impact methodology. Appendix D shows the survey instrument used in 2014.

One of the most important ways in which mining companies contribute to the state and local economy is by providing jobs to Arizona residents. There were 11,953 workers on mining company payrolls in 2014. This figure includes employees at company headquarters as well as those working at mine sites and support facilities such as railroads. The total wages and salaries paid by mining companies in 2014 was \$932 million. A more complete measure of labor income (employee compensation) takes in to account not only wages and salaries but payroll taxes paid by the employer and fringe benefits such as employer contributions to health insurance and retirement plans.

Another way in which mining companies contribute to the Arizona economy is by buying goods and services from other Arizona businesses. For 2014, Arizona mining companies reported purchasing \$2.765 billion worth of goods and services from Arizona vendors. Figure 5 shows the composition of this spending by major category. Arizona's mining companies spent \$756 million on wholesale purchases of mining and other equipment. They paid \$558 million to construction and mining contractors, and they spent \$283 million on outside professional services such as engineering, legal, environmental, and maintenance and repair. Other major categories of business purchases were fuels and lubricants (\$565 million) and electricity (\$356 million). The IMPLAN database includes information on industry production functions which makes it possible to estimate the Arizona jobs and incomes that are associated with purchases of goods and services from Arizona suppliers.

Figure 5: Purchases by Mining Companies from other Arizona Businesses, 2014



Source: 2014 Survey of Arizona mining companies

Estimates of the total economic impact of mining and exploration activities in Arizona are presented in Table 1. Economic impacts are measured in terms of three variables: employment, labor income, and total income. Employment is a count of both full- and part-time jobs. It includes both wage and salary workers and the self-employed. Labor income is the sum of employee compensation (including fringe benefits) and proprietor income (income of the self-employed). Total income is synonymous with value added. It includes not only labor income but the business taxes paid by companies (property, severance, etc.) and, with one exception, capital or property income. Capital income is not included in the value added generated directly within mining companies since that income largely accrues to shareholders worldwide rather than to residents of Arizona.

Table 1: Economic Impact of Mining on the State of Arizona, 2014

	Total Income (in mill \$s)	Labor Income (in mill \$s)	Employment
Direct effects from:			
Company operations	1,435	1,229	11,953
Supplier purchases	909	465	6,188
Indirect effects from:			
Consumer spending out of direct and indirect labor income	1,223	702	15,240
Spending out of S&L government tax revenues	725	554	10,424
Total impact	4,292	2,951	43,804
Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University			
Notes:			
1. Excluded from total income in the first line is capital income which may accrue to shareholders worldwide.			
2. Impacts shown on the second line refer to the direct impacts on first-tier suppliers of vendor purchases by mining companies. The indirect effects associated with these purchases are included among the impacts shown on the third line of the table.			

The first two lines of Table 1 show the direct impacts of mining companies operating in Arizona. The companies themselves employ 11,953 Arizona residents and pay a total income to employees equal to \$1.229 billion. This amounts to an average compensation of \$102,859 per worker. In addition to labor income, the total income figure in line one includes business taxes of \$206 million which mining companies pay to various state and local governments in Arizona.

The second line of the table shows the jobs and incomes supported among the first-tier suppliers of Arizona mining companies. By purchasing \$2.765 billion worth of goods and services from other Arizona businesses, mining companies directly generate 6,188 jobs, labor income of \$465 million, and total Arizona income equal to \$909 million. The total income figure of \$909 million falls well short of the \$2.765 billion paid by mining companies to Arizona vendors. There are two reasons for this. First, some of these payments simply reimburse suppliers for parts, components and services they purchase from firms located outside of Arizona. This is clearest in the case of mining equipment, which may be purchased from wholesalers in Arizona but is produced entirely out of state. Some income accrues to Arizona,

but only the portion that represents a payment for wholesale trade services. Secondly, some of the payments serve to compensate first-tier suppliers for goods and services they purchase from other Arizona businesses. The jobs and incomes associated with these upstream effects are included in the third line of the table.

The lower part of the table shows the indirect or so-called “multiplier” effects of mining company operations. The third line includes two types of indirect effects: (1) impacts stemming from upstream purchases by first-tier suppliers of Arizona mining companies and (2) impacts generated by the consumer spending of both mining company employees and all other employees connected with the economic impact process. There are a total of 15,240 jobs generated by this part of the multiplier process, labor income of \$702 million, and total Arizona income of \$1.223 billion.

