

**THE ECONOMIC IMPACT OF
THE MINING INDUSTRY
ON THE STATE OF ARIZONA
2012**



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by

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Executive Summary

The purpose of this report is to measure the 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 multiplier effects that arise through interindustry purchases and the recycling of income within the state economy. The analysis indicates that mining activity in 2012 provided a total of 52,100 Arizona jobs and generated \$4.80 billion in total income for workers, business and property owners, and governments in Arizona.

The impacts reported are based on primary data collected in surveys of Arizona mining companies for the operating year 2012. Companies surveyed include all of the major copper producers in the state, companies that made significant equipment purchases and other investments in 2012 and expect to be producing copper in the near future, a coal producer, a uranium producer, and several mining exploration companies. Companies involved in sand, gravel and rock products were not included in the analysis.

There were approximately 12,100 employees of mining companies residing in Arizona in 2012. 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 in residence.

The total income paid to employees of Arizona mining companies in 2012 was \$1.20 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 \$99,500 in 2012. This compares with an average income of \$49,750 per worker across all industries in Arizona.

Arizona mining companies spent a total of \$3.20 billion in 2012 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 generate 8,500 jobs and income of \$1.07 billion just among first-tier suppliers.

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 to the industry, and the spending of state and local governments out of new tax revenues. For the Arizona mining industry, these indirect effects amount to an additional 31,500 jobs and income of \$2.33 billion.

Including both the direct and indirect impacts, mining activity in 2012 is estimated to have provided a total of 52,100 Arizona jobs and income of \$4.80 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 \$63,500. This is significantly higher than \$49,750, the average labor income of all Arizona workers.

The mining industry makes an important contribution to the Arizona economy through the revenues it generates for state and local governments. In 2012, the mining companies themselves paid \$206 million in business taxes to Arizona governments. Employees of mining companies are estimated to have paid \$93 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 \$17,000 per employee. This compares with an average of \$3,000 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 \$7,700 per worker. This compares with a statewide figure of \$3,900 per worker.

In total, the mining companies and their employees pay to Arizona state and local governments \$24,700 per worker. This is 3½ 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, 2012

Introduction

Mining has played a central role in the economic history of Arizona. 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 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 multiplier effects that arise through interindustry linkages and the recycling of income within the local 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. The report concludes in Section VI by comparing the economic impact of mining in 2012 with its impact in 2011.

I. Overview of the Arizona Mining Industry

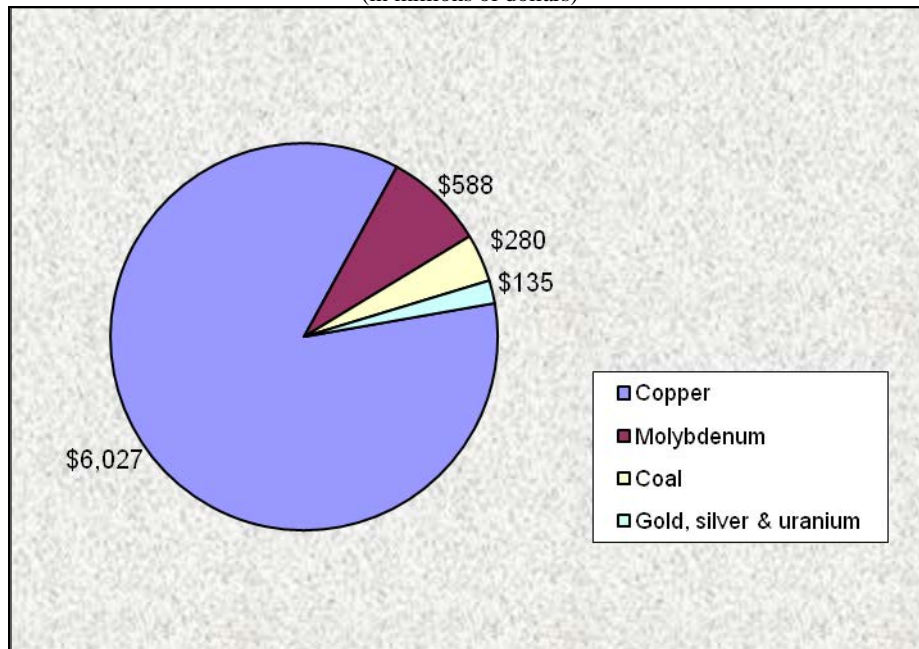
Copper has been the predominant output of mining activity in Arizona for more than a century. This continues to be the case today. There are two large employers and several medium-sized employers of workers involved in copper mining. Companies with the largest employment are Freeport-McMoRan Copper & Gold Inc. and ASARCO LLC. Freeport-McMoRan has its headquarters in Phoenix and operates mines in Gila, Graham, Greenlee, Pima, and Yavapai counties. ASARCO has administrative offices in Tucson and mining operations in Gila, Pima and Pinal counties. Firms with smaller employment operating in the state are Mercator Minerals, Carlota Copper Company, BHP Billiton, Florence Copper, Resolution Copper and Rosemont Copper. Mercator Minerals has a mine in Mohave County. Carlota Copper and BHP Billiton operate mines in Gila County. 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. Molybdenum, gold and silver are important by-products of copper mining.

