

An Overview of the Coal Economy in Appalachia

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Executive Summary

This report details major trends in coal production in the Appalachian Region over roughly the past decade. Highlights of this research are as follows:

COAL PRODUCTION

- **OVERALL COAL PRODUCTION DECLINE:** Coal production fell by nearly 45 percent overall in Appalachia between 2005 and 2015. This is more than double the rate of national decline in coal production of around 21 percent.
- **DRIVERS OF NATIONAL DROP IN COAL DEMAND:** Losses in coal production stem from a perfect storm of three major national factors that have depressed demand for coal: Significant reductions in the cost of natural gas—a competitor fuel to coal in the electric power industry—due to greatly enhanced productive capacity; a regulatory environment that has increased the cost of burning coal for electric power generators; and weak international demand in recent years.
- **CONCENTRATION OF COAL PRODUCTION LOSSES:** Losses in coal production are heavily concentrated in Central Appalachia, primarily in southern West Virginia and eastern Kentucky. This concentration of losses can be traced to low coal mine worker productivity in this region. After aggressive mining in Central Appalachia for more than a century, the remaining coal is more expensive to extract, compared to other coal-producing regions, because it tends to be deeper in the ground and/or seams tend to be thinner.
- **COAL PRODUCTION FORECAST:** Our forecast predicts a stabilization of coal output in Appalachia. This results largely from the expectation of higher natural gas prices in coming years as infrastructure enhancements broaden markets for natural gas, as well as from an expectation that there will be no major regulatory changes that increase the cost of burning coal in coming years. While production in the Northern and Southern Appalachia will largely remain stable, we expect a modest recovery in Central Appalachia due to improvements in global demand for metallurgical coal. Overall, however, expected improvements will capture only a small fraction of the decline that has been observed over the past decade.

EMPLOYMENT and UNEMPLOYMENT

- **COAL INDUSTRY EMPLOYMENT and EMPLOYMENT DIVERSIFICATION:** Coal industry employment fell by around 27 percent between 2005 and 2015. These losses were heavily concentrated in Central Appalachia. Further, the counties with the highest dependence on the coal industry tended to be rural counties in Central Appalachia. Overall, many of the counties that had the greatest dependence on the coal industry suffered the greatest losses in coal production and employment.
- **TOTAL PRIVATE SECTOR EMPLOYMENT:** Total private-sector employment in Appalachian coal-mining counties has been generally flat over the past few years. Further, total private-sector employment in the mining counties in Central Appalachia has fallen substantially in recent years. These facts provide evidence that the decline in coal, coupled with heavy reliance on coal in some counties, has led to broader negative spillover effects to regional economies.
- **UNEMPLOYMENT:** Coal mining counties in Central Appalachia have consistently posted relatively high unemployment rates in recent years.
- **COUNTY SNAPSHOT—CENTRAL AND NORTHERN APPALACHIA:** We provide a close examination of two specific heavy coal-producing counties—Marshall County, West Virginia, in Northern

Appalachia, and Boone County, West Virginia, in Central Appalachia. Here we see that these counties have exhibited vastly different outcomes in recent years in terms of the coal industry and in terms of broader economic outcomes. Our analysis highlights how economic conditions can vary widely across counties.

POPULATION, LABOR FORCE, and POPULATION AGE DISTRIBUTION

- **POPULATION AND LABOR FORCE:** Total population has fallen by a small margin in the coal mining counties of Central Appalachia in recent years, perhaps partly as a result of the decline in the coal industry. Although the overall population loss has been relatively modest, the drop has been especially pronounced in the prime working-age population in the mining counties of Appalachia. The labor force has declined substantially in the coal mining counties of Central Appalachia.
- **POPULATION AGE DISTRIBUTION:** Partially as a result of the loss in prime working-age residents, coal-mining counties in Appalachia have experienced noticeable increases in the share of individuals who are of retirement age.

INCOME and POVERTY

- **WAGES AND SALARY INCOME:** Wages and salary income per job tends to be higher in the mining counties of Appalachia, compared to non-mining Appalachian counties. This is likely the result, in part, of high wages in the coal industry. Wage and salary incomes tend to be lower in the coal-mining counties of Central Appalachia, compared to Appalachia's other coal-producing regions.
- **POVERTY:** While poverty has been higher in the mining counties of Appalachia compared to the non-mining counties for many years, poverty has risen substantially in both groups of counties in recent years. In the long-term, poverty has been substantially higher in the coal-mining counties of Central Appalachia compared to the other coal-producing regions of Appalachia.

EDUCATION and HEALTH

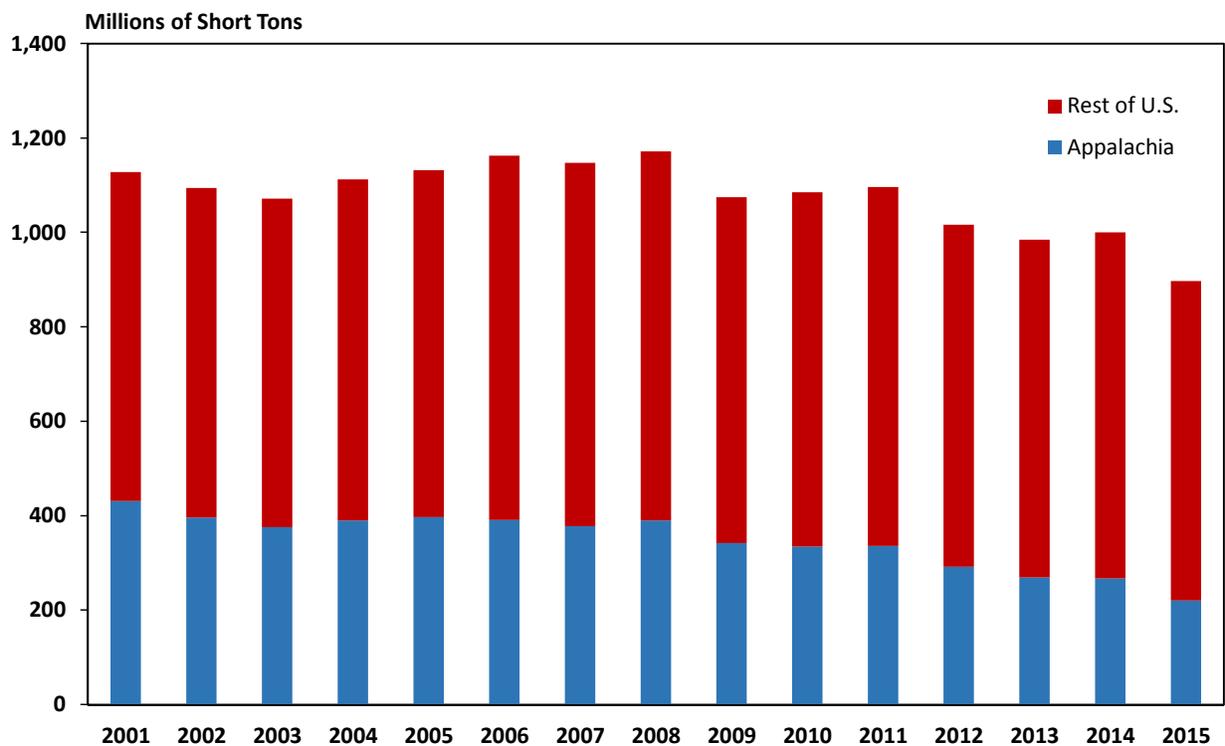
- **EDUCATION:** Although weak education outcomes represent a significant economic development challenge in Appalachia in general, the data do not reveal that the attainment of a bachelor's degree differs noticeably between the mining and non-mining counties of Appalachia. Rates of college attainment are by far the lowest in the mining counties of Central Appalachia, compared to the mining counties in the other Appalachian coal-producing regions.
- **HEALTH:** Poor health outcomes represent another significant economic development challenge in Appalachia. The data reveal that overall mortality rates are significantly higher in the mining counties of Appalachia compared to other counties in the U.S. Further, mortality in the mining counties of Central Appalachia, which has increased noticeably in recent years, is highest compared to the mining counties in the other Appalachian coal-producing regions.

Chapter I: Coal Production in Appalachia

Recent Trends in Coal Production

The coal industry in the United States and in Appalachia has undergone a severe downturn over the last decade as demand for coal has fallen across the United States. Total coal production in the United States fell from about 1.1 billion short tons in 2005 to approximately 897 million short tons in 2015, a drop of almost 21 percent (see Figure 1). The large majority of this decline came in Appalachia, where coal production dropped by 176 million tons, a drop of almost 45 percent.

Figure 1: Coal Production in Appalachia and the Rest of United States

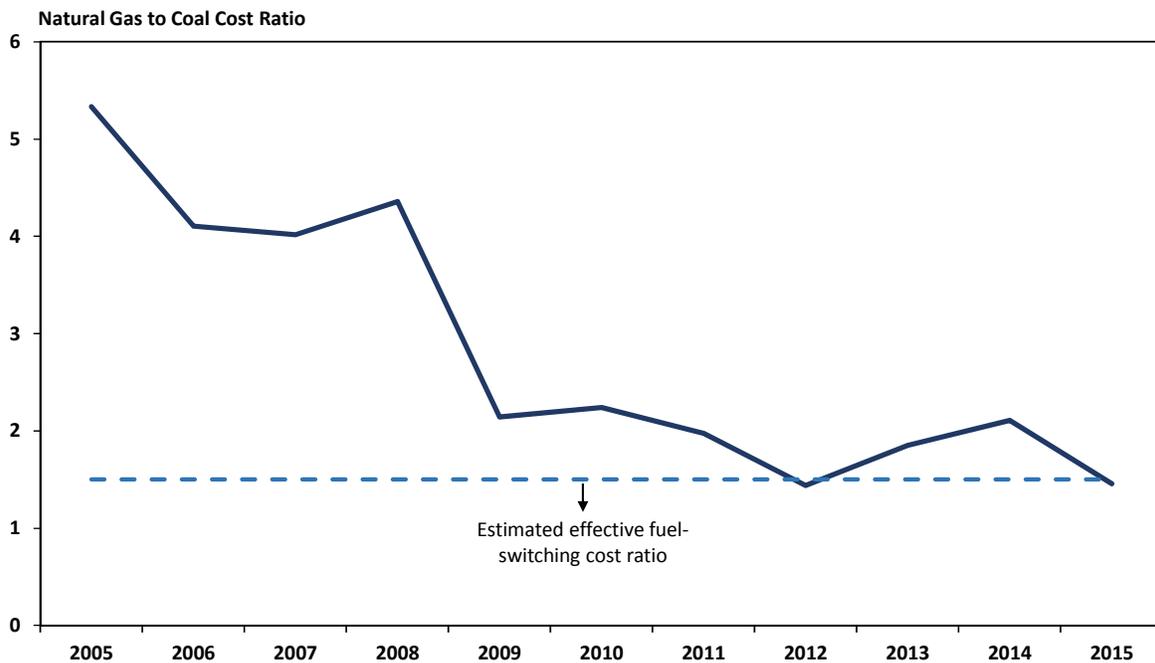


Source: U.S. Energy Information Administration

NATURAL GAS PRICES: A major contributing factor to the fall in coal demand has been the decline of natural gas prices in the electric power sector, which constitutes the largest source of domestic demand for coal. The price of natural gas—a competitor fuel to coal for electric power generation—has fallen significantly in recent years due to a surge in the nation’s productive capacity of natural gas. The widespread use of horizontal drilling and hydraulic fracturing techniques in shale formations, such as the Marcellus and Utica, has led to a dramatic increase in natural gas production—to the point that the U.S. is now a net exporter of natural gas.

As a result of these natural gas production increases, the ratio of natural gas prices to coal prices for electricity generation has fallen significantly since 2005, as shown in Figure 2. In 2005, natural gas cost more than five times as much as coal, but that ratio fell below 1.5 in 2015, a level where natural gas competes effectively with coal (Lego and Deskins, 2016).

Figure 2: Ratio of the Cost of Fuel for Electricity Generation between Natural Gas and Coal, United States

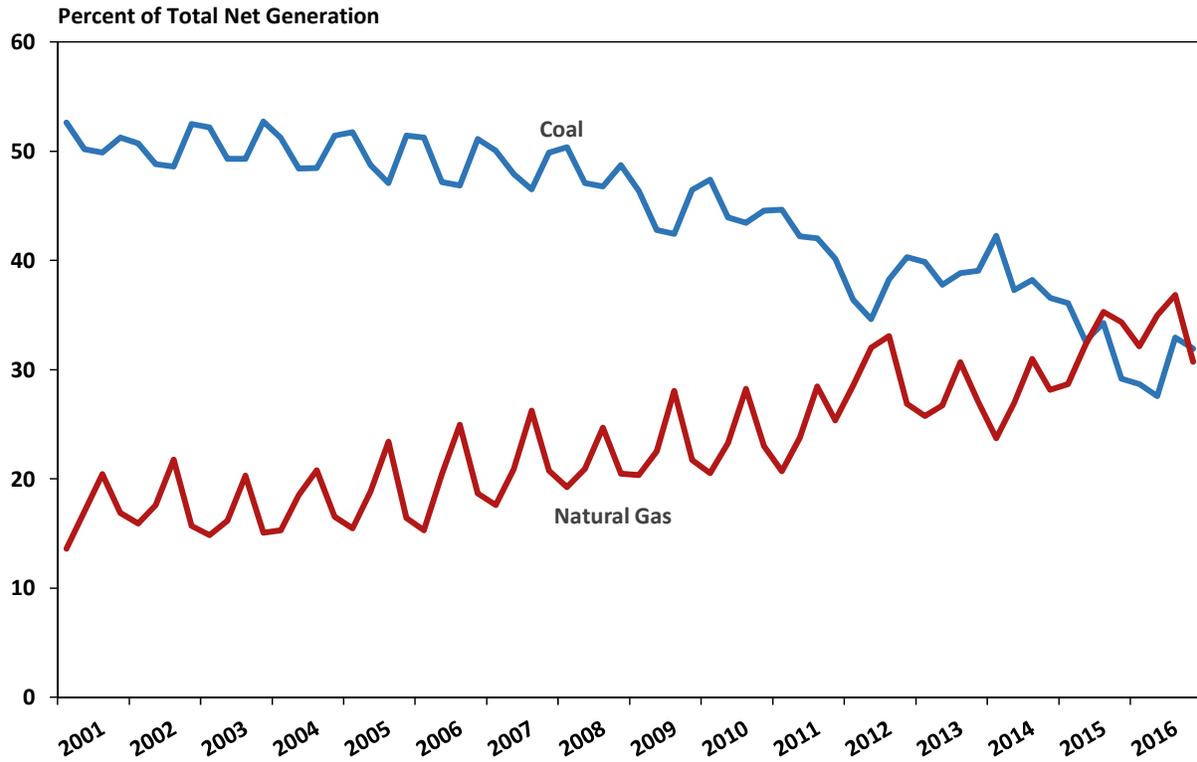


Source: U.S. Energy Information Administration

ENVIRONMENTAL REGULATIONS: While natural gas prices provide the most important factor in declining coal demand in the electric power sector, the federal environmental regulatory climate has also increased the cost of burning coal through a series of regulations. In particular, the Mercury and Air Toxics Standards (MATS) Rule, which was implemented in April 2015, rendered some older, high-emission plants unprofitable to operate. Estimates by Beasley et al. (2013) indicate that the MATS rules were expected to contribute to the retirement of about four gigawatts (GW) of coal-fired electric generating capacity, constituting about 22 percent of the 17 GW of retirements forecast by the authors at the time. Coal retirements between 2013 and 2015 totaled nearly 28 GW, the majority of which—16.5 GW—came in 2015 when the MATS rules required compliance. Preliminary data show that another 8 GW of coal-fired capacity was retired in 2016.

From the perspective of electric power generators, these two dynamics have increased the relative cost of burning coal while decreasing the relative cost of burning natural gas. As a result, the share of national electric power generation derived from coal has fallen significantly while the share derived from natural gas has increased correspondingly, as illustrated in Figure 3.