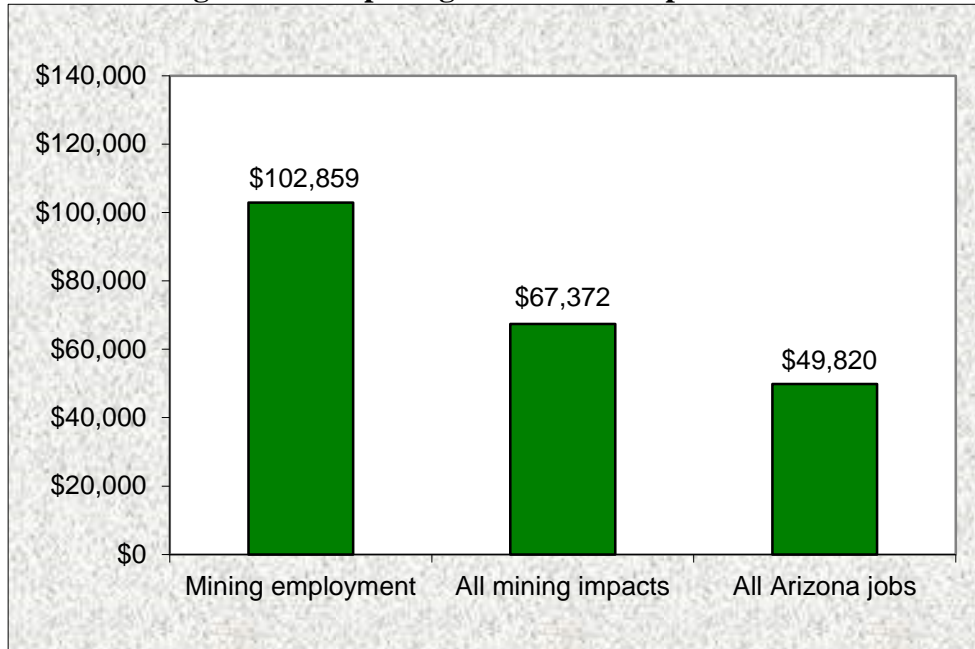
The fourth line of the table presents estimates of a final piece to the multiplier process: the jobs and incomes supported by the spending of new tax revenues by Arizona state and local governments. Mining activity in Arizona is estimated to generate, both directly and indirectly, a total of \$482 million in state and local tax revenues (to be discussed further in Section V). The spending of these tax revenues creates 10,424 jobs, labor income of \$554 million, and total income of \$725 million. These impacts are large, especially the employment impacts. The number of jobs generated by the spending of new tax revenues is larger than the number of jobs directly supported by mining company purchases from first-tier suppliers. There are two reasons for the large size of the tax impacts. First, mining companies generate a large amount of tax revenue. This is due partly to the high business taxes they pay and partly because their employees, being highly compensated, also pay high taxes. Second, provision of government services is a relatively labor intensive activity. A given quantity of dollars spent on government services supports a relatively large number of jobs.

For 2014, the total economic impact of mining is estimated to be 43,804 Arizona jobs, labor income of \$2.951 billion, and total income of \$4.292 billion. For perspective, the employment impact of the mining industry is 1.3 percent of total Arizona employment and the impact of the industry on labor income is 1.7 percent of total Arizona labor income.

The estimates reported in Table 1 are downward biased in that they do not include impacts from the operations of the Mineral Park copper mine in Mohave County. The mine had been owned and operated by Mercator Minerals which filed for bankruptcy in September 2014. Because of its financial difficulties, Mercator Minerals was unable to provide a completed economic impact survey for 2014.

The mining industry in Arizona serves not only to increase the absolute size of the state’s economy but to raise the average standard of living when measured across all residents of the state. As shown in Figure 6, the average labor income of mining company employees is \$102,860 per worker. The average labor income across all employment directly and indirectly supported by the mining industry is \$67,370. Both figures are significantly higher than \$49,820, the average labor income of all Arizona workers.

Figure 6: Comparing Labor Income per Worker



Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University

IV. Impacts by County

A considerable effort was made to track and measure economic impacts at the level of individual counties. The methodology is explained in Appendix C. The county-level results are shown in Table 2 and in Figures 7 and 8.