As reported by the companies who participated in the mining survey, Arizona in 2012 produced 1.63 billion pounds of copper, 44 million pounds of molybdenum, 8 million tons of coal, 3.8 million ounces of silver, 5,600 ounces of gold and approximately 375,000 pounds of uranium. When expressed in dollars, copper makes up 86 percent of the value of Arizona mining output, followed by molybdenum at 8 percent, coal at 4 percent, and gold, silver and uranium combining for 2 percent (see Figure 1).

Figure 1: Value of Arizona Mining Outputs, 2012

(in millions of dollars)



Source: Quantities of mining outputs are from the 2012 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 growth of regions, economists find it useful to divide a region’s economic activities into two groups. *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.

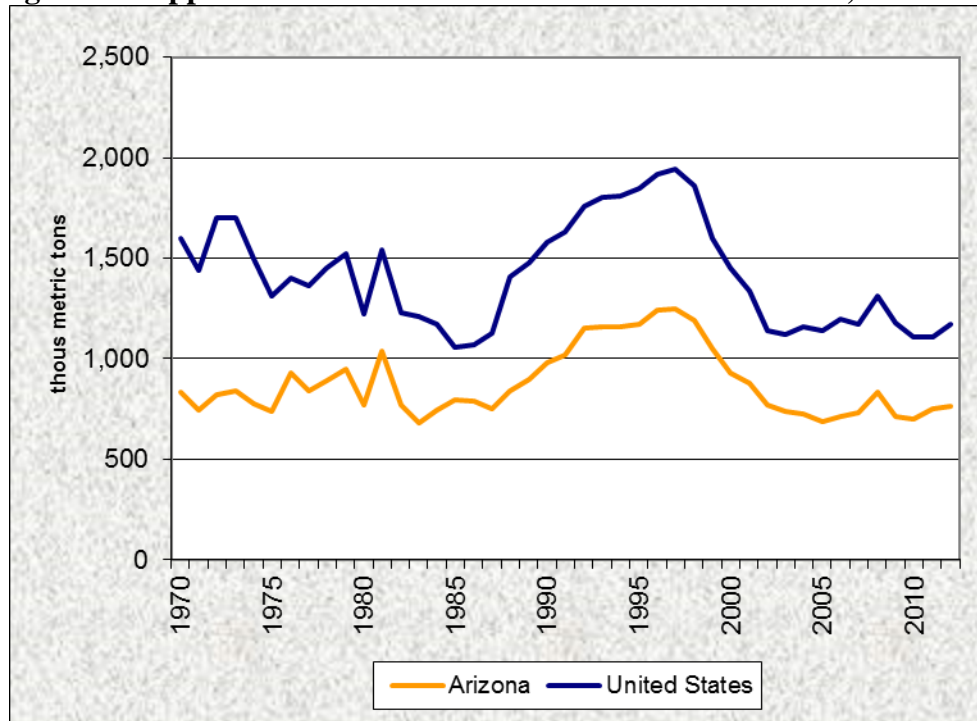
Because of a lack of hard information on trade flows at the subnational level, economists commonly use employment data to identify the basic activities of a region. Industries with employment that is disproportionately large by national standards are presumed to be engaged in

export activity. Such an economic base analysis was carried out for the state of Arizona (see Appendix A). 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, aerospace industries such as guided missile manufacturing and the manufacture of search and navigation instruments, and air transportation.

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 slightly to 763,000 metric tons in 2012 from 751,000 metric tons in 2011. Because of mine closures and declining yields at mature sites, copper production in the state remains below the levels of the mid 1990s, despite near record high prices for refined copper. Arizona copper production in 2012 was 61 percent of its level in 1997 (see Figure 2).