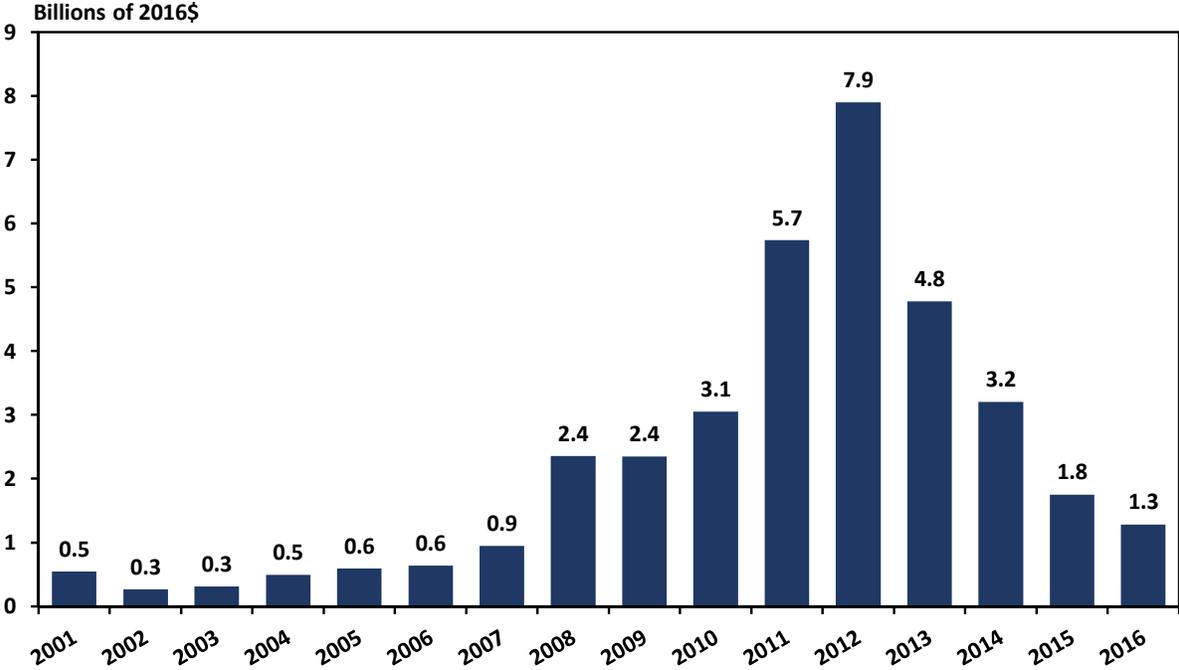
Figure 3: Share of U.S. Electricity Generation from Coal and Natural Gas



Source: U.S. Energy Information Administration

EXPORTS: In addition to the issues associated with natural gas and the environmental regulatory climate, international demand for U.S. coal exports weakened from around 2012 through at least mid-2016.¹ Coal exports from West Virginia, for instance, fell from approximately \$7.9 billion in 2012 to \$1.3 billion in 2016, as shown in Figure 4. The period between 2011 and 2013 appear to be anomalous years for global coal markets from both a supply and demand perspective that pushed exports from West Virginia to highly atypical levels. For example, a major flood event for the Australian state of Queensland during 2010-2011 shut in a large share of the nation’s thermal and coking coal production for many months. Demand from the Asia-Pacific region that would have traditionally been met by Australia—along with a few other major producing countries in Asia—was temporarily replaced in part by output from Central Appalachian mines (which includes Southern West Virginia).

Figure 4: West Virginia Coal Exports

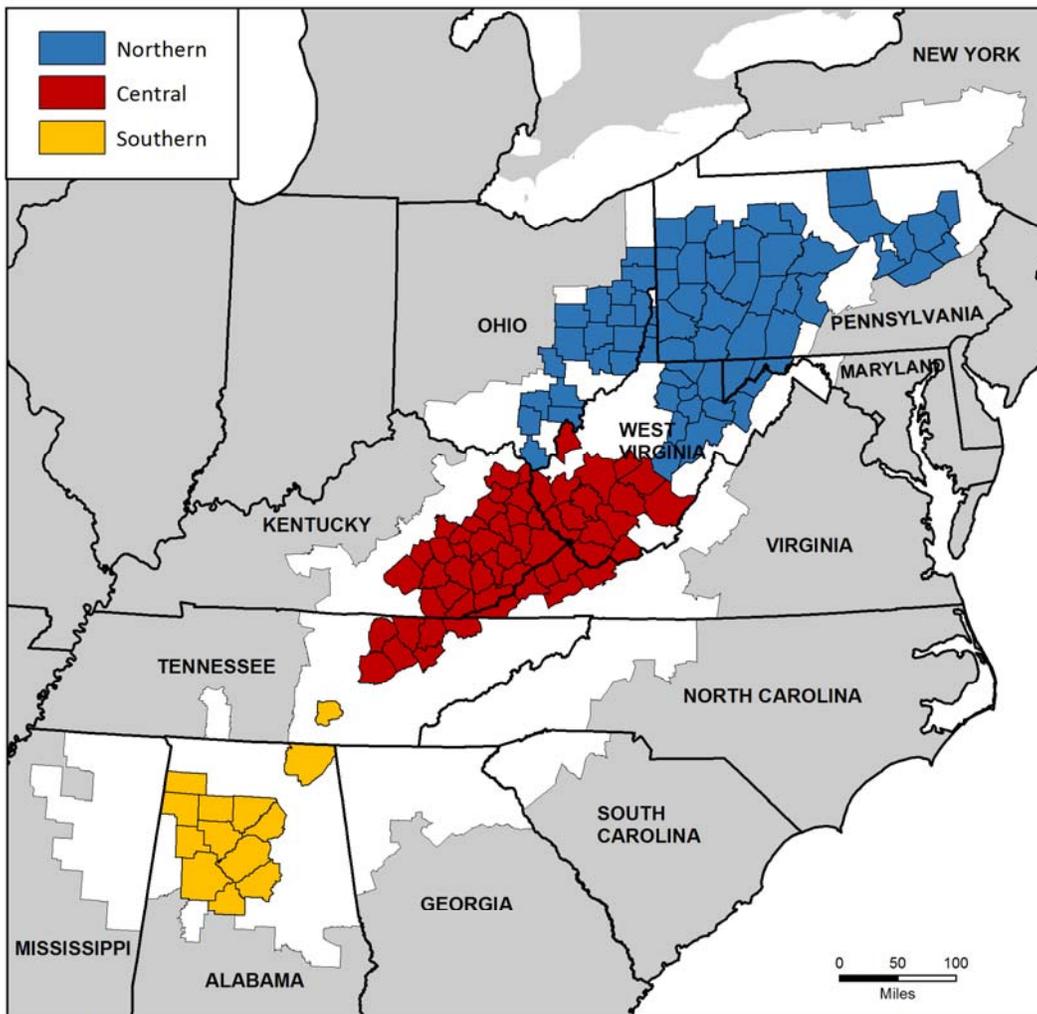


Source: U.S. Department of Commerce TradeStats

¹ For a more thorough discussion of these issues, see Lego and Deskins (2016).

PRODUCTION BY REGION: Upon examining coal production losses more closely across the three major coal-producing regions in Appalachia, Central Appalachia has endured the largest drop-off in output over the past decade by a large margin. As illustrated in Figures 5 and 6, Central Appalachia saw coal output plunge by more than 61 percent between 2005 and 2015, compared with a 38-percent decline for Southern Appalachia and a decline of 16 percent in Northern Appalachia. Indeed, mines in Northern Appalachia went from producing roughly 60 percent of the total tonnage coming from Central Appalachia to producing 30 percent more coal than that coming from Central Appalachia over the course of only a decade.

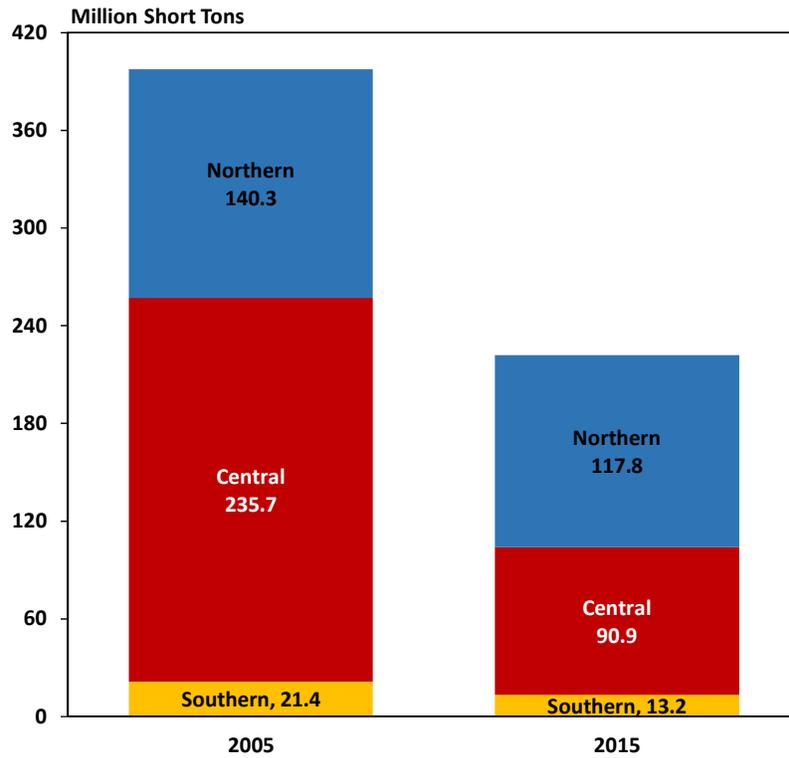
Figure 5: Appalachian Coal-Producing Regions



Source: U.S. Energy Information Administration

Notes: The figure includes only counties that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015. Two Mississippi coal-mining counties are by EIA definition not part of the Appalachian coal-producing regions and as a result are excluded from the analysis.

Figure 6: Coal Production, Appalachian Coal-Producing Regions

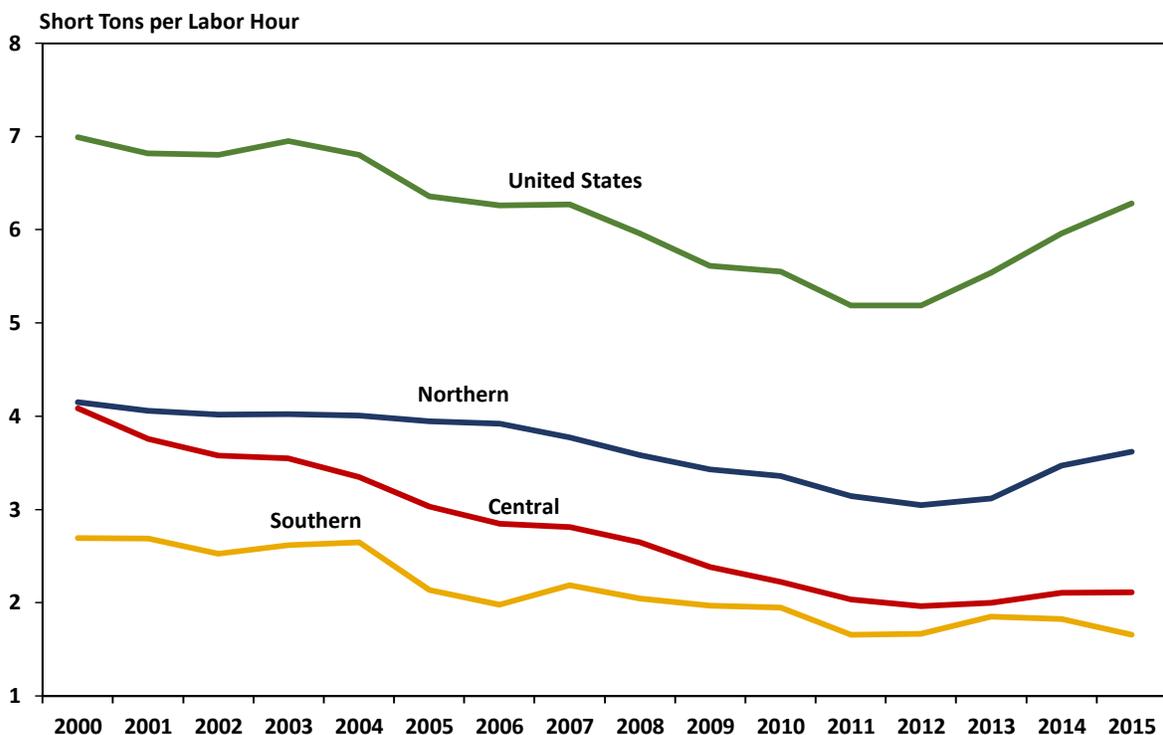


Source: U.S. Mine Safety and Health Administration

Note: Appalachian coal-producing regions include only coal-mining counties in Appalachia, which include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

COAL MINE WORKER PRODUCTIVITY: A key driver of the relative decline in coal production across the Appalachian coal-producing regions is worker productivity. As illustrated in Figure 7, coal mine worker productivity fell by about half in Central Appalachia from the early 2000s until 2012, and it has stabilized at around 2 short tons per labor hour. Since the coal in this region has been mined aggressively for more than a century, remaining reserves tend to be deeper underground and/or within thinner seams that require more units of labor to extract. This raises production costs on Central Appalachia’s lower-value thermal coal reserves when compared to Northern Appalachia and other regions in the United States, as well as its large metallurgical reserves when compared to nations such as Australia, Indonesia and South Africa. Thus, the impacts from declining domestic and global coal demand will manifest most noticeably in areas with higher-cost production—like Central Appalachia.

Figure 7: Coal Mine Worker Productivity, U.S. and Appalachian Coal-Producing Regions

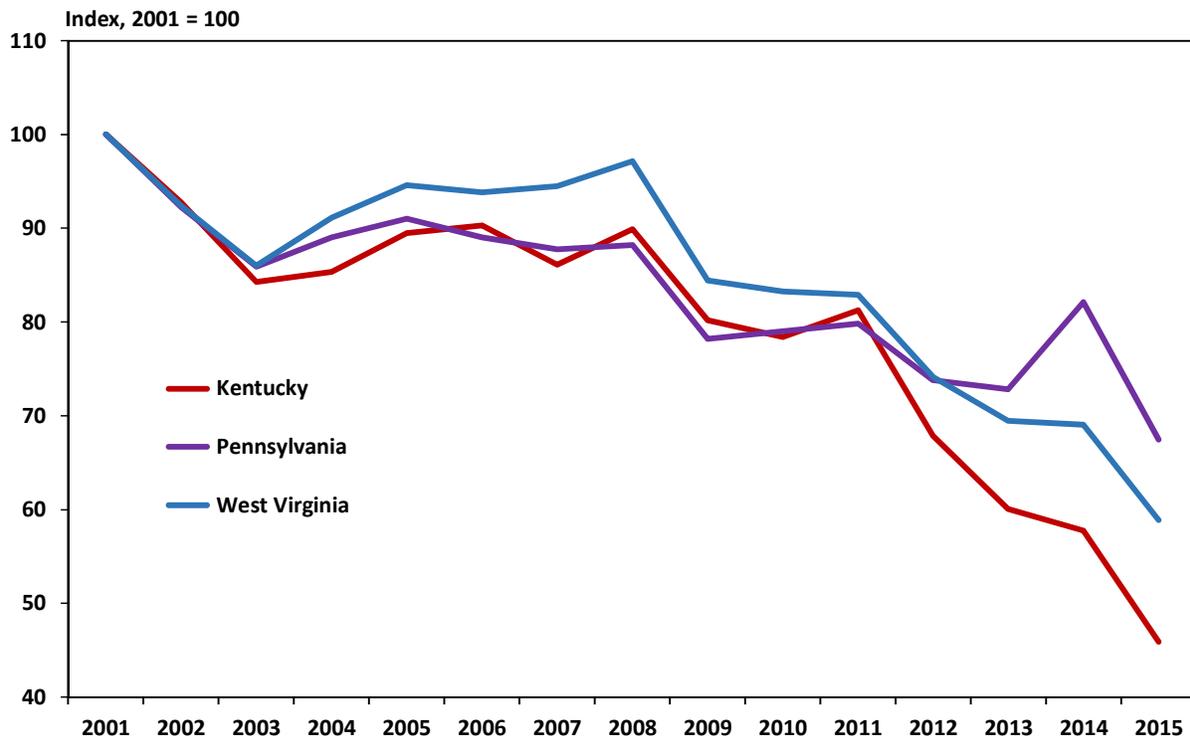


Source: U.S. Mine Safety and Health Administration
 Note: Appalachian regions include only Appalachian coal-mining counties.