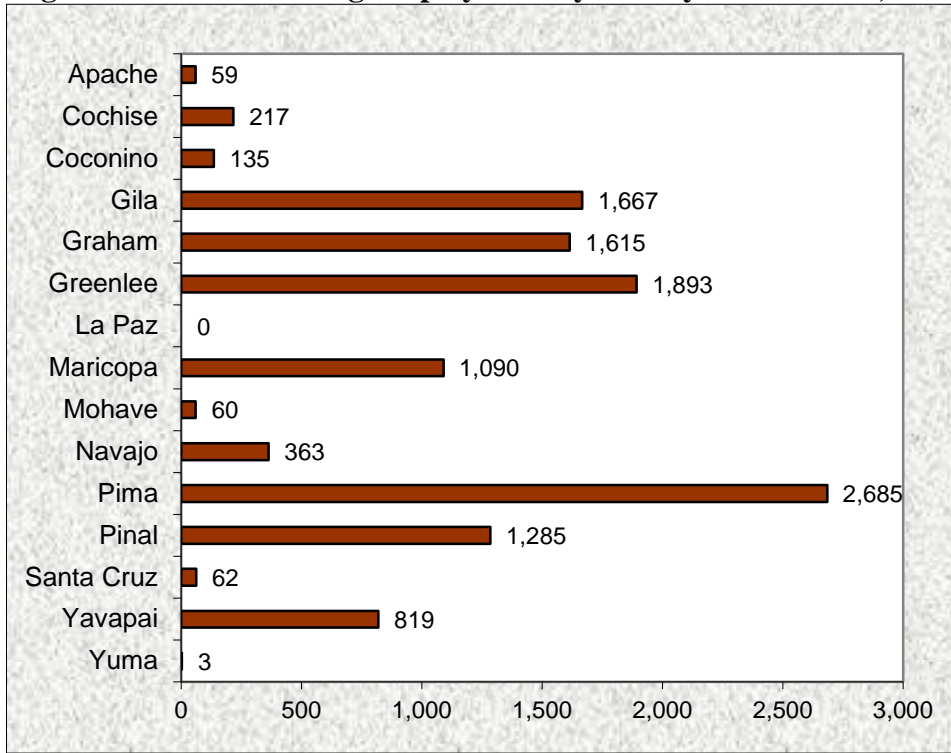
Table 2: Total Economic Impact of Mining by County, 2014

County	Total Income (in mill \$s)	Labor Income (in mill \$s)	Employment
Apache	26	21	399
Cochise	87	52	834
Coconino	84	59	1,001
Gila	275	222	2,960
Graham	249	206	2,668
Greenlee	247	216	2,598
La Paz	2	2	33
Maricopa	1,589	1,033	15,825
Mohave	28	21	335
Navajo	187	92	1,656
Pima	1,095	702	10,857
Pinal	226	182	2,529
Santa Cruz	5	4	70
Yavapai	170	124	1,733
Yuma	22	17	307
Total impact	4,292	2,951	43,804

Source: L. William Seidman Research Institute,
W.P. Carey School of Business, Arizona State University

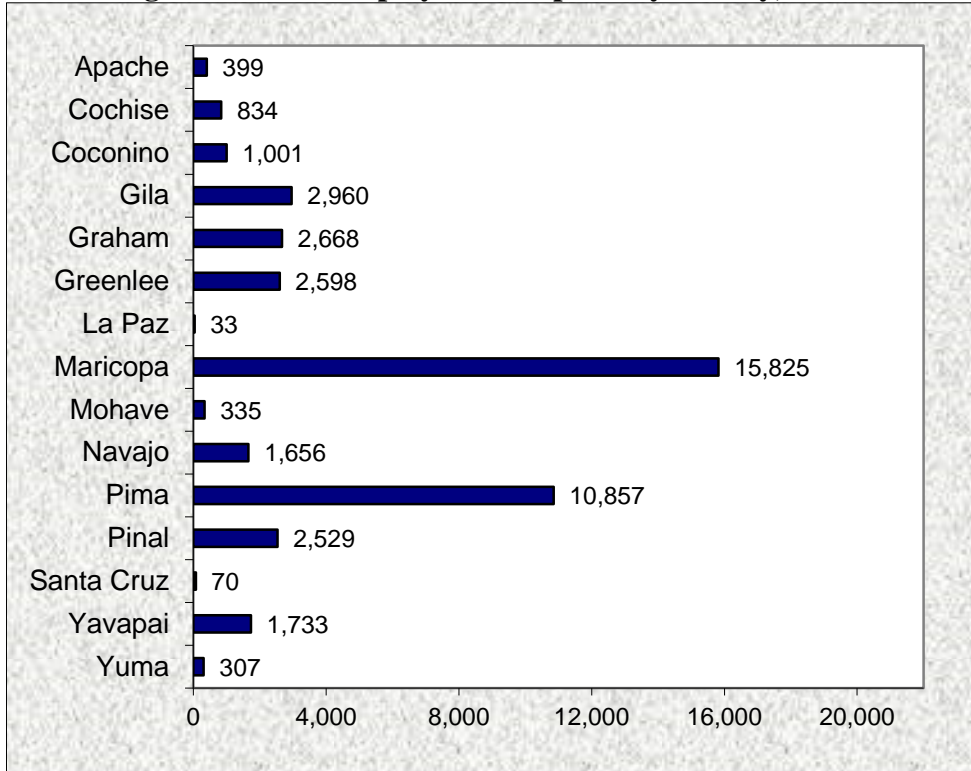
Mining activity is distributed widely throughout the state of Arizona. As indicated in Figure 7, each of five counties is home to at least 1,200 mining company employees (or 10 percent of total mining employment): Gila, Graham, Greenlee, Pima and Pinal. Two other counties—Maricopa and Yavapai—have at least 800 mining company employees as residents. Pima, the county with the most mining employees, accounts for only 22 percent of the 11,953 mining employees living in the state.