Figure 2: Copper Production in Arizona and the United States, 1970-2012



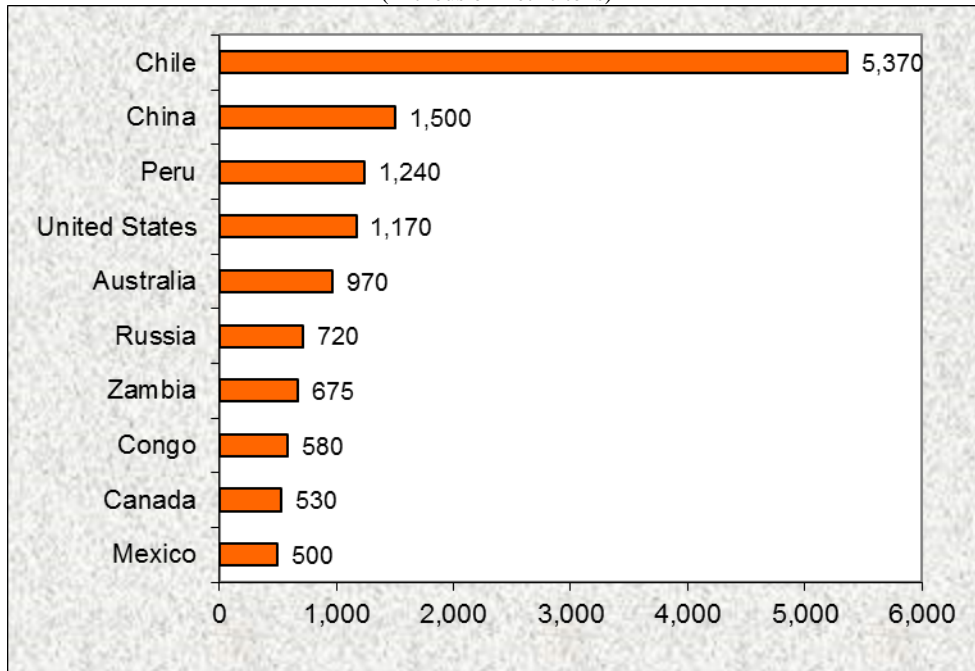
Source: U.S. Geological Survey

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 2012, 65 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 2012 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 2012, the U.S. was the fourth largest copper producing nation in the world. Arizona itself was the sixth largest producer of mined copper.

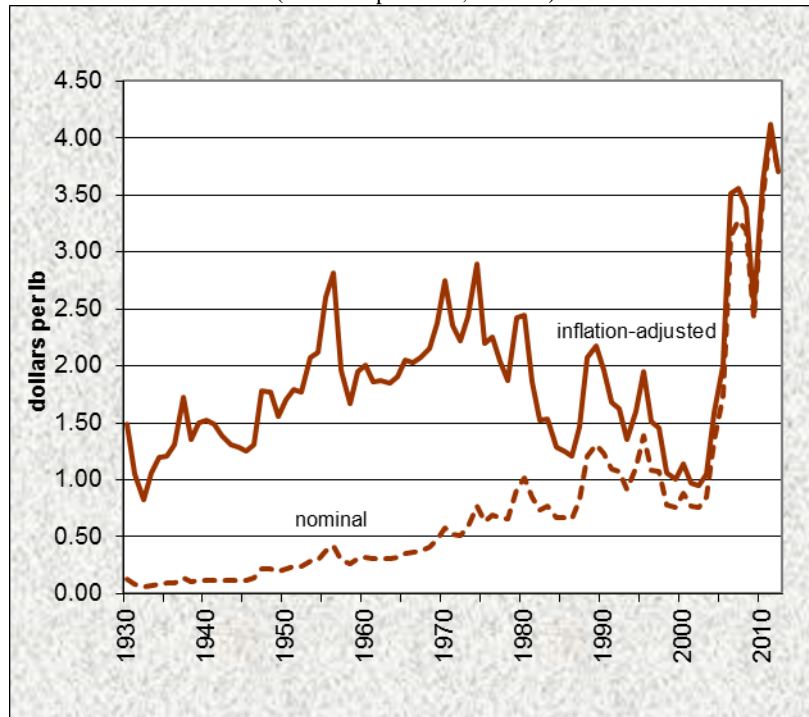
Figure 3: Top 10 Copper-Producing Countries in 2012
(in thous of metric tons)



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 2012 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 2012 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 2012 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 \$2.90 in 1974 to \$0.95 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 and continues to this day, albeit with a significant hiccup during the recession of 2008-2009. Over the past decade, U.S. producer prices for cathode copper have almost quadrupled, going from \$0.95 per pound in 2002 to \$3.70 in 2012. Propelling the rise in prices of copper and other industrial raw materials has been strong economic growth in China, India, Brazil and other highly-populated developing countries. These countries have made large investments in construction and electricity infrastructure. The

demand for copper also has been boosted by increased purchases of consumer electronic equipment throughout the world.