PRODUCTION BY STATE: In Figure 8, we examine the progression over time of coal mine output for the Region’s top coal-producing states of West Virginia, Kentucky and Pennsylvania. As mentioned above, the decline in mined coal tonnage over the past decade or so has been felt in every major U.S. coal-producing region except for Illinois, but the impact has been felt much more within Appalachia’s major coal-producing states. Furthermore, reflecting the differences in productivity and extraction costs discussed earlier, the rate of decline in coal output observed for each state has varied dramatically. For example, coal production in Pennsylvania during 2015 is approximately one-fourth lower than its

2005 levels, while coal output for West Virginia and Kentucky has slumped by 38 and 49 percent, respectively, compared to a decade earlier. However, differences within these two states during this time period have been especially large. Southern West Virginia and Eastern Kentucky, both of which fall within the higher-cost Central Appalachian coal-producing regions, have experienced significantly larger drops in coal production, with output plunging at respective rates of 57 and 70 percent since 2005. By comparison, northern West Virginia, which lies in Northern Appalachia, actually registered an increase in coal production between 2005 and 2015 due to the opening or expansion of several highly productive mining operations.

Figure 8: Coal Production, Select Appalachian States

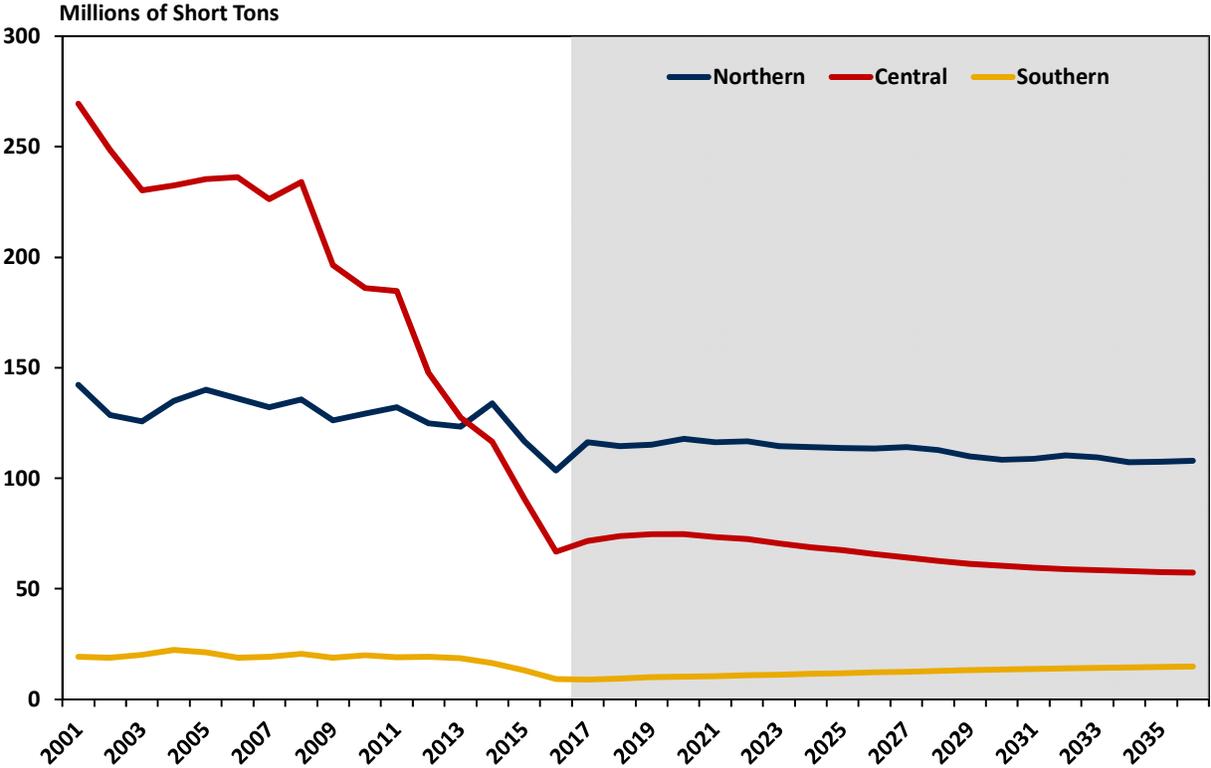


Sources: U.S. Energy Information Administration

Coal Production Forecast

REGIONAL COAL PRODUCTION OUTLOOK: In this section, we turn to the 20-year outlook for coal production in Appalachia. We anticipate a moderate increase in the Region’s overall level of coal output, but the mix of coal mined in each area will help to drive some of the underlying differences in performance. Central Appalachia is expected to enjoy some increase in metallurgical coal production as the global steel market continues to re-align itself following China’s protracted economic slowdown, as well as an upturn in domestic demand driven by investment in pipeline infrastructure for the oil and gas industries. However, the overall long-term trajectory for Central Appalachian coal in general remains down because of its higher costs compared to other coal-producing regions in the U.S. and abroad, plus the fact that natural gas and other fuels continue to account for a growing share of baseload electricity generation domestically and internationally. Northern Appalachian coal production will generally remain steady as lower production costs for several of the region’s large-scale operators enable the basin’s coal to remain competitive, while Southern Appalachian production will tend to rise modestly over the long-term thanks to rising global demand for metallurgical coal.

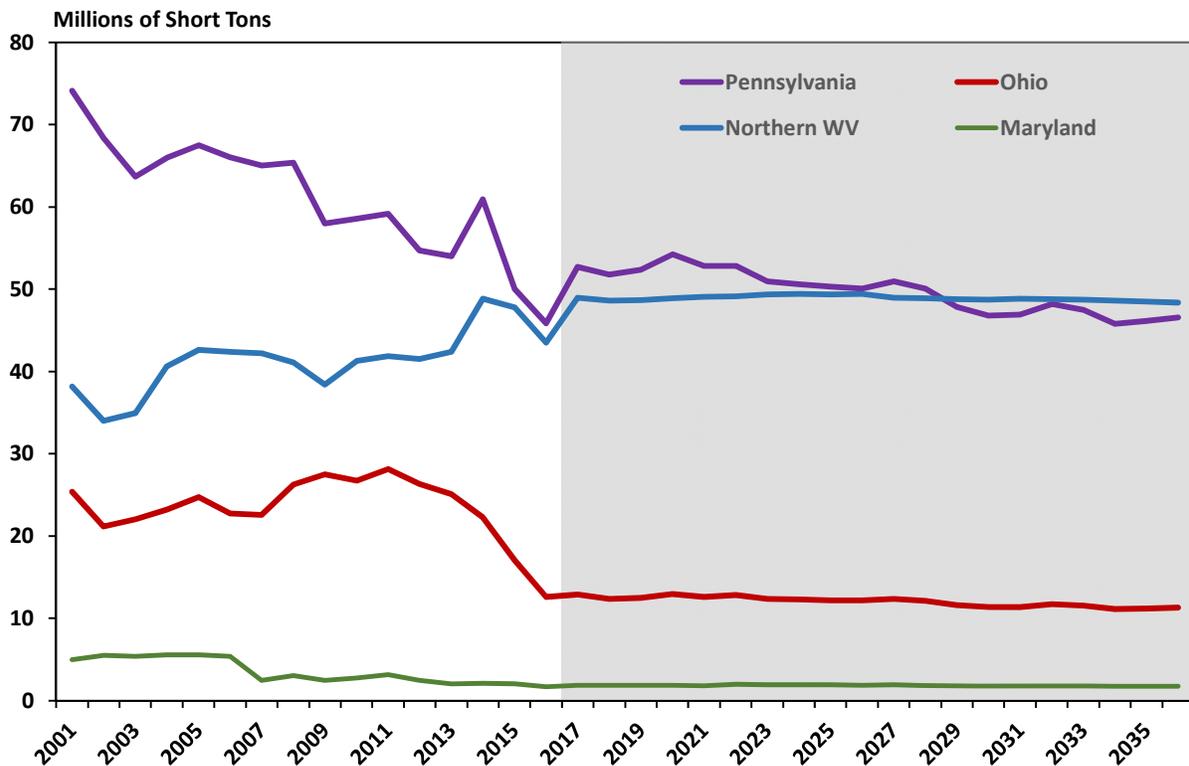
Figure 9: Coal Production Forecast, Individual Appalachian Coal-Producing Regions



Sources: U.S. Energy Information Administration; WVU Bureau of Business & Economic Research
 Note: Shaded area indicates forecast.

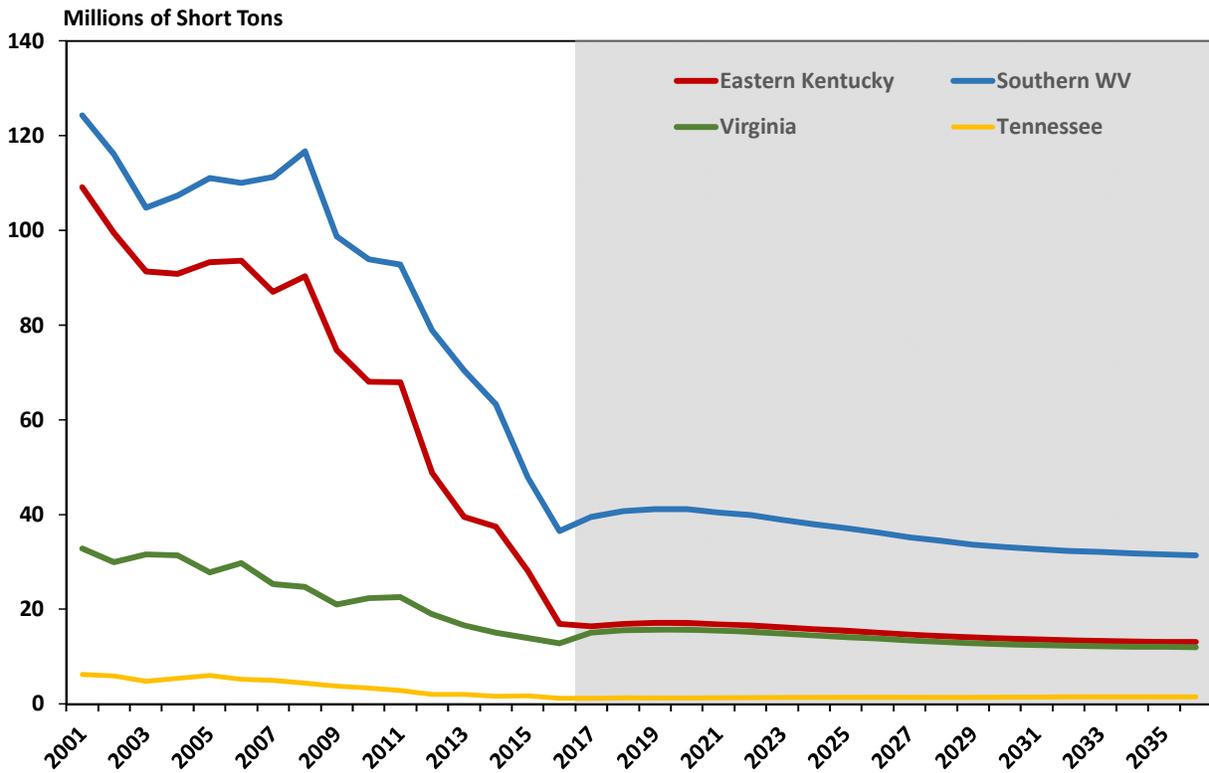
STATE OUTLOOKS: In Figures 10, 11, and 12, we provide a forecast of coal production for each of the states (or portions of states) that lie within the Appalachian Region. In Northern Appalachia, Pennsylvania and Ohio will see a continued downward trend in coal output as their electricity generation portfolios shift further away from coal (to a lesser extent in Ohio). Northern West Virginia is eventually expected to become the basin’s largest coal producer by tonnage. In Figure 11, we see a moderate near-term increase in coal produced in southern West Virginia, mostly in response to improved conditions in the metallurgical coal market but also thanks to better relative price comparisons for thermal coal as natural gas prices drift higher. Eastern Kentucky is expected to enjoy little, if any, appreciable gains in production, as the area contains much less in the way of the higher-value metallurgical coal reserves than what is found in southern West Virginia. Both areas will see production trend lower over the next 20 years as dwindling reserves make more of their coal increasingly non-competitive on price under most market conditions. For Southern Appalachia, metallurgical coal output from Alabama’s mines should begin to stabilize and slowly rise over the next few years as the global steel market continues to reset itself and the dollar loses some strength. Longer term, global economic growth will continue to push steel demand higher, but capacity constraints at regional ports and production cost disadvantages compared to global coal powers such as Australia will limit growth in coal production in Appalachia.

Figure 10: Coal Production Forecast by State, Northern Appalachia



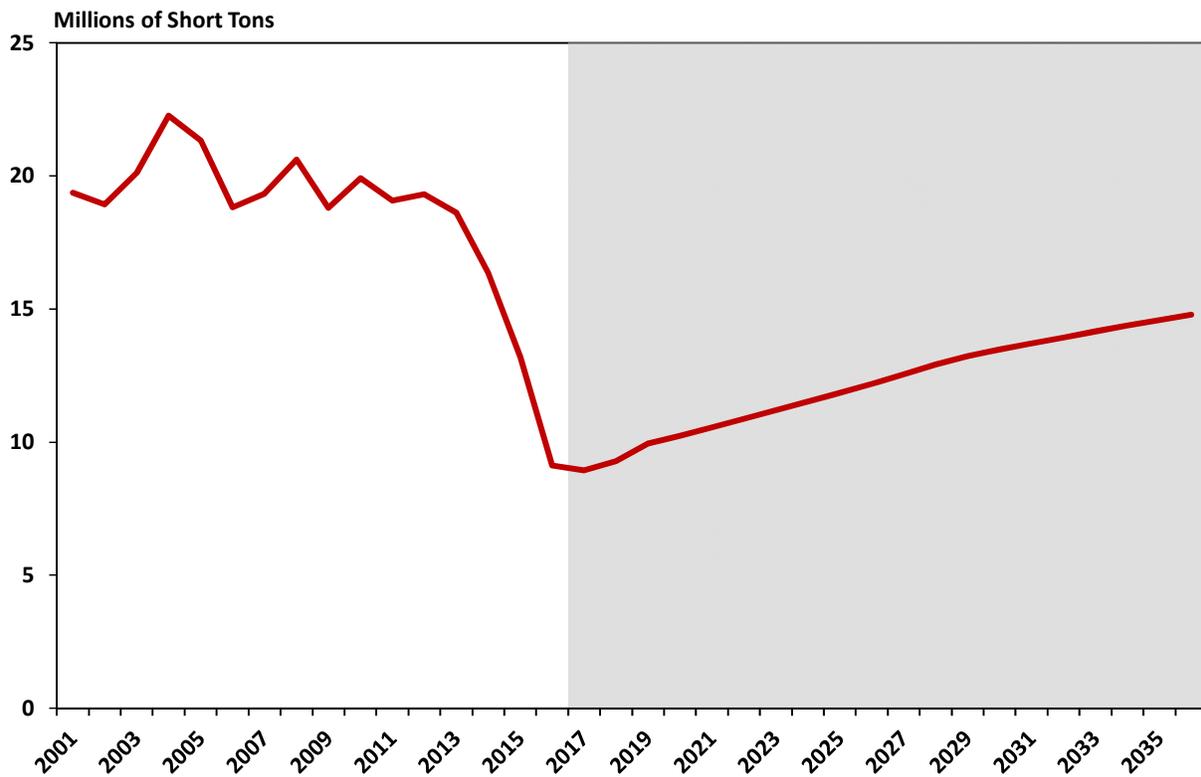
Sources: U.S. Energy Information Administration; WVU Bureau of Business & Economic Research
 Note: Shaded area indicates forecast.

Figure 11: Coal Production Forecast by State, Central Appalachia



Sources: U.S. Energy Information Administration; WVU Bureau of Business & Economic Research
 Note: Shaded area indicates forecast.