Figure 7: Arizona Mining Employment by County of Residence, 2014



Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University

Figure 8: Total Employment Impacts by County, 2014



Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University

The total economic impacts from mining, including both direct and indirect effects, are much more concentrated. Maricopa County accounts for 36 percent, and Pima County accounts for 25 percent, of all mining-related jobs. No other county accounts for as much as 7 percent of total mining-related employment. Economic impacts that stem from supplier purchases are heavily concentrated in Phoenix and Tucson. Consumer spending in rural counties is supported by goods and distribution services from large urban areas. Finally, because of their large populations, Maricopa and Pima counties claim a large share of the jobs supported by the spending of mining-related general tax revenues.

V. State and Local Government Revenues

The mining industry makes an important contribution to the Arizona economy through the taxes that are paid both directly and indirectly to state and local governments. Table 3 summarizes estimates of the fiscal impact of the mining industry. The methods used to prepare these estimates are explained in Appendix C.

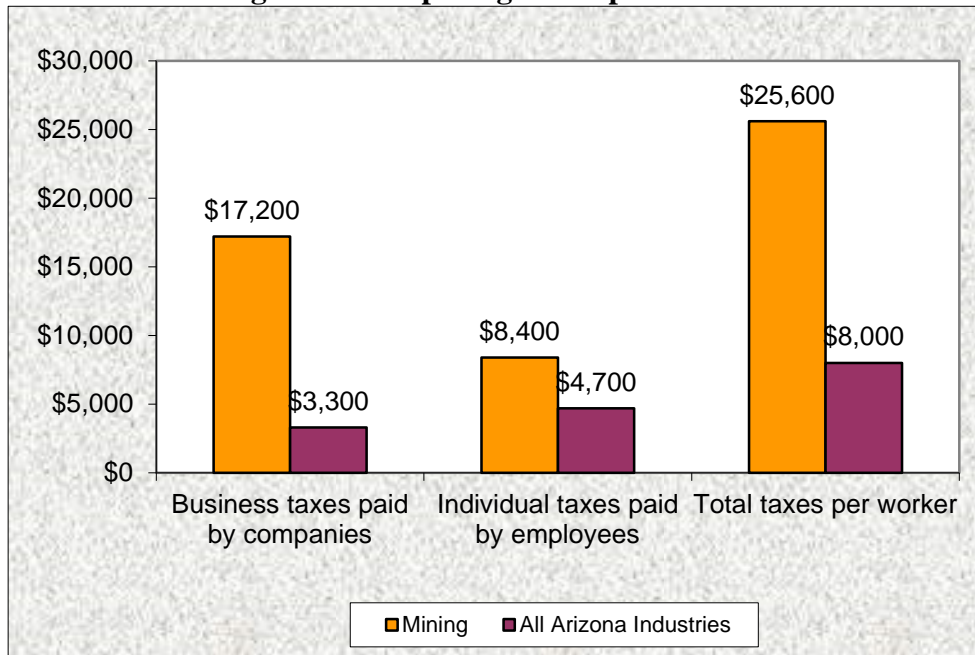
Table 3: Impact of Mining on Arizona State and Local Government Revenues, 2014
(in millions of dollars)