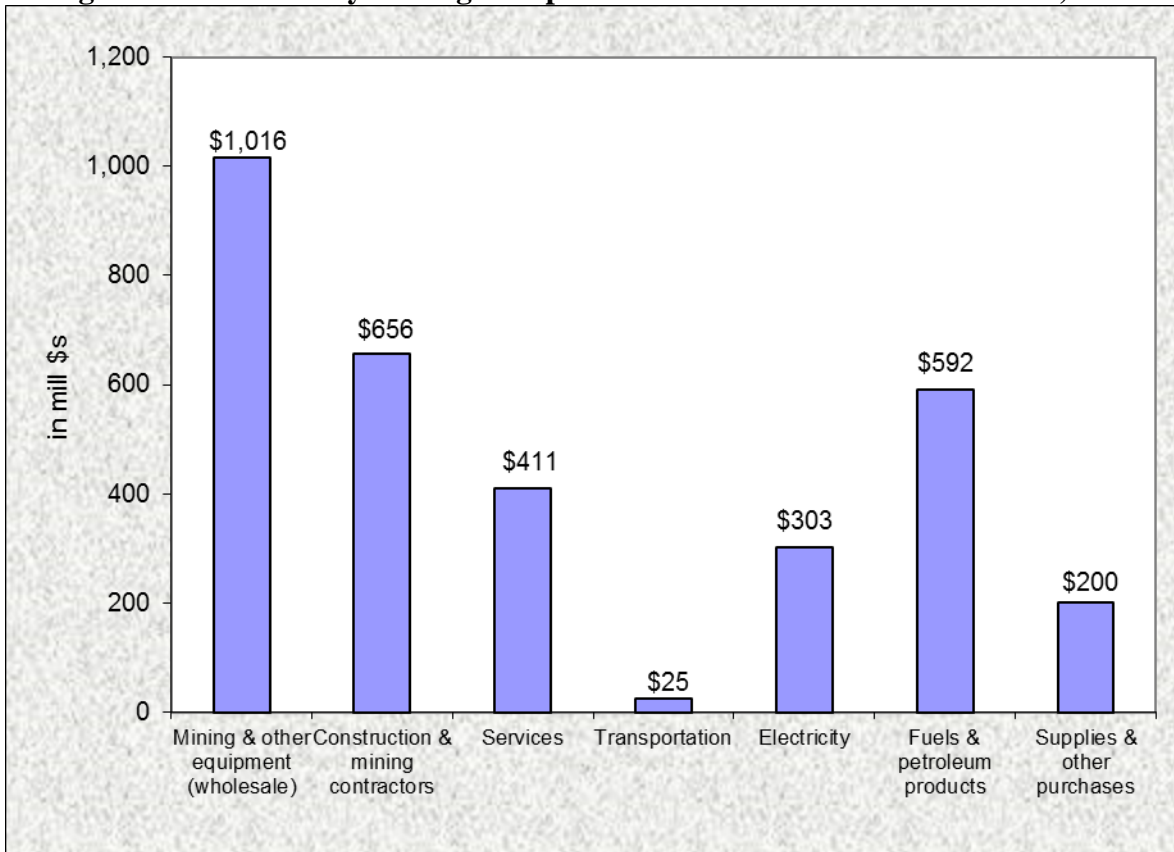
III. Economic Impact of the Arizona Mining Industry

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) surveys 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 multiplier effects associated with the operations of mining companies. Impacts are for the year 2012. Appendix B provides a complete account of the economic impact methodology.

One of the most important ways in which mining companies contribute to the local economy is by providing jobs to Arizona residents. There were 12,095 workers on mining company payrolls in 2012. This figure includes employees at company headquarters as well as those working at mine sites. The total wages and salaries paid by mining companies in 2012 was \$900 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 affect the Arizona economy is by buying goods and services from other Arizona businesses. For 2012, Arizona mining companies reported purchasing \$3.203 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 \$1.016 billion on wholesale purchases of mining and other equipment. They paid \$656 million to construction and mining contractors, and they spent \$411 million on outside services such as engineering, legal, environmental, and maintenance and repair. Other major categories of business purchases were fuels and lubricants (\$592 million) and electricity (\$303 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, 2012



Source: 2012 Survey of Arizona mining companies

Estimates of the full economic impact of mining and exploration activity 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, 2012

	Total Income (in mill \$s)	Labor Income (in mill \$s)	Employment
Direct effects from:			
Company operations	1,410	1,204	12,095
Supplier purchases	1,067	619	8,467
Indirect effects from:			
Consumer spending out of direct and indirect labor income	1,535	892	19,785
Spending out of S&L government tax revenues	793	596	11,791
Total impact	4,804	3,311	52,138
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 12,095 Arizona residents and pay a total income to employees equal to \$1.204 billion. This amounts to an average compensation of \$99,500 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 \$3.203 billion worth of goods and services from other Arizona businesses, mining companies directly generate 8,467 jobs, labor income of \$619 million, and total Arizona income equal to \$1.067 billion. The total income figure of \$1.067 billion falls well short of the \$3.203 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.