Figure 12: Coal Production Forecast, Southern Appalachia*



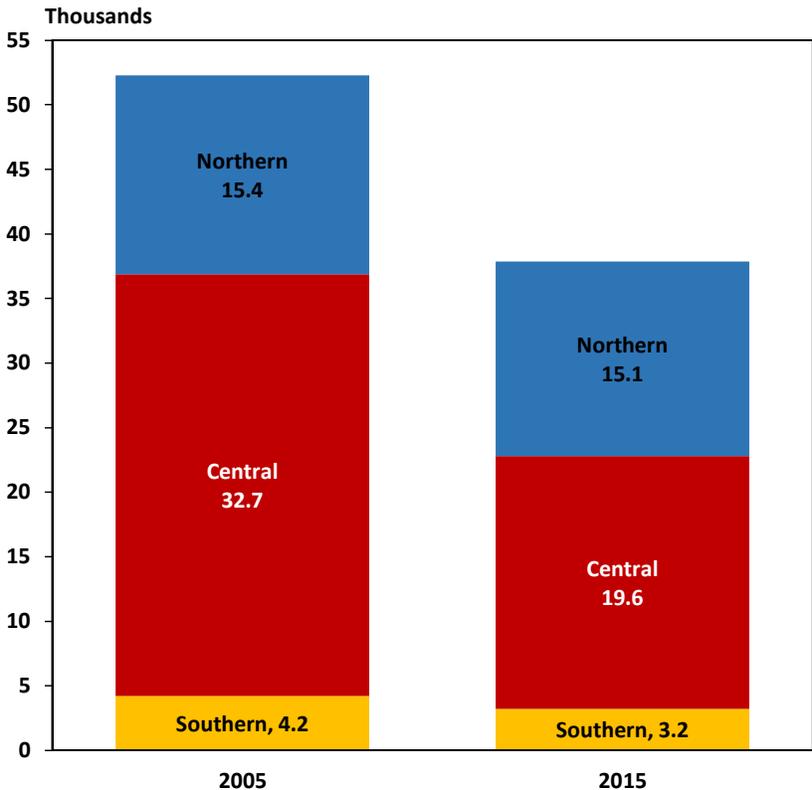
Sources: U.S. Energy Information Administration; WVU Bureau of Business & Economic Research
Note: Shaded area indicates forecast. *Southern Appalachian Coal Basin consists predominantly of Alabama

Chapter 2: Economic Performance in Appalachia’s Coal-Producing Region

Employment and Unemployment in Appalachia

Figure 13 compares coal employment levels within each of the three Appalachian coal-producing regions during 2005 and 2015. Here we see that overall employment in the industry has declined by around 27 percent over the period, considerably less than the 44 percent drop in production described above. Central Appalachia accounts for the measured disparity in coal production and employment declines observed over the past 10 years. Many mines in Central Appalachia had to hire workers in order to extract dwindling reserves while global coal demand was still strong between 2008 and 2012, which caused mine employment to increase while output was, at its best, stable. Nonetheless, in a pattern similar to the production context, the drop in coal employment has been much more heavily concentrated in Central Appalachia. Payroll levels have fallen by around 40 percent, compared to largely similar coal workforce levels in both the Northern and Southern Appalachia regions.

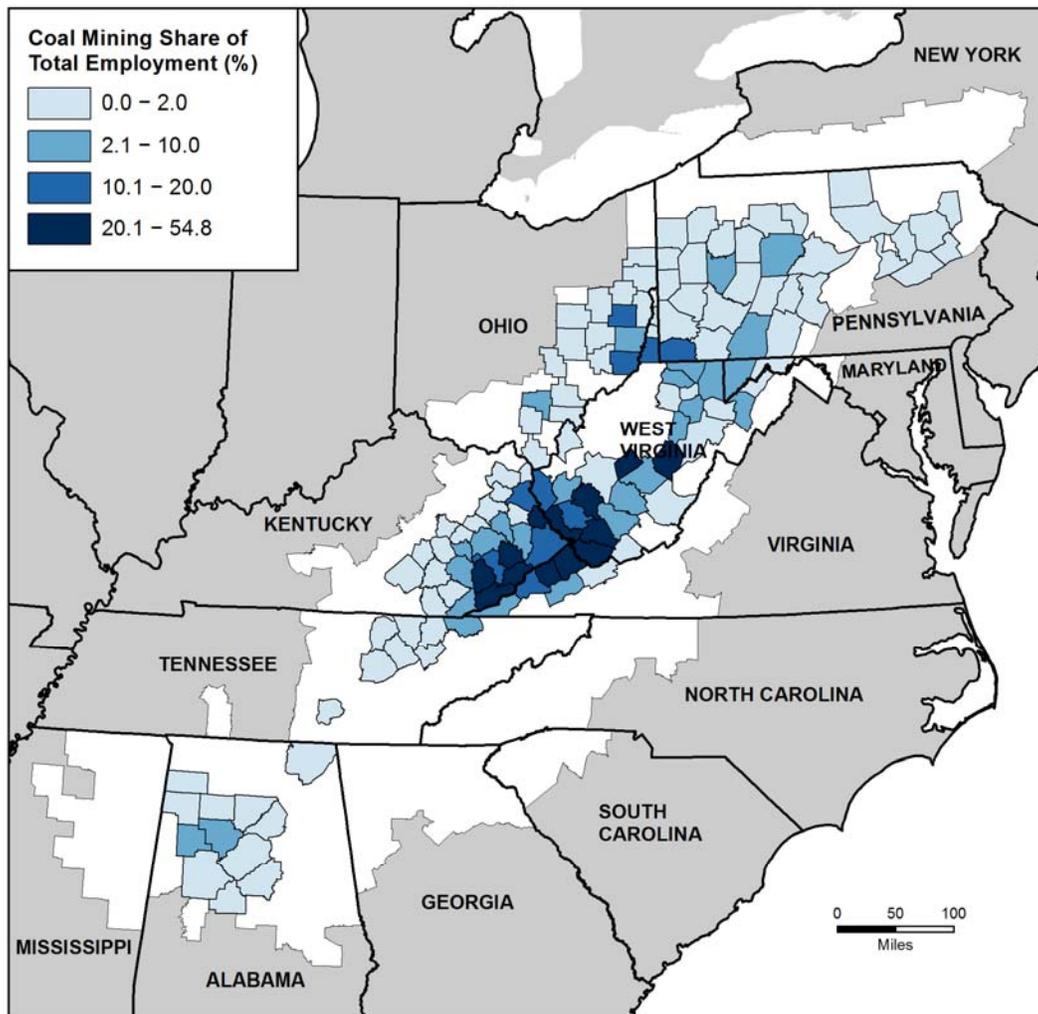
Figure 13: Coal Mining Employment, Appalachian Coal-producing Regions



Source: U.S. Mine Safety and Health Administration
Note: Appalachian regions include only Appalachian coal-mining counties.

EMPLOYMENT DIVERSIFICATION BY COUNTY: In Figure 14 we illustrate coal mining employment as a share of total employment for each coal-producing county in Appalachia in 2005. Here we see extremely wide variation across counties. The large majority—86 of the 137 coal-producing counties—saw less than 2 percent of their total employment in coal. Twenty-eight of the counties saw an employment share between 2 and 10 percent. However, 11 counties had a coal-mining employment share of between 10 and 20 percent while 13 counties have more than 20 percent of their employment in coal. The higher concentration tends to cluster in the rural counties in Central Appalachia—in particular eastern Kentucky and southern West Virginia—and all of the counties with an employment share of more than 20 percent are in Central Appalachia. Overall, one general conclusion from this overview is that the largest loss in coal production has tended to occur in the areas with the highest dependence on coal-mining jobs, pointing to high levels of economic stress as the economy adjusts to lower levels of coal production.

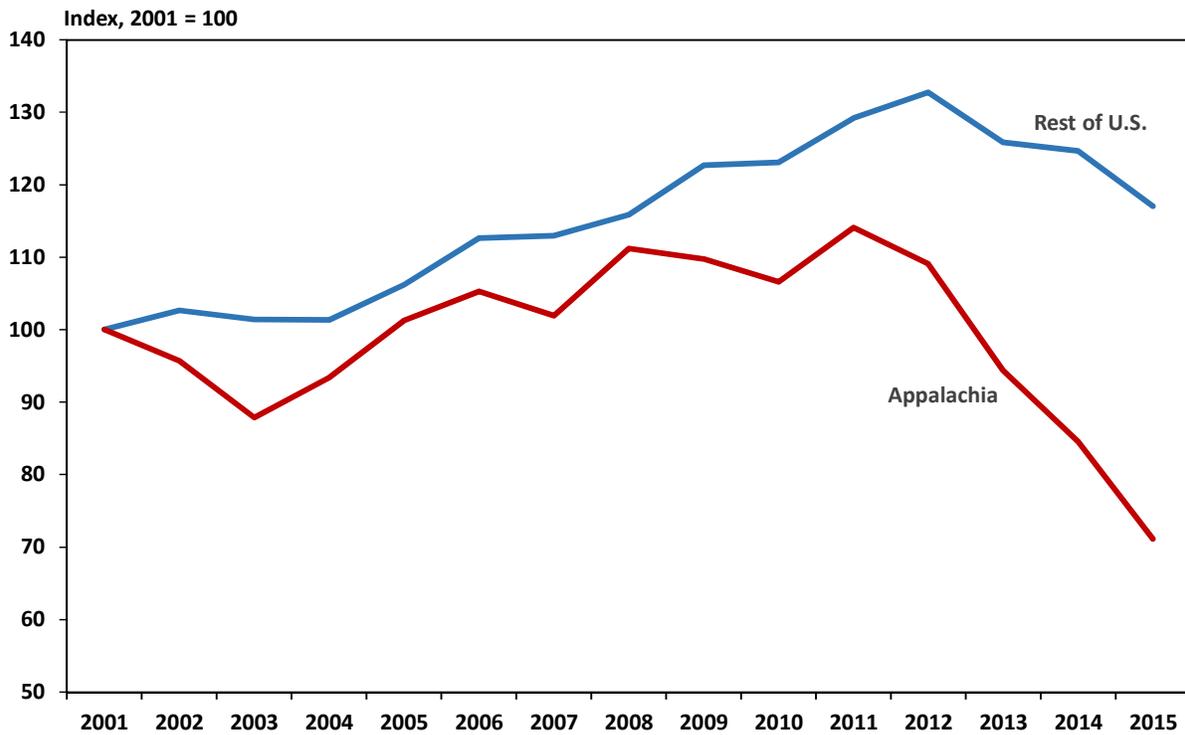
Figure 14: Coal Mining Share of Total Employment, 2005



Sources: U.S. Mine Safety and Health Administration and U.S. Bureau of Labor Statistics
 Note: Figure includes only Appalachian coal-mining counties.

COAL EMPLOYMENT BY REGION: In Figure 15 we provide an overview of how coal employment has dropped in Appalachia versus the rest of the nation. Here we observe a decline in Appalachia that is considerably larger than the national decline, consistent with the analysis of production above.

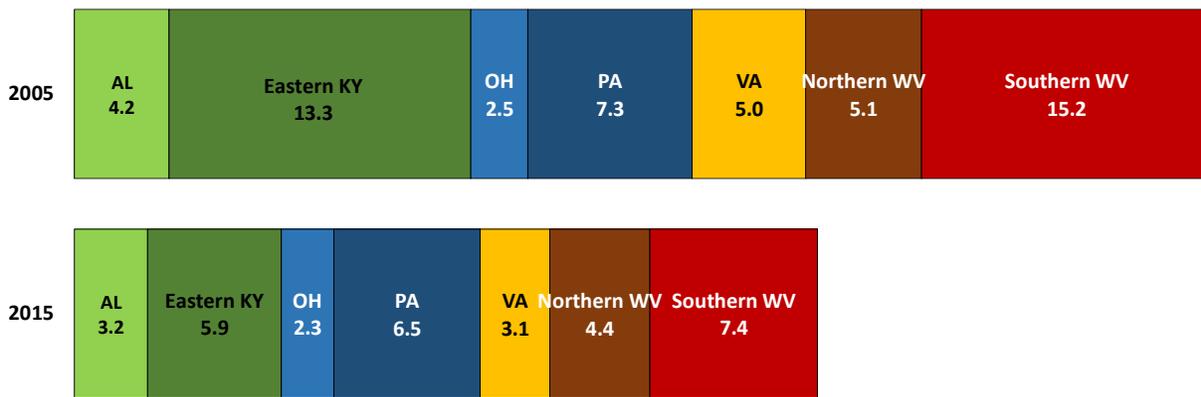
Figure 15: Coal-Mining Employment, U.S. and Appalachia



Sources: U.S. Energy Information Administration

COAL EMPLOYMENT BY STATE: In Figure 16 we offer a more in-depth examination of recent changes in coal employment for the coal-producing states in Appalachia. As discussed above, with the differences in production for the Region’s major coal-producing states, eastern Kentucky registered the largest drop in coal employment between 2005 and 2015 (51 percent). Southern West Virginia experienced similar regional differences within the state, as employment at mines in the state’s northern counties remained stable while southern West Virginia mine employment fell by around 39 percent during the 2005-2015 time period.

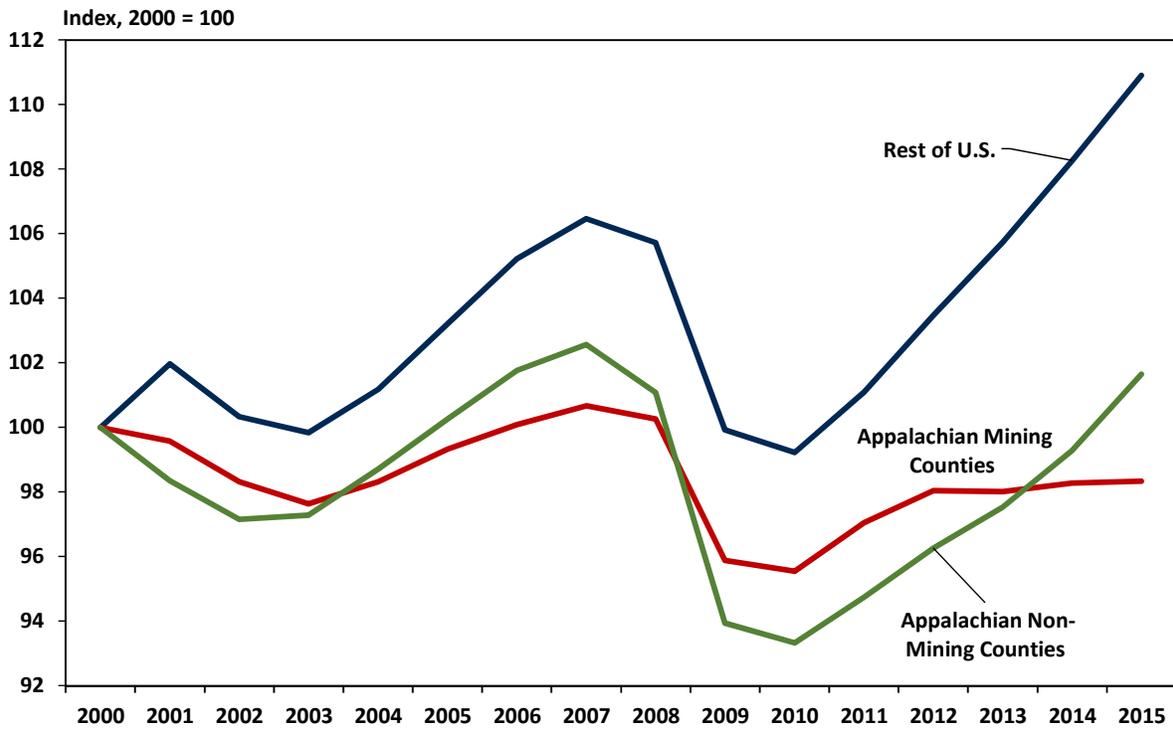
Figure 16: Coal-Mining Employment by Appalachian State (Thousands)



Source: U.S. Mine Safety and Health Administration
 Note: Figure includes only Appalachian coal-mining counties.

TOTAL EMPLOYMENT IN APPLACHIA: With Figure 17 we turn to an examination of broader trends in employment in Appalachia. In particular, here we present total private-sector employment for Appalachia and rest of the U.S. As depicted, total private-sector employment in the mining counties has been virtually flat since 2012. This evidence suggests that the loss in coal employment has led to broader spillover effects which have suppressed overall economic growth in the relevant regions.