Business taxes paid by mining companies	206
Individual taxes paid by mining company employees	100
Taxes generated through the multiplier process	176
Total Arizona state and local taxes	482
Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University	

In 2014, the mining companies themselves paid \$206 million in business taxes to Arizona state and local governments. The most important categories of business tax payments were property, severance, royalty payments for mining on state-owned or tribal land, and sales taxes. Employees of mining companies are estimated to have paid \$100 million in individual taxes. Finally, Arizona state and local governments are estimated to have collected \$176 million in revenues because of the indirect effects of the mining industry on jobs and incomes in the state, including economic activity associated with supplier purchases and activity supported by the consumer spending of workers whose incomes are directly or indirectly connected to mining.

Because the provision of state and local government services is heavily tied to population, it is useful to compare the taxes paid per employee by the mining industry with the statewide ratio of total taxes to total employment (see Figure 9). Industries with per employee tax contributions that exceed the statewide average can be thought of as making a net fiscal contribution to the state. The companies and their employees are likely to be paying in taxes an amount that exceeds the value of the services they receive. The difference effectively serves to subsidize the provision of government services for other residents of the state.

Figure 9: Comparing Taxes per Worker



Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University

The business taxes paid by mining companies operating in the state average \$17,200 per company employee. Total business taxes collected in the state amount to approximately \$3,300 per Arizona worker. On this basis, mining companies in Arizona pay more than 5 times as much in taxes as does the average Arizona business.

Because of their relatively high compensation, mining company employees also pay more in state and local taxes than does the average Arizona worker. Individual taxes paid by mining employees are estimated to be \$8,400 per worker. This compares with a statewide figure of \$4,700 per worker.

In total, the mining companies and their employees pay to Arizona state and local governments \$25,600 per worker. This is more than 3 times as much as is paid by the average business and its workers.

Sources

Ernst and Young, "Total State and Local Business Taxes: State-by-State Estimates for Fiscal Year 2013," August 2014.

L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University, *Surveys of Arizona Mining Companies*, annual.

Minnesota IMPLAN Group, Inc. *IMPLAN Professional: Social Accounting & Impact Analysis Software* (Stillwater, MN).

Bureau of Labor Statistics, *Consumer Expenditure Survey, 2013* (Table 2301), <http://www.bls.gov/cex/2013/combined/higherincome.pdf>

U.S. Census Bureau, *State and Local Government Finances, FY 2012*, <http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>

U.S. Geological Survey, Minerals Information, <http://minerals.usgs.gov/minerals/>

Appendix A: Glossary of Terms

Economic impacts are measured in terms of three variables: employment, labor income and total income.

- *Employment* is a count of both full- and part-time jobs. It includes both workers on company payrolls and those who are self-employed.

- *Labor income* is the sum of employee compensation and proprietor income (income of the self-employed). Employee compensation is synonymous with the total payroll cost of a company's employees. It includes wages and salaries, the employer's portion of payroll taxes and fringe benefits such as employer contributions to health insurance and retirement plans.

- *Total income* is total value added. It is also synonymous with gross regional product. Total income includes labor income, capital or property income and business taxes paid by companies. One exception to this rule is that when measuring the direct contribution of mining companies to total income in Arizona, we exclude the capital income of the mining companies themselves since that income accrues largely to shareholders worldwide rather than to residents of Arizona.

- *Business taxes* include business property taxes, severance taxes, sales and excise taxes paid by businesses on their input purchases and capital expenditures, gross receipts taxes, corporate income and franchise taxes, unemployment insurance taxes and royalty payments made to governments for operations on public land.

The total economic impact of a company consists of the direct effects of the company's operations and the indirect or so-called multiplier effects that arise through interindustry purchases and the recycling of income within the regional economy.

- *Direct effects* are the jobs and incomes directly associated with a company's operations plus the jobs and incomes that are supported by the company's purchases of goods and services from first-tier suppliers.

- *Indirect effects* include the additional jobs and incomes that are generated when first-tier suppliers make upstream purchases from other regional businesses, when households make consumer purchases out of the income that is directly or indirectly generated through the multiplier process, and when state and local governments spend new tax revenues.