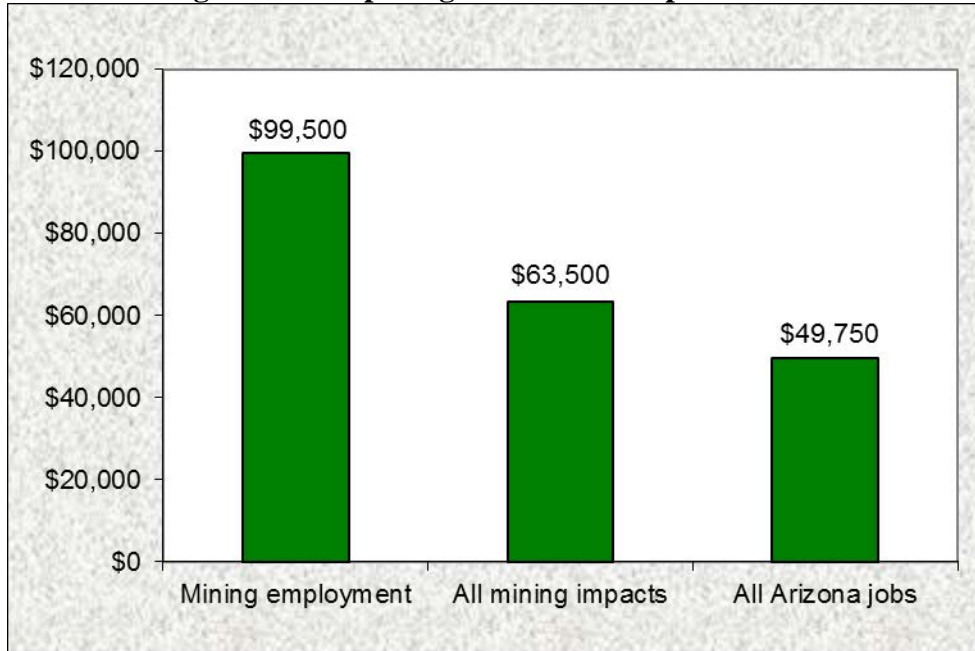
The lower part of the table shows the indirect or so-called “multiplier” effects of mining company operations. The third line includes two types of indirect effects: (1) impacts stemming from upstream purchases by first-tier suppliers of Arizona mining companies and (2) impacts generated by the consumer spending of both mining company employees and all other employees connected with the economic impact process. There are a total of 19,785 jobs generated by this part of the multiplier process, labor income of \$892 million, and total Arizona income of \$1.535 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 \$502 million in state and local tax revenues (to be discussed further in Section V). The spending of these tax revenues creates 11,791 jobs, labor income of \$596 million, and total income of \$793 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 2012, the total economic impact of mining is estimated to be 52,138 Arizona jobs, labor income of \$3.311 billion, and total income of \$4.804 billion. For perspective, the employment impact of the mining industry is 1.6 percent of total Arizona employment and the impact of the industry on labor income is 2.1 percent of total Arizona labor income.

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 of its residents. As shown in Figure 6, the average labor income of mining company employees is \$99,500 per worker. The average labor income across all employment directly and indirectly supported by the mining industry is \$63,500. Both figures are significantly higher than \$49,750, 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 B. The county-level results are shown in Table 2 and in Figures 7 and 8.