Figure 17: Private Sector Employment, Select Appalachian County Groups

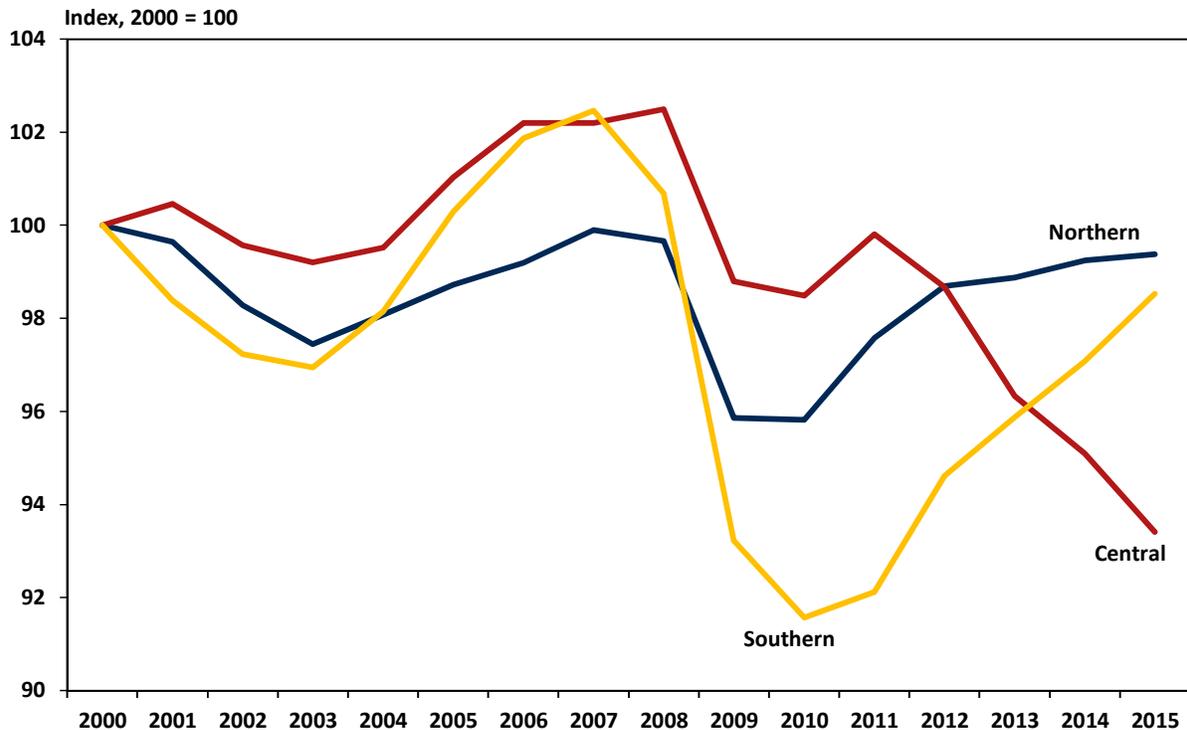


Source: Quarterly Census of Employment and Wages (QCEW), U.S. Bureau of Labor Statistics

Note: Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

In Figure 18 we look further into private-sector employment in the three coal-producing regions in Appalachia. Here we see that the suppression shown in Figure 17 has occurred only in Central Appalachia where coal-mining employment accounts for around 5 percent. The coal-mining counties of both Northern and Southern Appalachia, where coal-mining employment accounts for less than 1 percent, have experienced stable employment growth over the past four years or so, indicating relatively small negative spillover effects relative to the private sector employment as a whole.

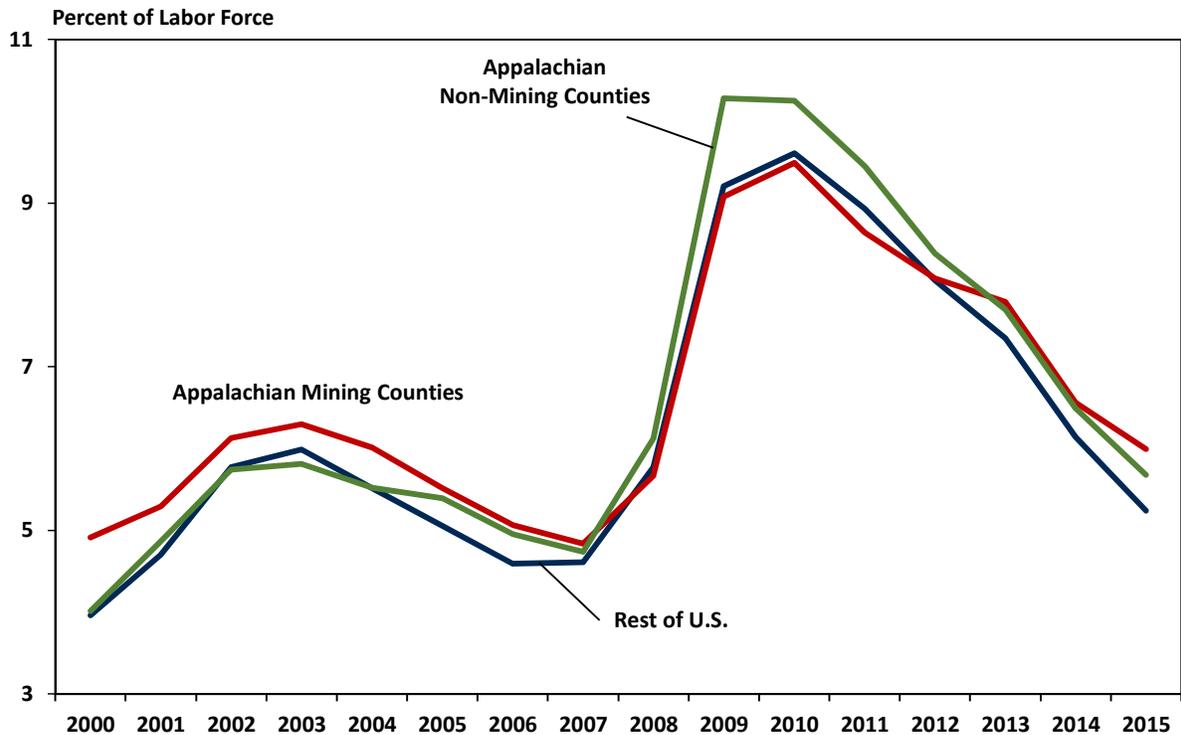
Figure 18: Private Sector Employment, Appalachian Coal-Producing Regions



Source: Quarterly Census of Employment and Wages (QCEW), U.S. Bureau of Labor Statistics
 Note: Appalachian regions include only Appalachian coal-mining counties.

UNEMPLOYMENT IN APPLACHIA: In Figure 19 we compare unemployment in Appalachian mining counties, non-mining counties, and rest of the U.S. It shows that after 2012 the coal-mining counties in Appalachia exhibit the highest rate of unemployment, although not by a very large margin. In Figure 20 we report the unemployment rate for each of Appalachia coal-producing regions. Here we do see that the coal-mining counties of Central Appalachia exhibit the highest rate of unemployment, and the margin is substantial.

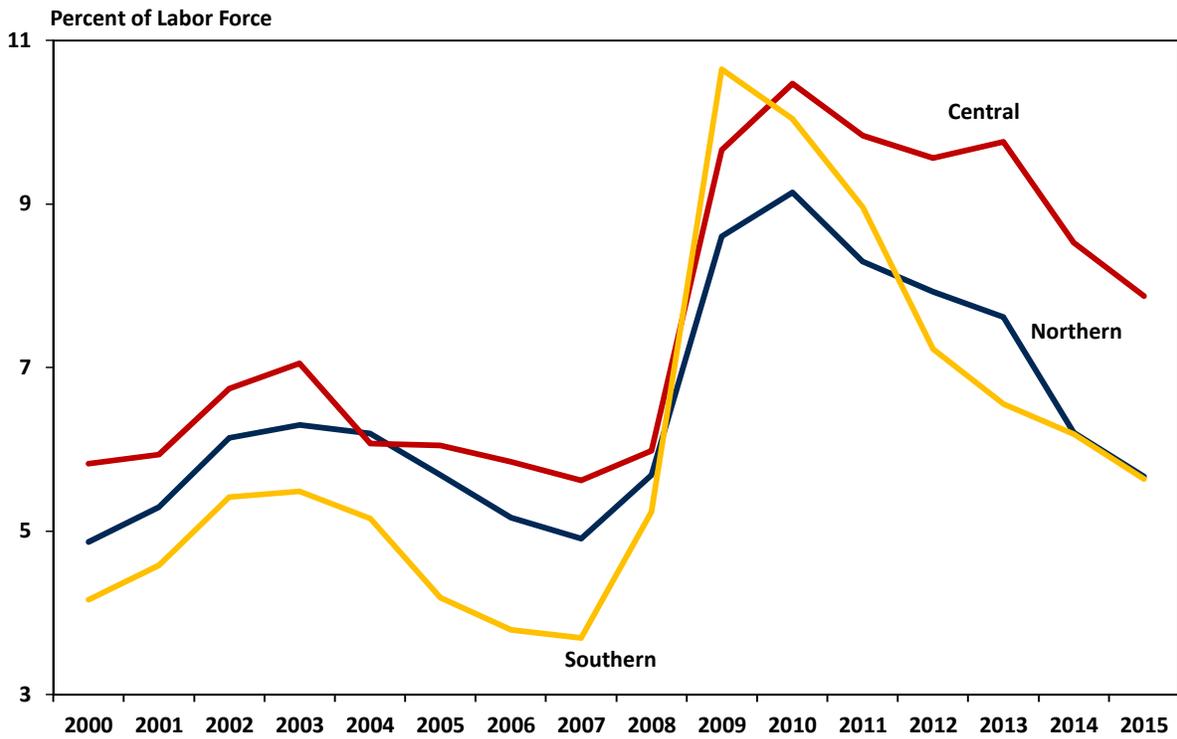
Figure 19: Unemployment Rate, Select Appalachian County Groups



Source: Local Area Unemployment Statistics, U.S. Bureau of Labor Statistics

Note: Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

Figure 20: Unemployment Rate, Appalachian Coal-Producing Regions



Source: Local Area Unemployment Statistics, U.S. Bureau of Labor Statistics

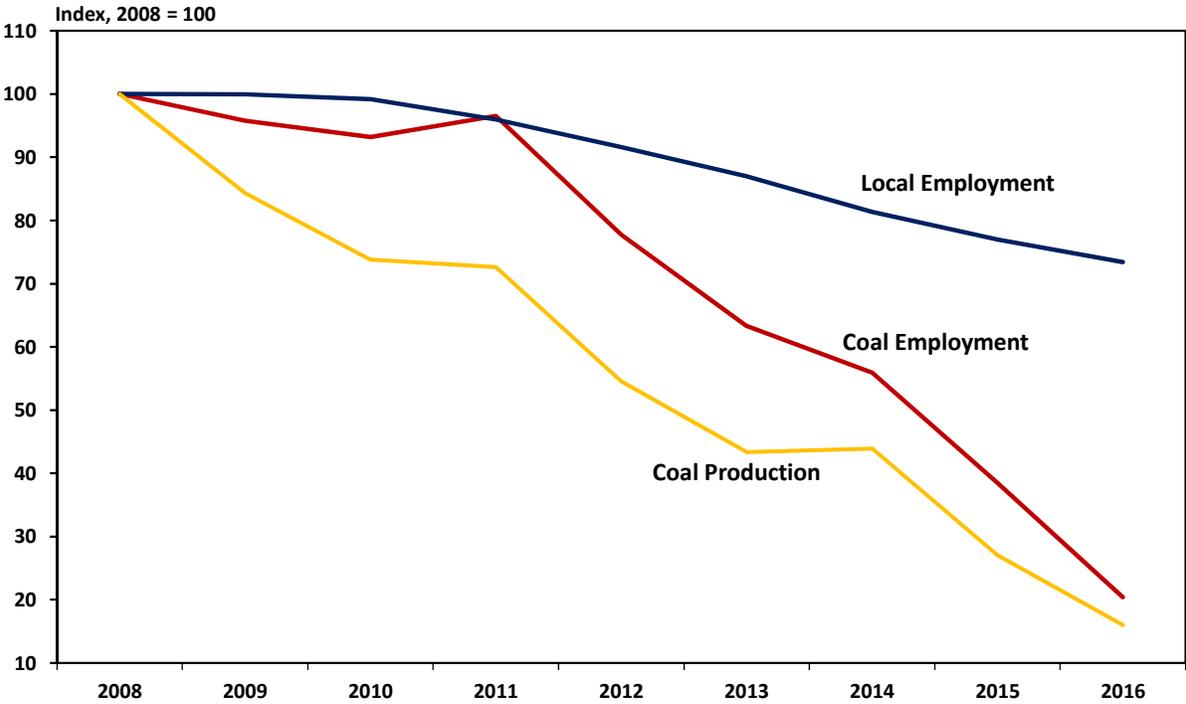
Note: Appalachian regions include only Appalachian coal-mining counties.

County Profiles: Marshall and Boone Counties

Next we provide a snapshot of two coal-producing counties in West Virginia: Boone and Marshall counties. Marshall County—in Northern Appalachia—is currently the top coal-producing county in West Virginia. Boone County—in Central Appalachia—held the title of top West Virginia coal-producing county for many years. In Figures 21 and 22, we report coal production and coal employment for each county. We also include a measure of “Local Employment” which we define to be employment from various sectors, mainly the private service providing sectors, that depend on local demand and that likely relate to spillover effects associated with the coal industry.

BOONE COUNTY: As illustrated in Figure 21, Boone County has experienced substantial declines in coal mine output and employment in recent years, with both declining by around 80 percent between 2008 and 2016. It is important to note that coal employment accounted for more than half of total employment in the county in 2008. Note that there was not a substantial decline in coal employment until a few years after production began to fall as employers may be driven to maintain their workforce for as long as possible and until it is evident that the drop in production is long-term in nature. “Local employment” exhibits a more gradual erosion over time—evidence of the negative spillover effect associated with lost coal employment to the broader community.

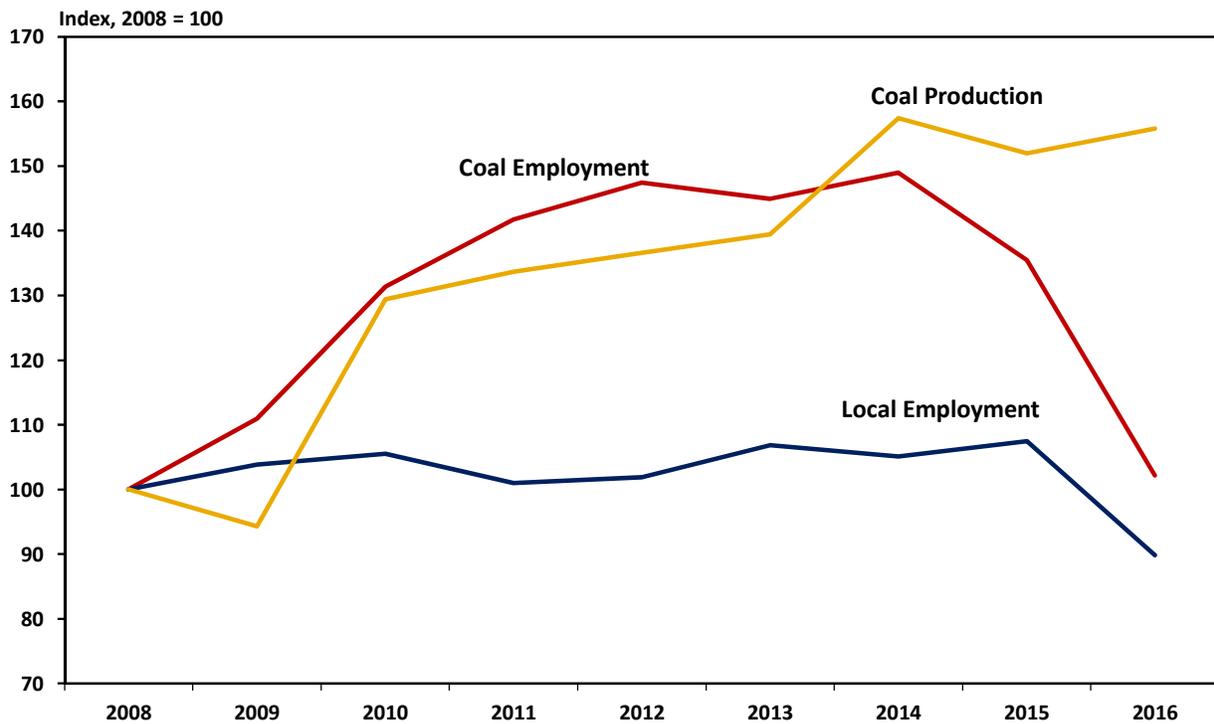
Figure 21: Select Economic Performance Metrics—Boone County, West Virginia



Source: U.S. Mine Safety and Health Administration; U.S. Bureau of Labor Statistics

MARSHALL COUNTY: In Figure 22 we illustrate parallel metrics for Marshall County. Here we actually see increases in coal production over the period due to significant efficiency enhancements that have come from a single large-scale mining operation in the county. Overall the entire period coal employment is roughly flat, although the metric grew early in the period and then later declined. “Local employment” has fallen by around 10 percent over the period. Marshall County has a much more diverse economic base and a number of factors may be affecting “local employment.” Overall, these two counties illustrate extremely wide variation in outcomes across specific coal-producing counties.