Appendix B: Mining as an Important Economic Base Activity in Arizona

Regional economists commonly use economic base analysis to explain the amount of employment and production in a state or region, i.e., to understand why people and employers chose to locate in one particular area rather than in other parts of the country. Economic base industries sell in national or international markets and generate export income that can be used to pay for goods and services produced outside of the region. Nonbasic industries, those that only sell locally, exist to supply goods and services to local residents. They are dependent on economic base industries and grow or shrink depending on the performance of basic industries.

Because of a lack of hard information on trade flows at the subnational level, economists often use employment data to identify the basic industries in a region. Industries with employment that is disproportionately large by national standards are presumed to be engaged in export activity. Such an economic base analysis was carried out for the state of Arizona. The results are reported in Table B1. Column (4) of the table shows the location quotients of individual industries. Location quotients are calculated as the ratio of an industry's employment share in the state economy to its share nationwide. Economic base industries are identified by a location quotient that exceeds one. Column (5) provides an employment-based estimate of the export activity in a basic industry. Export-base employment is the difference between actual industry employment and what would be expected were the share of industry employment in the region equal to the national average. The particular calculations shown in Table B1 are based on employment data for 2013. The list of a region's top economic base industries identified by this kind of analysis generally does not vary much from year to year.

Table B 1: Economic Base Industries in Arizona

	Arizona		United States	Location Quotient	Arizona Export Base
	Number of Workers (1)	Percent of Total (2)	Percent of Total (3)	Ratio of (2) to (3) (4)	Number of Workers (5)
Nondepository credit intermediation	45,420	1.33	0.55	2.42	26,657
Business support services	40,931	1.20	0.64	1.86	18,953
Semiconductors and related devices	18,810	0.55	0.10	5.76	15,543
Copper mining	11,445	0.33	0.01	34.37	11,112
Outpatient care centers	26,667	0.78	0.46	1.69	10,878
Guided missile and space vehicle manufacturing	11,664	0.34	0.03	11.04	10,608
Office administrative services	20,000	0.59	0.34	1.70	8,220
Vegetable and melon farming	8,084	0.24	0.06	3.86	5,988
Search, detection and navigation instruments	7,464	0.22	0.07	3.14	5,083
All industries	3,417,501	100.00	100.00		

Source: Center for Business Research, L. William Seidman Research Institute, College of Business, Arizona State University, using IMPLAN 2013 data files.

Notes: Based on employment levels in 2013. Industries listed in the table are those with a location quotient of at least 1.60 and export-base employment of at least 5,000 workers. Industry definitions follow the IMPLAN sectoring scheme which is based on NAICS 4-digit codes.

Copper mining is seen to be among the top ten economic base industries in Arizona. Copper mining has a location quotient of 34, by far the largest location quotient in the table, and it provides an export base of approximately 11,000 workers when measured in terms of employment. Other industries identified as being important to the economic base of Arizona include call center and other back-office operations (which are included in both nondepository credit intermediation and business support services), semiconductor manufacturing, and aerospace industries such as guided missile manufacturing and the manufacture of search and navigation instruments.

The figures reported in Table B1 understate the importance of mining and other economic base industries on the Arizona economy. The figures are based on direct employment only and do not include employment related to industry suppliers and other indirect effects. The purpose of economic impact analysis is to provide a full accounting of the contribution of an industry to a regional economy, including interindustry linkages and multiplier effects. An economic impact analysis of Arizona's mining industry is presented in section III of the report.

Appendix C: Economic Impact Methodology

The economic impact estimates presented in this report are based primarily on two sources of information: (1) a survey of mining companies operating in Arizona and (2) the IMPLAN input-output model and software. A survey questionnaire sent to mining companies collected information on employment, payrolls, state and local taxes, and purchases from local suppliers related to mining and exploration operations in Arizona during 2014. IMPLAN was used to estimate the economic interdependencies or so-called multiplier effects generated by the operating expenditures of mining companies.

Company surveys

Completed survey questionnaires were received from 11 companies with mining or exploration operations in Arizona (see Table C1). The list includes all but one of the major copper-producing companies and Peabody Energy which operates a large coal mine in Navajo County. Because of its financial difficulties, Mercator Minerals was unable to provide a completed survey for its Mineral Park operations during 2014.