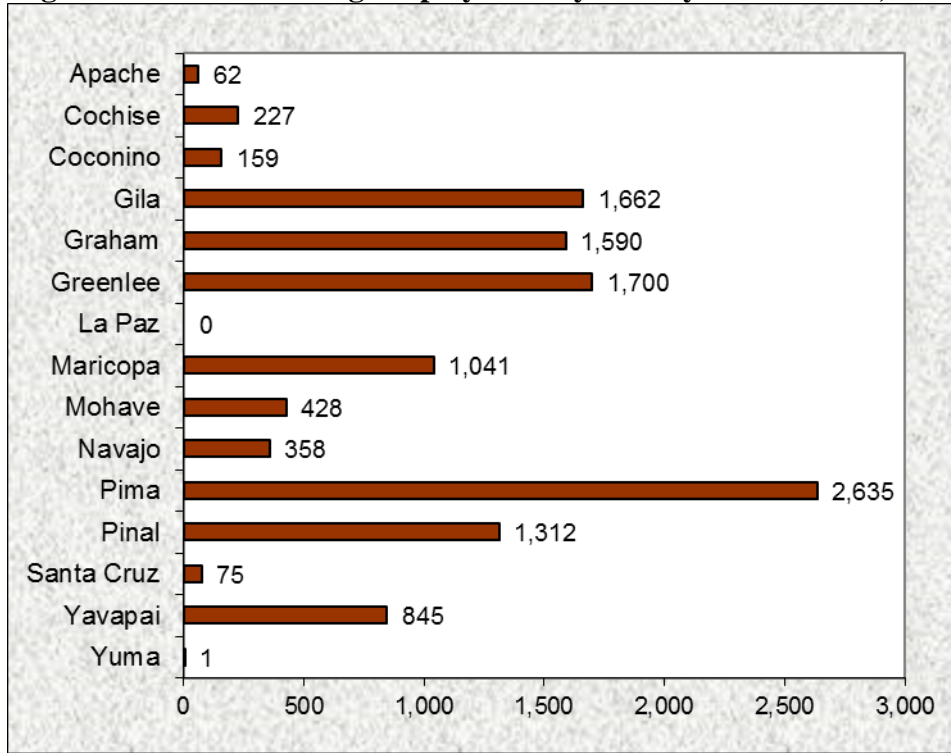
Table 2: Total Economic Impact of Mining by County, 2012

County	Total Income (in mill \$s)	Labor Income (in mill \$s)	Employment
Apache	27	21	410
Cochise	80	53	936
Coconino	89	63	1,065
Gila	279	215	3,414
Graham	215	183	2,595
Greenlee	219	185	2,533
La Paz	3	2	39
Maricopa	1,793	1,216	18,883
Mohave	106	72	1,235
Navajo	188	92	1,667
Pima	1,327	847	14,230
Pinal	266	214	2,797
Santa Cruz	6	4	83
Yavapai	182	124	1,891
Yuma	25	18	361
Total impact	4,804	3,311	52,138

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

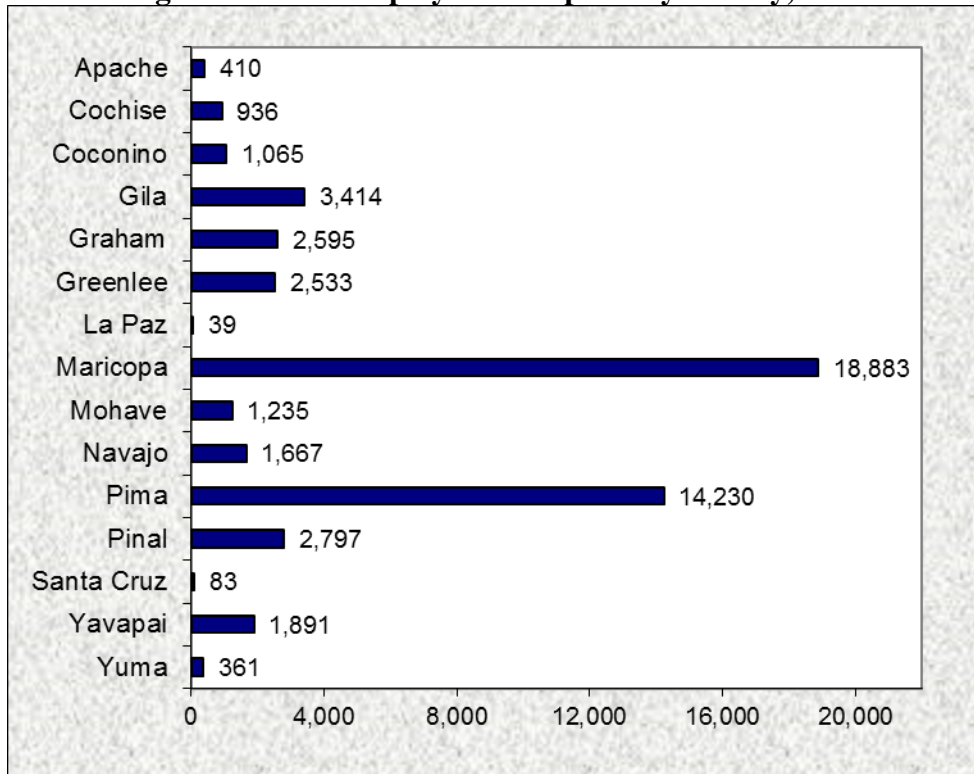
Mining activity is distributed widely throughout the state of Arizona. As indicated in Figure 7, each of five counties is home to at least 1,200 mining company employees (or 10 percent of total mining employment): Gila, Graham, Greenlee, Pima and Pinal. Two other counties—Maricopa and Yavapai—have at least 800 mining company employees as residents. No county accounts for as much as 25 percent of total Arizona mining employment.