Figure 22: Select Economic Performance Metrics—Marshall County, West Virginia

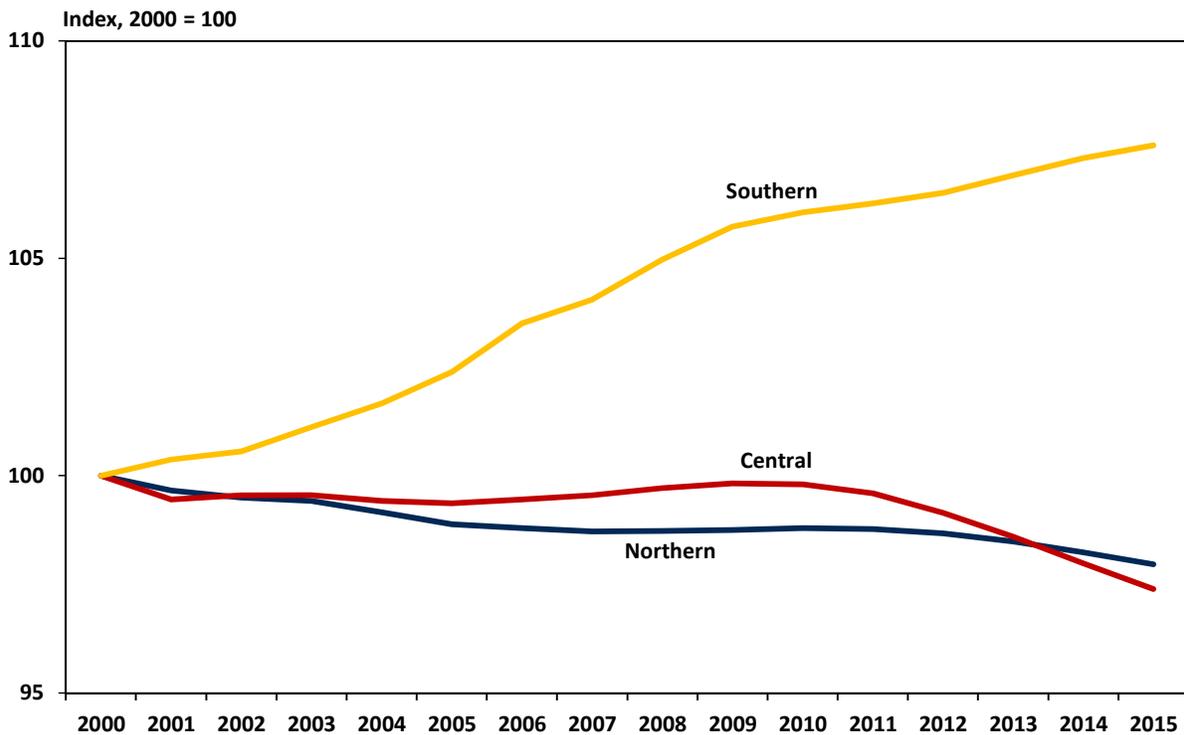


Source: U.S. Mine Safety and Health Administration; U.S. Bureau of Labor Statistics

Population and Migration in Appalachia

In this section we turn to population flows in Appalachia as they may be affected by the coal industry. Beginning with Figure 23, we report the change in total population for the coal-producing counties for each Appalachian coal-producing region. Consistent with the trends discussed above, Central Appalachia’s coal-producing counties have seen relatively sharp population declines over the past four years. This compares with a longer-term decay in the coal-producing counties of Northern Appalachia and strong growth in Southern Appalachia.

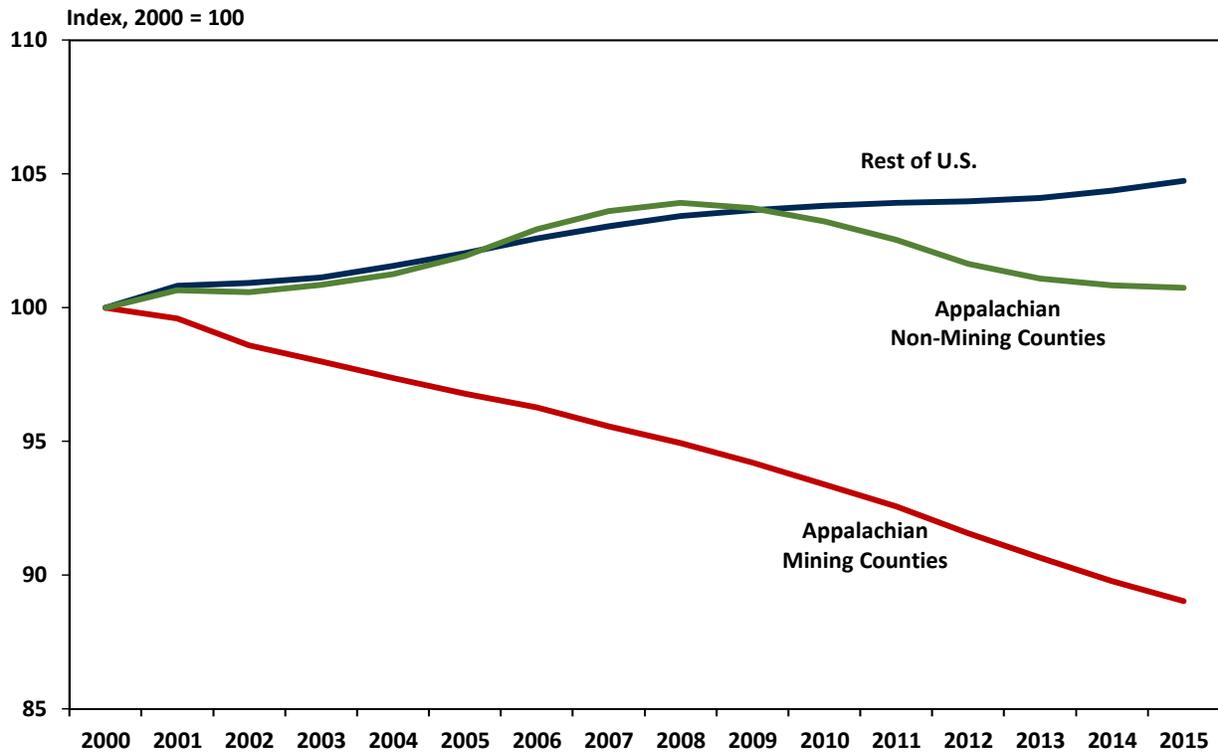
Figure 23: Total Population, Appalachian Coal-Producing Regions



Sources: 2000-2009 Intercensal Population Estimates and Vintage 2015 Population Estimates, U.S. Census Bureau
Note: Appalachian regions include only Appalachian coal-mining counties.

PRIME WORKING-AGE POPULATION: It is likely that coal losses that spur population losses will affect the prime working-age population more so than older segments of the population. In Figure 24 we compare the population in Appalachian mining counties, non-mining counties, and rest of the U.S. Here we see that mining counties in Appalachia have seen by far the worst prime-age population losses, whereas the prime-age population has generally been stable in the non-mining counties.

Figure 24: Population 25-54 Years Old, Select Appalachian County Groups

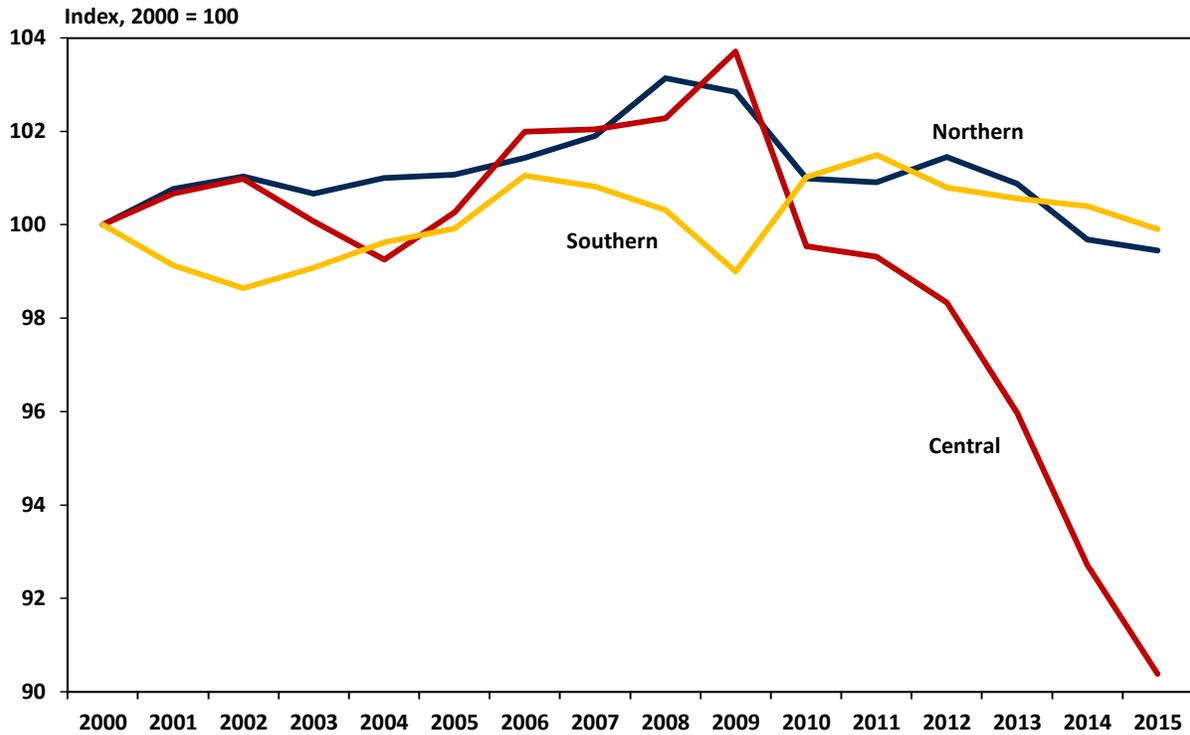


Sources: 2000-2009 Intercensal Population Estimates and Vintage 2015 Population Estimates, U.S. Census Bureau
 Note: Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

While not shown in a figure, data indicate that the prime working-age population losses have been most pronounced in recent years in the coal-mining counties of Central Appalachia, although mining counties in Northern Appalachia have also seen a long-term decline in the prime working-age population.

LABOR FORCE: In Figure 25 we report the labor force for each of the three Appalachian coal-producing regions. Here we see an extremely sharp drop in the labor force in Central Appalachia, consistent with the working-age population losses in this region.

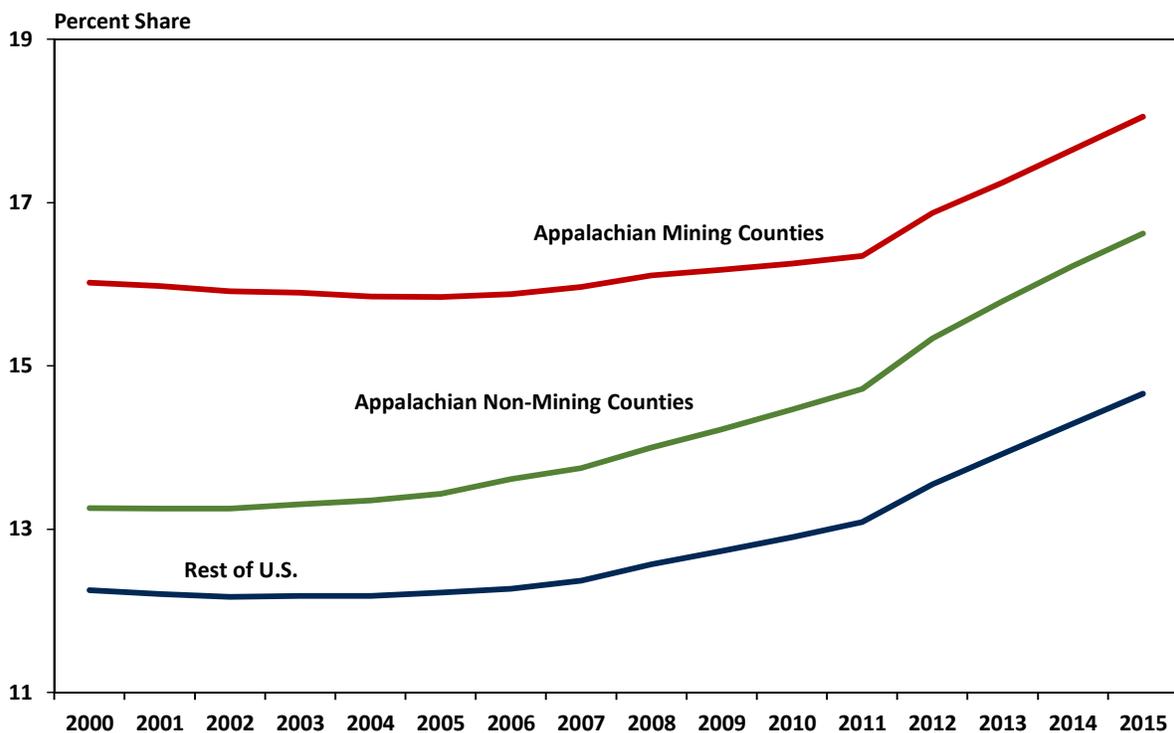
Figure 25: Civilian Labor Force, Appalachian Coal-Producing Regions



Source: Local Area Unemployment Statistics, U.S. Bureau of Labor Statistics
Note: Appalachian regions include only Appalachian coal-mining counties.

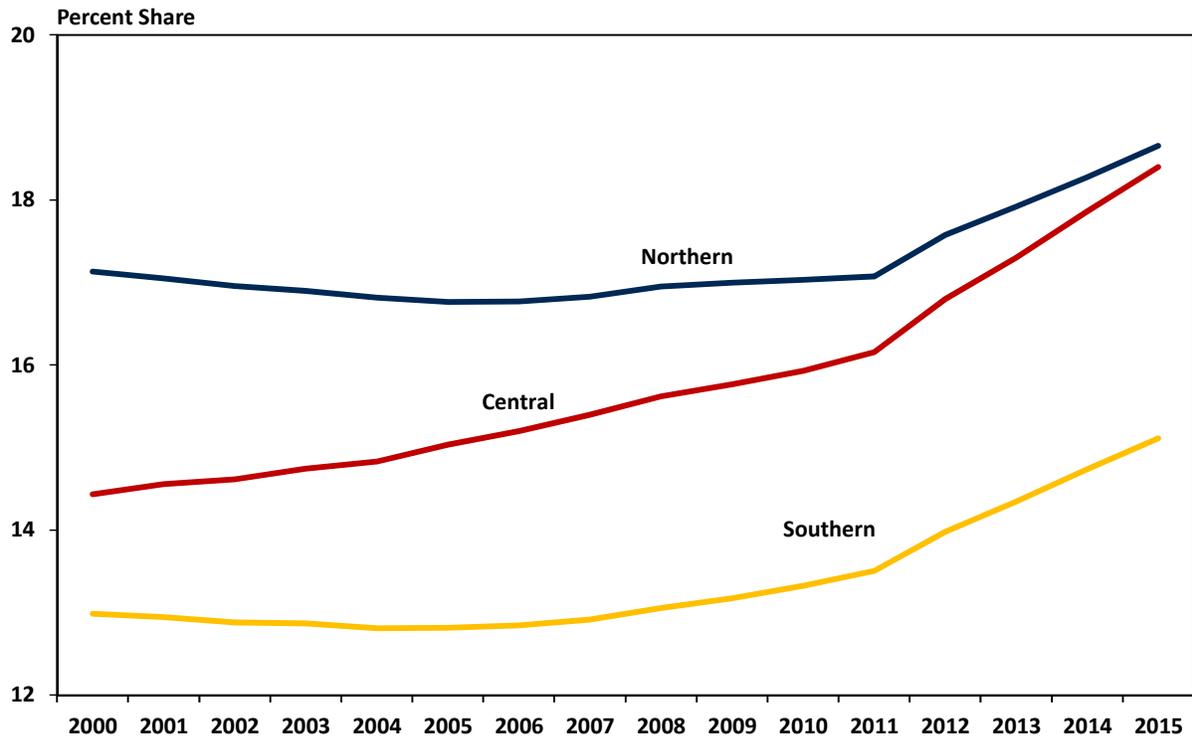
POPULATION DISTRIBUTION—RETIREMENT AGE: In light of population losses among the prime working age, it stands to reason that coal-mining counties of Appalachia are getting older on average. With Figures 26 and 27 we explore the share of retirement-aged men and women living in Appalachia compared to Appalachian non-mining counties and rest of the U.S. In Figure 26 we report the share of the population that is 65 years old or older across three geographic areas. As illustrated, coal-mining counties have the highest retirement-aged population share. However, the figure has increased noticeably across all area groupings in recent years. In Figure 27 we report the retirement-age population share by Appalachian coal-producing region. Note the substantial increase in the retirement-aged population share in Central Appalachia. Although not reported, the population share in the prime working-age category have fallen largely in a parallel manner across the various geographic groupings.