Table C 1: Arizona Mining Companies Surveyed for Operations in 2014

ASARCO LLC
Capstone Mining
Carlota Copper
Energy Fuels
Excelsior Mining
Florence Copper
Freeport-McMoRan, Inc.
Golden Vertex
Peabody Energy
Resolution Copper
Rosemont Copper

The survey generated information on employment headcounts as of Dec. 31, 2014 and totals for the year for wages and salaries and other payroll costs, including payroll taxes and fringe benefits such as employer contributions to health care and retirement plans. The survey also provided information on mining company purchases from other Arizona businesses broken out by major category (mining equipment, construction and mining contractors, professional and business services, transportation, electricity and fuels). The survey also gathered detailed information on property, severance and other state and local taxes paid or accrued in 2014. The complete survey instrument is shown in Appendix D.

IMPLAN

In economic impact analysis, estimates of the effects of a company's operations on the local economy are not limited to the direct jobs/incomes provided by the company or the jobs/incomes supported among its first-tier suppliers. The estimated impacts also include indirect or so-called multiplier effects that arise when a business' immediate suppliers place upstream demands on other producers, when workers directly or indirectly associated with company operations spend a portion of their incomes in the local economy, and when governments spend new tax revenues. Estimates of multiplier effects are made using an "input-output" model—a system of linear equations which describes the interindustry relationships in an economy. The input-output model used in this study was an Arizona-specific version of IMPLAN, a model used widely by researchers throughout the United States. In addition to providing estimates of multiplier effects, IMPLAN has a detailed database which makes it possible to estimate the jobs and incomes directly supported by purchases from first-tier suppliers.

The specific model used was based on IMPLAN's 2013 economic database. In building the model, trade flows were calculated using IMPLAN's "regional purchase coefficients," which are econometrically-derived estimates of the percentage of demand for a specific commodity that is satisfied by local producers. Type SAM (Social Accounting Matrix) multipliers were used with the amount of recycled spending limited to the private sector. State and local tax revenues generated during the process were also assumed to be recycled, but these calculations were performed outside of IMPLAN. First, an estimate was made of the direct and indirect effects of mining industry operations on tax revenues (see below). IMPLAN was then used to estimate the impact of this money being spent by Arizona governments.

Economic impact variables

Economic impacts were measured in terms of three variables: total income, labor income, and employment. *Total income* is synonymous with gross product or value added. It is the sum of employee compensation, proprietor income, property income, and indirect business taxes. *Labor income* is the sum of proprietor income (income of the self-employed) and the total compensation of payroll employees. Employee compensation consists of wages, salaries and benefits, including employer contributions to health insurance and retirement pensions. *Employment* is a count of full- and part-time jobs. It includes both wage and salary workers and the self-employed. All monetary variables are expressed in 2013 dollars.

Estimates by county

When possible, estimates of the jobs and incomes generated by the mining industry were allocated across individual counties on the basis of the residences of employees rather than the location of their employment. In the survey, mining companies were asked to provide a breakdown of the counties in which their employees reside. Employment totals and the labor income earned by mining company employees were allocated across counties using this information. The county distribution of mining company payrolls was helpful when estimating the geographic incidence of impacts relating to consumer spending by mining company employees.

In the survey, mining companies were asked to provide detail on the commodity composition of their supplier purchases, but they were not asked to report the county locations of their suppliers. One important exception, however, was Freeport-McMoRan which provided information on the county destinations of all payments sent to Arizona businesses. With the detailed information made available by Freeport-McMoRan, it was possible to make reasonable estimates of the county distribution of supplier payments of other mining companies based on the locations of their operations.

Estimating state and local tax revenues

One of the objectives of this report was to estimate the impact of mining operations on Arizona state and local tax revenues. The survey collected information on the business taxes paid by mining companies—property, severance, sales, etc. Much more difficult to estimate are taxes paid by mining company employees and all of the taxes connected with the economic impact process.

Many taxes are local—for example, the property taxes paid to school districts or sales taxes paid to cities. In theory, to estimate these, one would need to have and utilize information with a high degree of geographic granularity on the incomes and spending of employees, suppliers and anyone else connected with the multiplier process. Such an analysis is beyond the scope of this project.

To make the calculations manageable, tax revenues generated at any phase of the economic impact process (apart from the business taxes paid directly by mining companies) were estimated by multiplying the income attributable to production in that phase by the statewide ratio of state and local taxes to income. In FY2012, total state and local taxes in Arizona represented 8.2 percent of gross state product (U.S. Census Bureau). In other words, on average, income generated from production in Arizona was taxed by state and local governments at a combined rate of 8.2 percent. With this figure in mind, taxes connected with the income earned and spent by mining employees were estimated by taking 8.2 percent of their labor income. Taxes associated with the production of goods and services that mining companies purchased from Arizona suppliers were estimated by taking 8.2 percent of the income generated from that production. Taxes associated with the multiplier process were also estimated in this way.