Figure 7: Arizona Mining Employment by County of Residence, 2012



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

Figure 8: Total Employment Impacts by County, 2012



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 27 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 B.

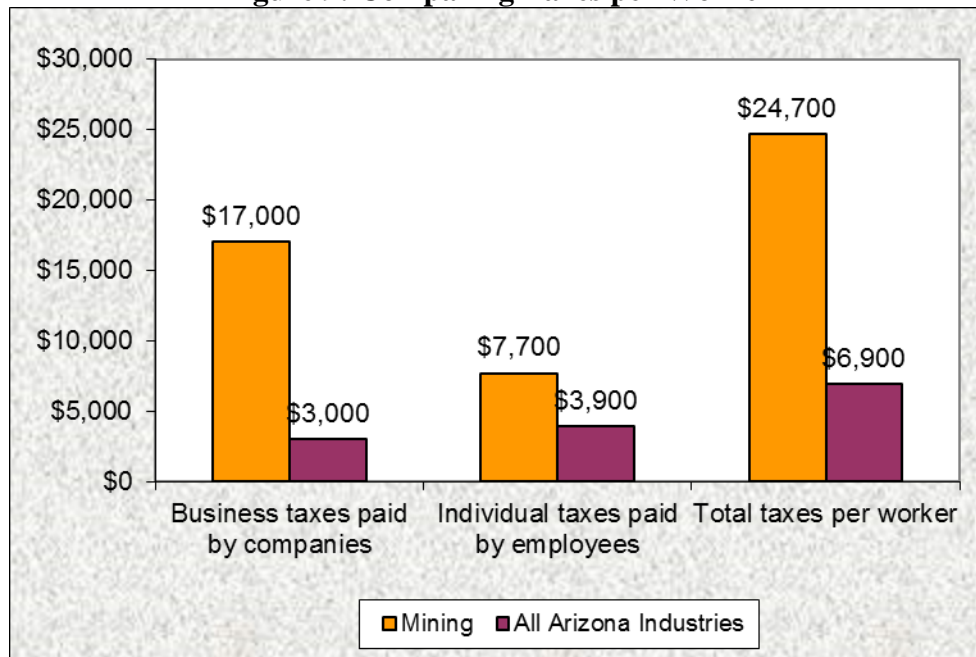
Table 3: Impact of Mining on Arizona State and Local Government Revenues, 2012
(in millions of dollars)

Business taxes paid by mining companies	206
Individual taxes paid by mining company employees	93
Taxes generated through the multiplier process	203
Total Arizona state and local taxes	502
Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University	

In 2012, 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 \$93 million in individual taxes. Finally, Arizona state and local governments are estimated to have collected \$203 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 \$17,000 per company employee. Total business taxes collected in the state amount to approximately \$3,000 per Arizona worker. On this basis, mining companies in Arizona pay more than 5½ 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 \$7,700 per worker. This compares with a statewide figure of \$3,900 per worker.

In total, the mining companies and their employees pay to Arizona state and local governments \$24,700 per worker. This is 3½ times as much as is paid by the average business and its workers.

VI. Change in Economic Impacts: 2011-2012

This section of the report provides a comparison of the mining impacts estimated for the operating year 2012 with those estimated for 2011. To compare apples to apples, the comparisons are restricted to mining companies that participated in both survey years. The comparison group consists of the major copper companies, Peabody Energy and Energy Fuels. To preserve the confidentiality of information disclosed in the surveys, the comparisons are presented as a difference in impacts between the years. The results are shown in Table 4.

Table 4: Change in Economic Impacts: 2011-2012

	Change 2011-2012
Direct impacts reported in surveys:	
Employment (number of workers)	981
Labor income (in mill \$s)	-2
Supplier purchases (in mill \$s)	344
Business taxes (in mill \$s)	-6
Total economic impacts:	
Employment (number of workers)	2,520
Labor income (in mill \$s)	87
Total income (in mill \$s)	188
Note: Comparisons restricted to companies that participated in both the 2011 and 2012 surveys.	
Source: L. William Seidman Research Institute, W.P. Carey School of Business, Arizona State University	

The upper half of the table focuses on the primary data reported by Arizona mining companies in the surveys. These data relate to the direct impacts mining companies have on the economy through their hiring of workers, purchases of goods and services from Arizona suppliers, and payments of taxes to state and local governments. Within the comparison group, mining employment was up 981 workers in 2012 from 2011, or about 8 percent when expressed as a percent of total mining employment in 2012. Total compensation paid to workers, on the other hand, was virtually unchanged. This implies that average compensation per worker was lower in 2012 than in 2011. The decline in average compensation may have been the result of a drop in the average number of hours worked per employee over the year.