Figure 26: Share of Population 65 Years or Older, Select Appalachian County Groups



Sources: 2000-2009 Intercensal Population Estimates and Vintage 2015 Population Estimates, U.S. Census Bureau
 Note: Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

Figure 27: Share of Population 65 Years or Older, Appalachian Coal-Producing Regions



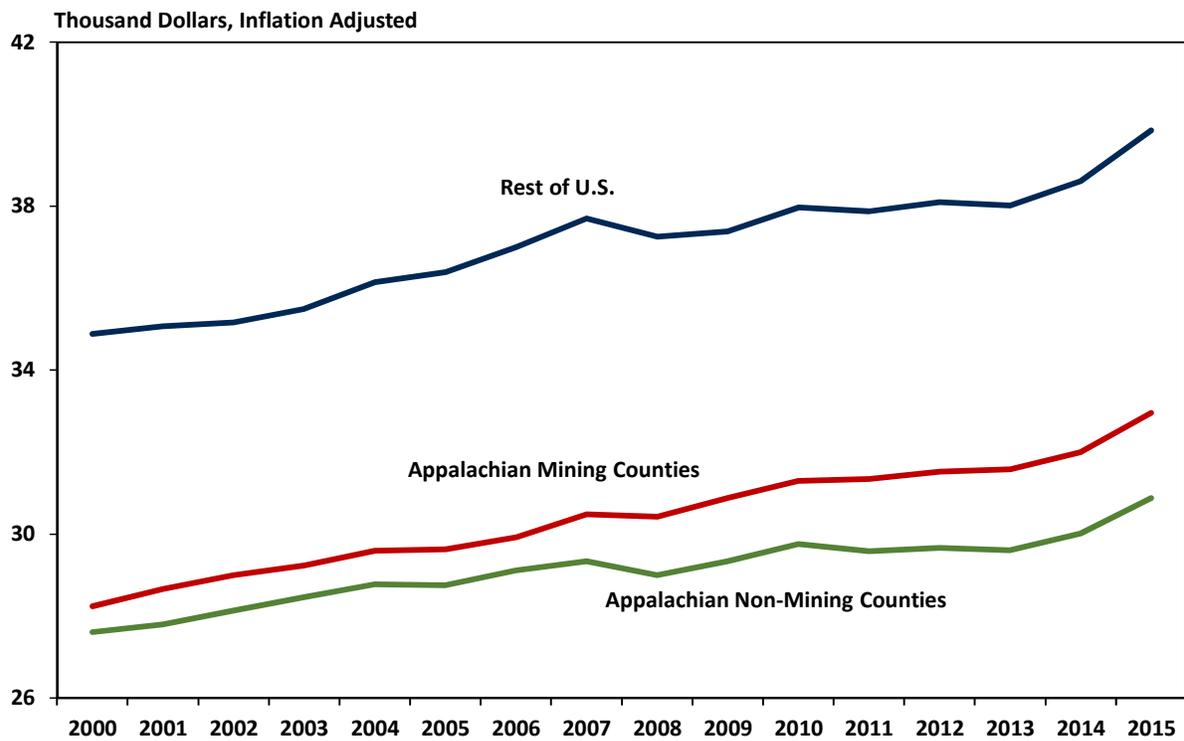
Sources: 2000-2009 Intercensal Population Estimates and Vintage 2015 Population Estimates, U.S. Census Bureau

Note: Appalachian regions include only Appalachian coal-mining counties.

Wages and Salaries and Poverty in Appalachia

WAGE AND SALARY INCOME: In this section we turn to income earned in Appalachia. As reported in Figure 28, wages and salaries per job are higher in Appalachian mining counties compared to Appalachian non-mining counties, likely the result of the high wages associated with coal mining jobs. However, wages and salaries in mining counties in Appalachia fall well below wages and salaries rest of the U.S.

Figure 28: Wage and Salary Income per Job, Select Appalachian County Groups

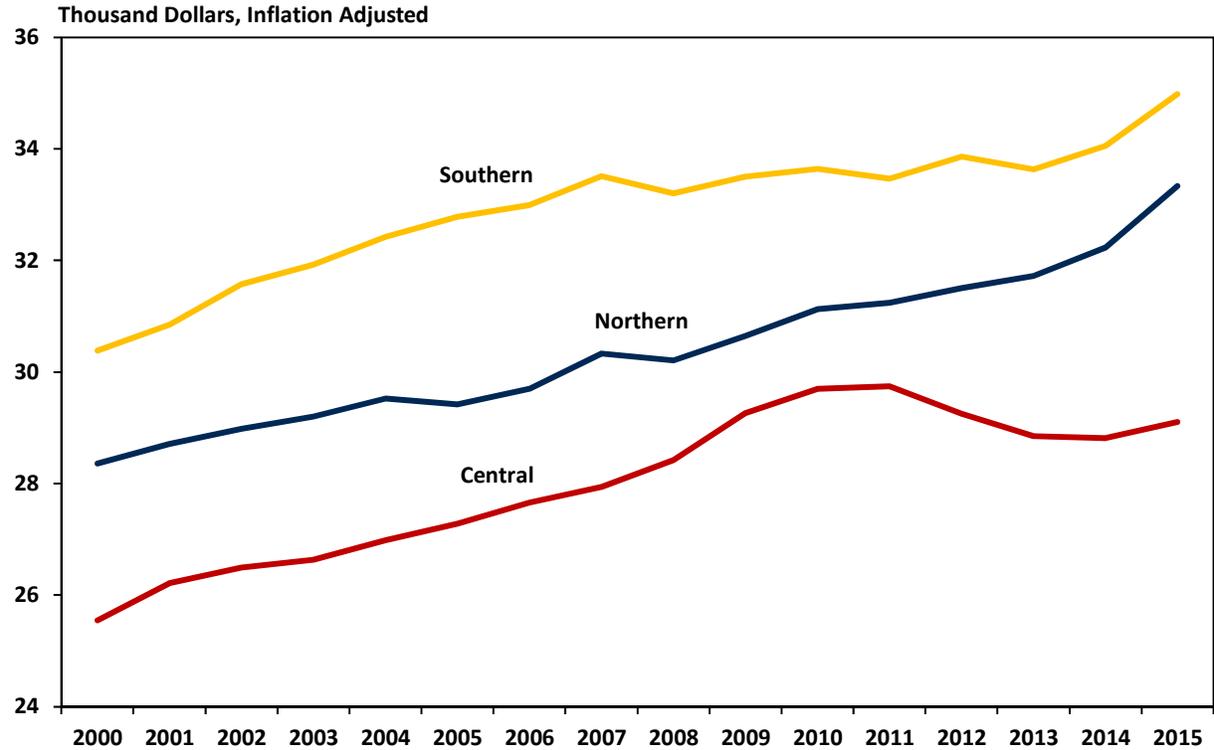


Source: U.S. Bureau of Economic Analysis

Note: Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015. Income is adjusted to inflation, with December 1999 CPI = 100.

In figure 29 we report wages and salaries per job across the Appalachian coal-producing regions. Here we see that wages and salaries are substantially lower in Central Appalachia. Moreover, wages and salaries in Central Appalachia starts falling in 2012, while those in the other coal-producing regions continues to rise. The lower wages and salaries suggest that jobs in Central Appalachia require lower level of skills than in Northern and Southern Appalachia. In 2015, only 21 percent of workforce in Central Appalachia has a bachelor’s degree or higher, far below Northern Appalachia (31 percent) and Southern Appalachia (33 percent).² In terms of industrial mix, Central Appalachia has a bigger concentration in lower paying industries such as government and retail trade.

Figure 29: Wage and Salary Income per Job, Appalachian Coal-Producing Regions

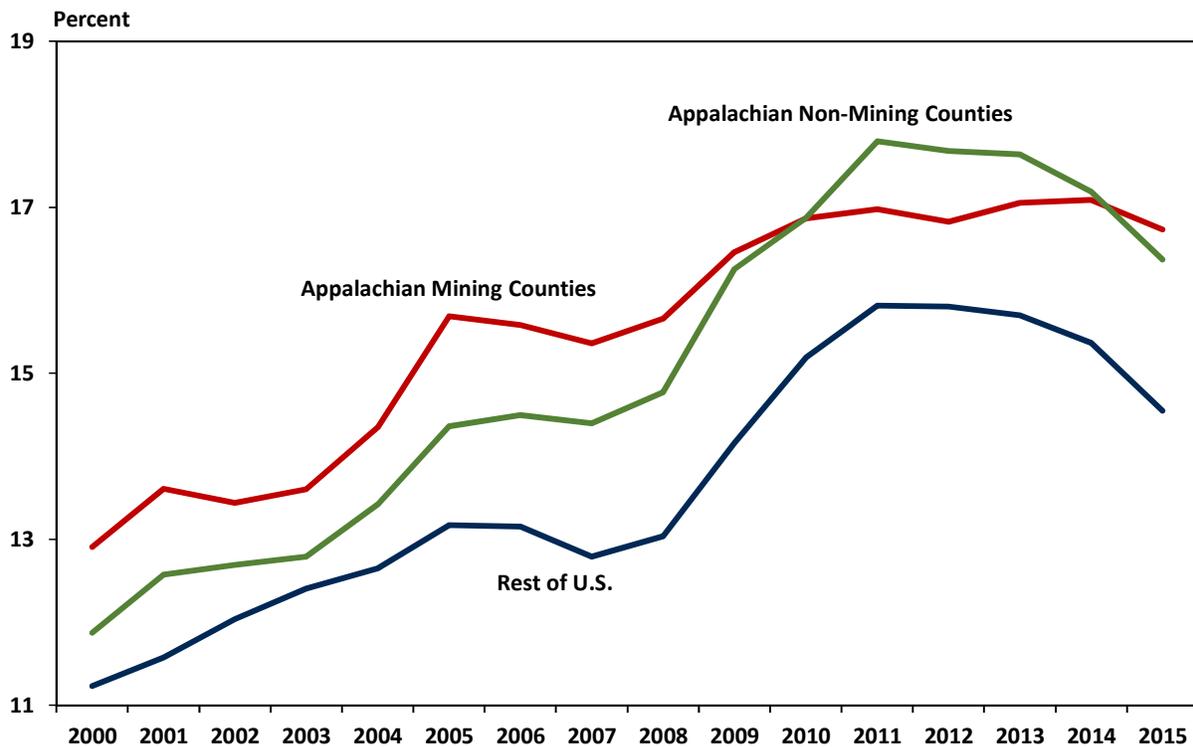


Source: U.S. Bureau of Economic Analysis
 Note: Appalachian regions include only Appalachian coal-mining counties. Income is adjusted to inflation, with December 1999 CPI = 100.

² 2015 American Community Survey, 5-Year Estimates, U.S. Census Bureau. This agrees with Figure 33, which shows that for people 25 years and over, the level of educational attainment in Central Appalachia is significantly below that in Northern and Southern Appalachia.

POVERTY: In this section we turn to poverty in Appalachia. As reported in Figure 30, the poverty rate is consistently higher in both Appalachian mining counties and non-mining counties compared with rest of the U.S. The poverty rate has increased everywhere in the U.S. However, while poverty rate in both Appalachia non-mining counties and rest of the U.S. starts declining in 2011, it is not the case in Appalachia mining counties. In Figure 31 we report the poverty rate for the coal mining counties for the three major Appalachian coal-producing regions. Consistent with many of the figures above, poverty is substantially higher in Central Appalachia.

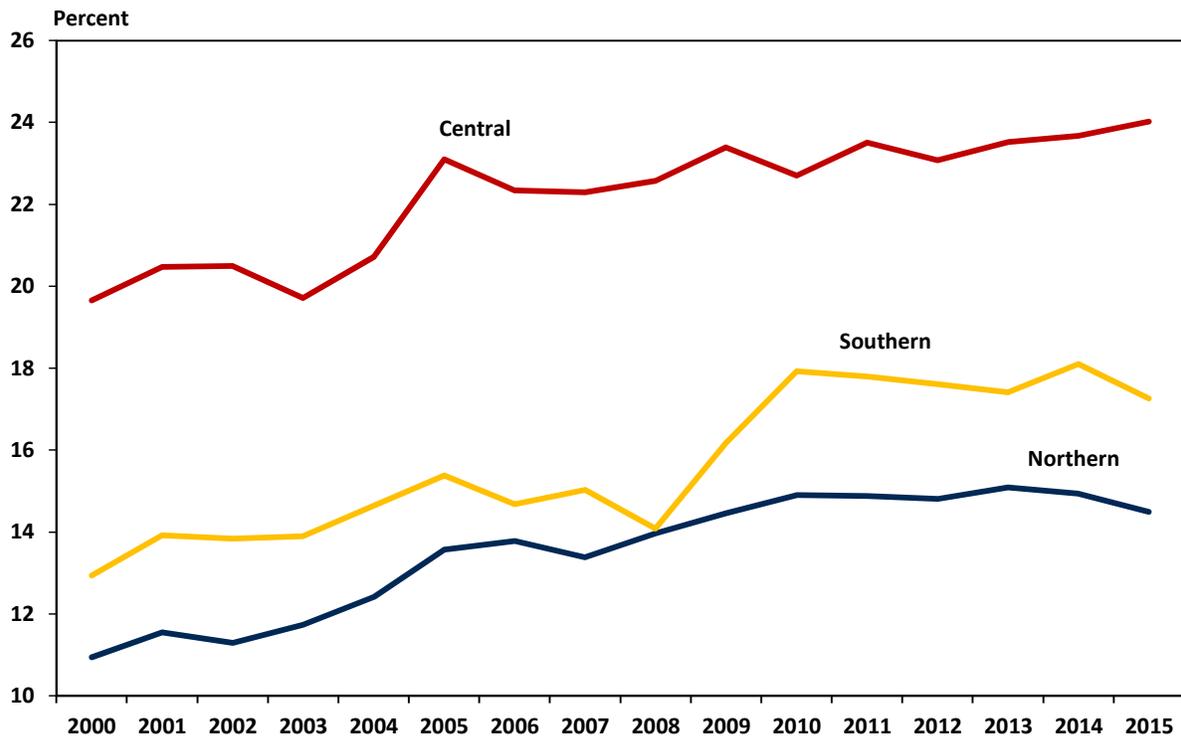
Figure 30: Poverty Rate, Select Appalachian County Groups



Source: Small Area Income and Poverty Estimates, U.S. Census Bureau

Note: Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

Figure 31: Poverty Rate, Appalachian Coal-Producing Regions



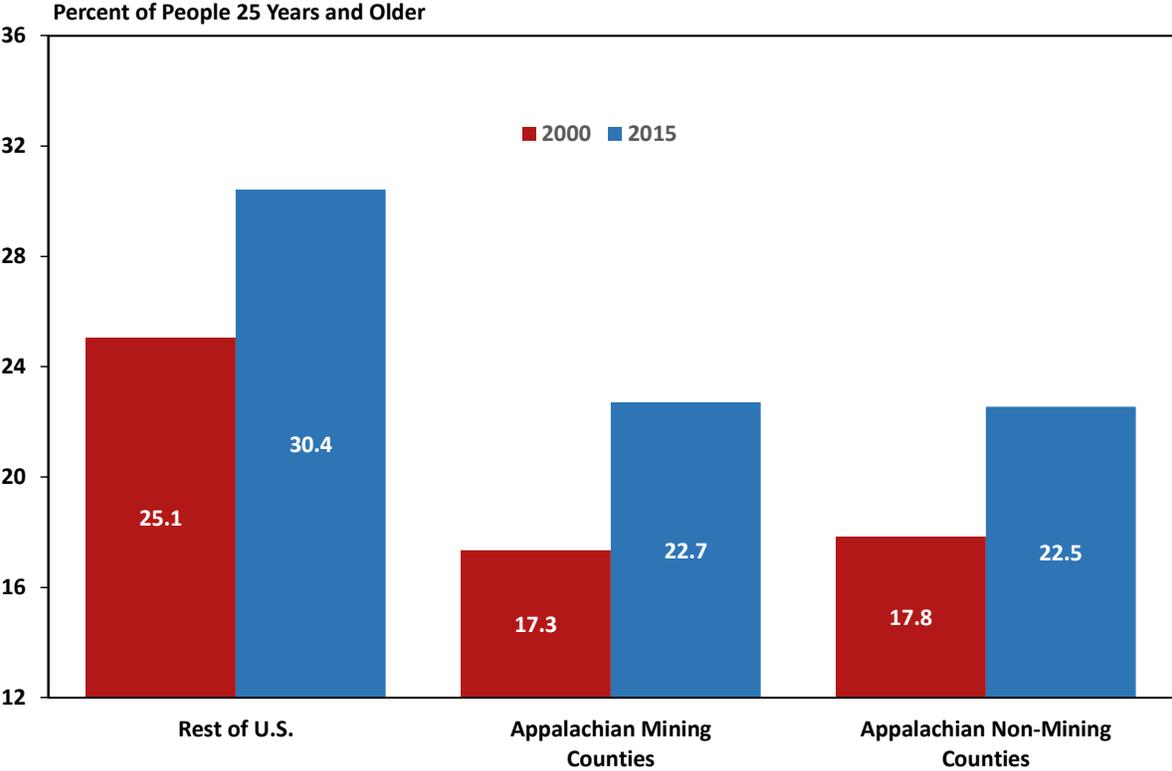
Source: Small Area Income and Poverty Estimates, U.S. Census Bureau

Note: Appalachian regions include only Appalachia coal-mining counties.