Inherent in the above methodology is an inability to separate state taxes from taxes accruing to local governments. Estimates of tax revenues generated by the mining industry, therefore, are reported at the state level only.

Spending of tax revenues

One channel to recognize in the economic impact process is the effect mining companies have on the Arizona economy when new tax revenues are spent by state and local governments. As noted above, we were generally unable to estimate new tax revenues at local levels of government. Also, because of intergovernmental flows of revenues, it is difficult to associate taxes raised at the level of a local government with provision of government services to that local area. Some taxes, for example, are collected by the county but sent to the state to be redistributed. Because of these difficulties, the only practical way of recognizing tax-related

impacts at the county level is to assume that the county gets a pro rata share of the total state and local tax revenues generated. The pro rata share used in our calculations was based on the county's share of the state population.

An exception to the procedure described above was the treatment of property taxes reported by surveyed mining companies. Property taxes paid by mining companies were assumed to be spent entirely within the counties in which the mining operations are located.

Appendix D: Survey Questionnaire

Data for Arizona Mining Association Report		
(For Year Ended December 31, 2014)		
*Note: Each mine or operating unit should be reported on a separate worksheet. If that is not possible, please explain what the data below represents.		
Name of mine or operating unit in Arizona		
A. State and local taxes paid or accrued in 2014	Amount	
	(in dollars)	
1. Property taxes paid in Arizona		
2. Arizona taxes on metal value (severance taxes)		
3. Sales and use taxes on purchases in Arizona		
4. Arizona state income taxes		
5. Royalties paid for mining on state-owned or tribal land		
6. Other Arizona state and local taxes, if any (please identify as best as possible)		
B. Payroll expenditures in 2014	Amount	
	(in dollars)	
1. Wages, salaries and any other cash compensation paid to employees who are Arizona residents		
2. Fringe benefits paid for Arizona employees (including employer contributions to health insurance and retirement plans, profit sharing, supplemental unemployment benefits and any other employer-paid benefits)		
3. Payroll taxes paid relating to employment of Arizona residents (includes employer contributions to FICA, unemployment taxes and any other employer-paid, payroll-related taxes)		
C. Employment of Arizona residents	Number	Percent
1. Number of Arizona employees as of December 31, 2014		
2. For the total number in item 1 above, list the number of employees by primary county of residence. If unavailable, provide an approximate percentage breakdown by county.		
County 1		
County 2		
County 3		
All other counties in Arizona		
Total (Headcount should tie to amount in #1. If percentages are used, total should equal 100%)		

D. Goods and services purchased from Arizona businesses in 2013 related to mining or administrative operations	Amount (in dollars)	Percent
*Note: Please include expenditures for environmental reclamation and remediation and community relations. You will be asked in Section E to report these again separately.		
1. Total purchases from Arizona vendors in 2014		
2. Breakdown by category. If unavailable, provide an approximate percentage breakdown by category.		
Mining and other equipment (wholesale purchases)		
Construction and mining contractors		
All other outside services (such as engineering, legal, environmental, repair and maintenance)		
Transportation (including trucking and rail)		
Electricity		
Fuels and petroleum products		
Costs for other supplies needed in the production process (such as explosives and chemicals)		
Any other purchases from Arizona vendors		
Total (Dollars should tie to amount in line #1. If percentages are used, total should equal 100%)	0	100%
E. Expenditures made in 2014 for environmental reclamation and remediation and community relations		
*Note: These expenditures also should have been included in Section D above.		
1. Expenditures for environmental reclamation, remediation, habitat restoration, etc.		
2. Community relations expenditures (from company or associated Foundations)		
*Note: Please attach any narrative your company has already prepared detailing particular programs relating to environmental restoration and community relations.		
F. Amounts of metals and other mining products produced in 2014		
	2014 Production	Units of Measurement
*Note: Be sure to specify the units in which you measure production: short tons, metric tons, pounds, kilograms, etc.		
Copper		
Gold		
Molybdenum		
Coal		
Uranium		
Other (e.g., Silver)		
G. Total revenue recorded in 2014 from sale of all metals and minerals, including by-products, produced in Arizona		
	Amount (in dollars)	