Purchases by mining companies from Arizona suppliers were up sharply in 2012—by \$344 million, or about 11 percent when measured as a percent of total industry purchases in 2012. The expenditure categories registering the largest gains were wholesale purchases of mining equipment (up \$240 million), fuels and petroleum products (up \$183 million), and payments to construction and mining contractors (up \$110 million). Payments to service providers, on the other hand, were down \$109 million for the year.

Despite an overall rise in dollar payments to Arizona suppliers, the number of Arizona jobs directly supported by this spending was down slightly and the associated labor income was essentially unchanged. The reason for the disparity between the expenditure figures and the economic impacts is that the expenditure categories registering the largest gains (e.g., wholesale purchases of mining equipment and fuels and petroleum products) have small local economic

impacts per \$1 million of spending, while the category registering a drop in expenditures (services) has relatively large local economic impacts.

The lower half of the table shows the differences between the total economic impacts of the mining industry in the two operating years. These are total economic impacts which include multiplier effects as well as direct effects. Overall, the mining industry generated 2,520 more jobs in 2012 than in 2011, an increase of about 5 percent when expressed relative to the total employment impact of the industry in 2012. In addition to the rise in direct mining company employment, there was a larger multiplier effect associated with the consumer spending of workers directly supported by mining operations. The higher estimate for this effect is based on U.S. government surveys which indicate a moderate rise in consumer spending by U.S. households in 2012.

The total economic impact of the mining industry on Arizona labor income was \$87 million higher in 2012 than in 2011, an increase of 2½ percent. The impact of the industry on total Arizona income was \$188 million higher in 2012, an increase of about 4 percent. Neither of these figures has been adjusted for inflation.

Sources

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Appendix A: 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 A1. 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 A1 are based on employment data for 2010. However, 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 A 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)
Employment services	103,342	3.25	2.14	1.52	35,487
Nondepository credit intermediation	74,711	2.35	1.66	1.42	22,128
Semiconductors and related devices	18,304	0.58	0.10	5.50	14,976
Business support services	34,828	1.10	0.63	1.74	14,775
Diagnostic labs and outpatient care	37,411	1.18	0.76	1.55	13,215
Guided missile and space vehicle manufacturing	11,132	0.35	0.03	11.23	10,140
Copper mining	10,400	0.33	0.01	37.57	10,123
Construction of new residential structures	25,672	0.81	0.50	1.62	9,839
Search, detection and navigation instruments	8,245	0.26	0.08	3.08	5,566
Air transportation	13,867	0.44	0.26	1.65	5,470
All industries	3,175,459	100.00	100.00		

Source: Center for Business Research, L. William Seidman Research Institute, College of Business, Arizona State University, using IMPLAN 2010 data files.

Notes: Industries listed in the table are those with a location quotient of at least 1.40 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 38, by far the largest location quotient in the table, and it provides an export base of approximately 10,100 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, aerospace industries such as guided missile manufacturing and the manufacture of search and navigation instruments, and air transportation.

The figures reported in Table A1 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 B: Economic Impact Methodology

The economic impact estimates presented in this report are based primarily on two sources of information: (1) surveys of mining companies operating in Arizona and (2) the IMPLAN input-output model and software. Surveys 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 2012. IMPLAN was used to estimate the economic interdependencies or so-called multiplier effects generated by the operating expenditures of mining companies.

Company surveys

Completed surveys were received from 13 companies with mining or exploration operations in Arizona (see Table B1). The list includes all of the major copper-producing companies and Peabody Energy which operates a large coal mine in Navajo County.

Table B 1: Arizona Mining Companies Surveyed for Operations in 2012

Alliance Mining
ASARCO
BHP Billiton
Carlota Copper
Energy Fuels
Florence Copper
Freeport-McMoRan Copper & Gold
Golden Vertex
Mercator Minerals
MinQuest
Peabody Energy
Resolution Copper
Rosemont Copper

The survey generated information on employment headcounts as of Dec. 31, 2012 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 2012.

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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 2010 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 2012 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 FY2010, total state and local taxes in Arizona represented 7.8 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 7.8 percent. With this figure in mind, taxes connected with the income earned and spent by mining employees were estimated by taking 7.8 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 7.8 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.