Education and Health in Appalachia

EDUCATION: We close with a brief examination of human capital outcomes in the Appalachian coal-producing regions. With Figures 32 and 33, we begin with the attainment of a bachelor’s degree or higher. In Figure 32 the data indicate that overall educational attainment is low in Appalachia compared to those non-Appalachian counties that are within the 13 states that contain Appalachia. However, attainment of a bachelor’s degree does not vary substantially between coal mining and non-mining counties. In Figure 33 we observe much lower rates of educational attainment in Central Appalachia. More detail data shows that in 2010 only 28 percent of college-age population (18 to 24) in Central Appalachia decide to pursue college education, compared to 49 percent in Northern Appalachia and 42 percent in Southern Appalachia.³

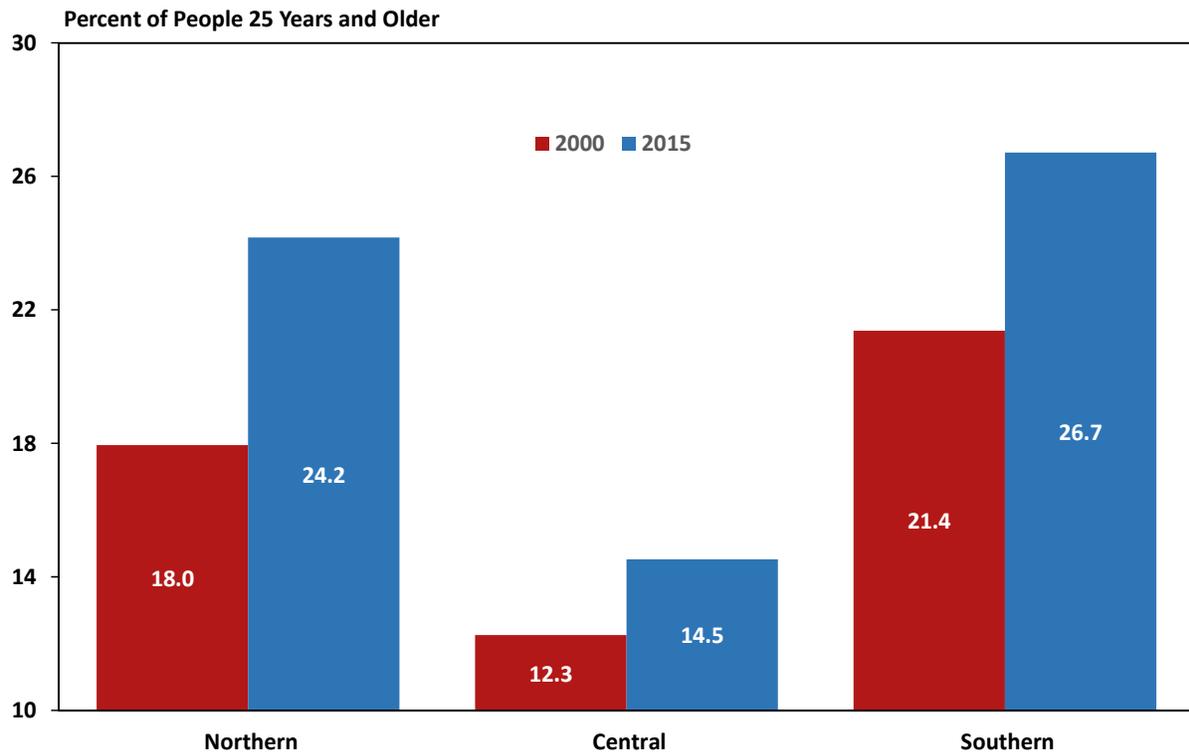
Figure 32: Attainment of a Bachelor’s Degree or Higher, Select Appalachian County Groups



Sources: 2000 Census and 2015 American Community Survey 5-Year Estimates, U.S. Census Bureau
Note: Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

³ 2010 American Community Survey, 5-Year Estimates, U.S. Census Bureau

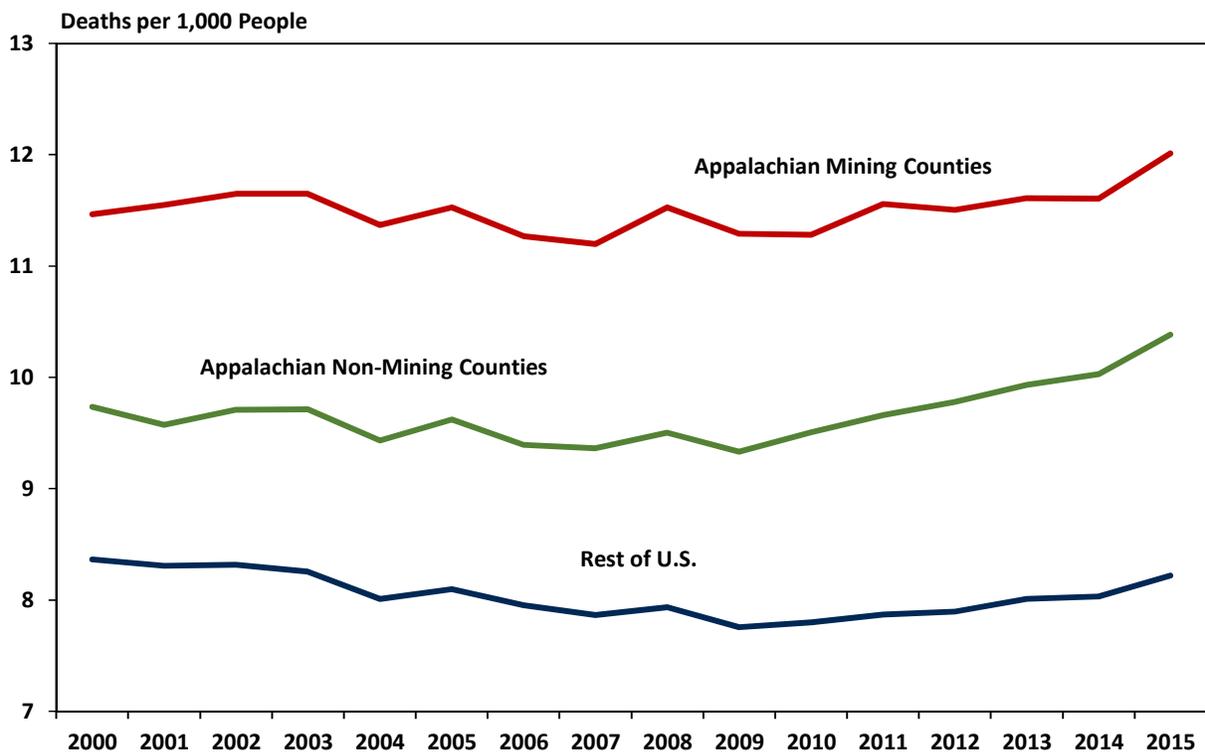
Figure 33: Attainment of a Bachelor's Degree or Higher, Appalachian Coal-Producing Regions



Sources: 2000 Census and 2015 American Community Survey 5-Year Estimates, U.S. Census Bureau
Note: Appalachian regions include only Appalachian coal-mining counties.

HEALTH: In Figures 34 and 35, we briefly examine health outcomes in Appalachia. In Figure 34, the data show that mining counties in Appalachia have substantially higher mortality rates than those for non-mining counties and rest of U.S. As these mortality rates reflect deaths from all causes, these rates are likely influenced in part by higher shares of population 65 years or older, as shown above. However, mortality rates have not risen as fast as the share of the older population; indeed, in rest of U.S. mortality rates have fallen since 2000, despite significant increases in the share of over-65 population.

Figure 34: All-Cause Mortality Rate, Select Appalachian County Groups

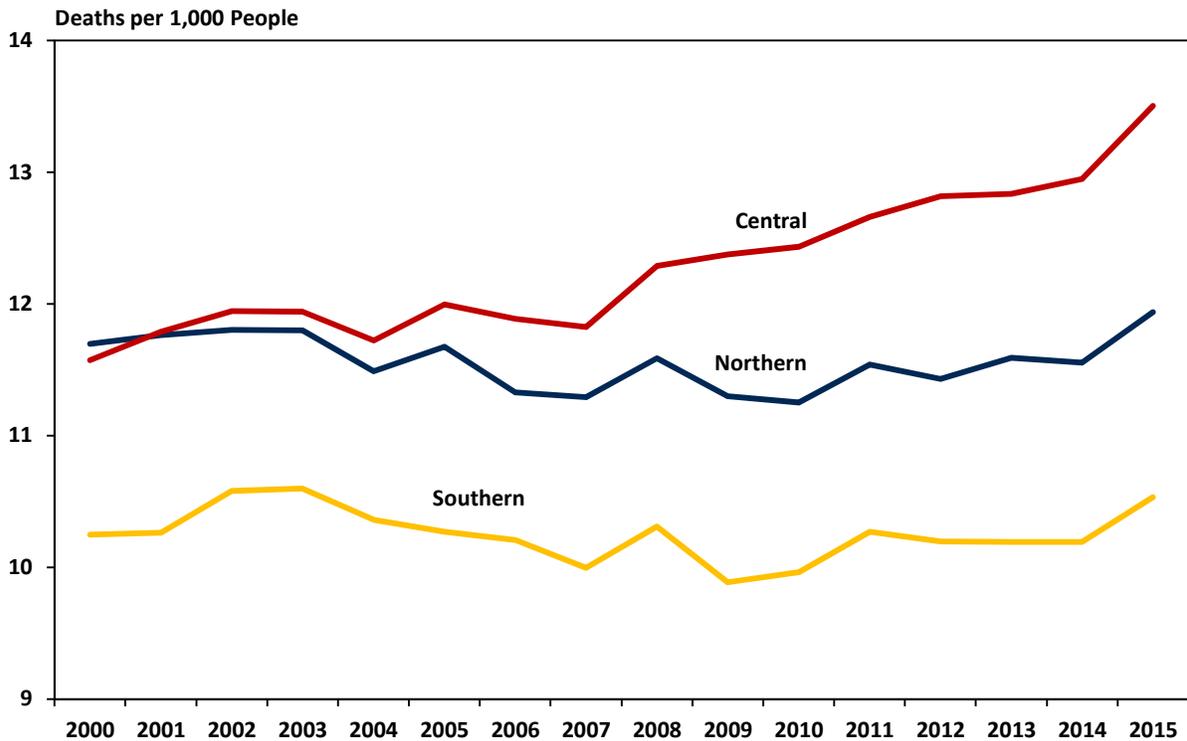


Source: U.S. Centers for Disease Control and Prevention

Note: Rates are not age-adjusted. Appalachian coal-mining counties include those that, based on MSHA data, have non-zero coal production or more than 10 coal-mining jobs from 2005 through 2015.

In Figure 35 we show mortality rates for each of the three Appalachian coal-producing regions. While mortality rates in Northern Appalachia and Southern Appalachia are relatively flat, mortality rates in Central Appalachia have risen substantially since 2000, rising from 11.6 deaths per 1,000 population in 2000 to 13.5 death per 1,000 population in 2015, an increase of more than 16 percent.

Figure 35: All-Cause Mortality Rate, Appalachian Coal-Producing Regions



Source: U.S. Centers for Disease Control and Prevention

Note: Rates are not age-adjusted. Appalachian regions include only Appalachian coal-mining counties.

Chapter 3: The Recent Literature on the Coal Economy in Appalachia

There has been little prior research on the entire coal ecosystem of mining, electricity generation, and transportation in Appalachia, which is the subject of this report. Higginbotham et al. (2010) examined the coal supply chain and the downstream industries of electricity production and transportation in West Virginia. The study found that coal mining supported approximately 25,000 jobs indirectly through the coal supply chain, which was larger than the 20,000 workers employed directly in the industry. The study also found that an additional 17,000 jobs were supported in downstream industries. Godby et al. (2015) also examined the broader coal economy in the state of Wyoming, finding that the downstream industries represented about 3 percent of the state's economy, in addition to the 11 percent estimated for the mining industry. Coal's share of employment was somewhat lower, at 1.8 percent, most likely reflecting the more capital-intensive nature of Wyoming's coal industry, which relies more on surface mining than the underground mines common in Appalachia.

The economic impacts of the coal industry itself, without consideration of the downstream industries, have been studied more widely. Much of the literature on the impact of the coal industry utilizes input-output techniques, which measure how an initial spending change in one industry affects the rest of the economy as that spending is multiplied throughout the supply chain.⁴ Leistriz, Dalsted, and Hertsgaard (1974) was one of the first studies to use input-output analysis to study the impact of coal development in North Dakota. The study found that coal development would stimulate economic gains throughout the local economy, though too much development would place pressure on government services and impose social costs on other local residents. A 2001 study published by the Appalachian Regional Commission (Thompson et al., 2001) used an input-output approach to estimate the impact from coal mining throughout the Appalachian Region. The study found that coal mining supported about 135,000 jobs in the Region, which was about 4.4 percent of total employment in the counties studied, and the economic output multiplier was estimated to be about 1.5. Using multipliers from the U.S. Bureau of Economic Analysis Regional Input-Output Modeling System (RIMS II), Konty and Bailey (2009) found that Kentucky's coal industry supported nearly \$11 billion in economic activity in the state. The economic activity supported more than 70,000 jobs, or roughly 2.6 percent of total state employment. The state's employment multiplier for the coal industry was 3.9, meaning that for every 10 jobs in the coal sector, an additional 29 jobs were created in the broader economy. Internationally, input-output models have been used to study the impact of coal mining in a number coal-producing

⁴ For a more detailed treatment of input-output methodologies, see Miller and Blair (2009).

regions, such as the United Kingdom (Beatty, Fothergill, and Powell, 2007) and Australia (Ivanova and Rolfe, 2011; Rolfe, Ivanova, and Lockie, 2006).

Other studies have examined the differing regional impacts of the coal industry; the effect of boom and bust cycles; and the potential for coal-based economies to hinder overall economic growth, the so-called “resource curse.” Kent (2016) chronicled the impact of the recent decline in the West Virginia coal industry noting effects similar to those detailed above. In particular, Kent notes that West Virginia’s southern coal fields—part of Central Appalachia—have had more negative economic outcomes than mines in the northern part of the state. Black, McKinnish, and Sanders (2005) examined the coal boom and bust cycle in the late 1970s to 1980s to estimate the impact on the broader economy. One important finding was that the coal industry had larger spillover effects in bust years than in boom years. For every 10 jobs lost in the coal sector during the industry’s bust, Black et al. found that there were an additional 3.5 jobs lost in the rest of the economy, compared with a gain of only 1.7 jobs during the boom years. The authors attributed this result to a greater loss of population during the bust period as coal miners moved out of affected areas. Wages in the broader economy also were affected by the boom and bust in the coal industry. Douglas and Walker (2012) find evidence that the presence of coal in a region results in a somewhat negative impact on overall economic growth, but they were unable to identify the causes of this decline. However, Betz et al. (2015) find little evidence of a resource curse in Appalachia, except for a small reduction in population growth, which may hinder long-run economic growth.

Overall, the literature indicates that the decline of the coal industry in Appalachia is expected to have significant negative impacts across the rest of the Region’s economy. Input-output studies show that the coal sector and its related downstream industries have high multiplier effects on the economy in the Region, indicating that the industry is central to the economy of the coal-producing regions in which it is located. Because of their linear assumptions, input-output models are by definition symmetric, meaning that a loss in the coal industry results in the same economic impacts in the negative direction as a gain would in the positive direction. However, other research suggests that the current bust cycle is likely to have a more significant drag on the overall economy in coal-producing regions than an equivalent gain. This literature suggests that mine closures and job losses are likely to result in population loss, which further depresses the local economies in the long-term. This finding is supported by resource curse literature that indicates declining coal economies have long-run impacts on economic growth.

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