Lawrence County and Scioto County's Power Industry Ecosystem and Coal Industry Ecosystem Report

Prepared by Center for Economic Development and Community Resilience, the Voinovich School of Leadership

and Public Service

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Tuyen Pham

Mikayla Rochelle

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### Lawrence County's and Scioto County's PIE dependence, Impact, and Risk

The closures of the coal fired power plants has had impacts on industries and regions in the Power Industry Ecosystem (PIE). However, the impacts differ from region to region and from industry to industry, depending on the nature of the region's economy and where an industry is in the supply chain. Since two coal-fired power plants were closed in Adams County in 2018, the demand for coal and its' supply chain is expected to decline. Jackson and Jarosi (2021) developed and implemented three measures – PIE Dependence, PIE Impact, and PIE Risk – to form a typology, which they later applied to identify if counties in the Appalachian Mountain Area are depressed, vulnerable, or currently in a hardship.

PIE dependence score measures how dependent a county's economy is on the power industry and its supply chain. Counties with smaller PIE dependence scores have a more diverse economy, meaning they have a better ability to adapt to change in power industry. These counties with lower PIE dependence scores are more resilient to the closures of coal-fired power plants in the region. The economy in counties with higher dependence score is tied strongly to the power industry, therefore, those counties are at greater risk when there is a coal-fired power plant closure in the region.

PIE Impact score measures the change in employment in power-oriented industries in a region between 2005 and 2018. A positive PIE impact score represents a gain in employment, a negative PIE impact score represents job loss. A county with larger negative value of PIE impact score means that county suffers greater negative impact. According to Jackson and Jarosi (2021), the changes in employment in the Appalachian counties are insubstantial (less than 15 change in PIE related employment). In addition, Jackson and Jarosi (2021) also found that 36.6% of all Appalachian counties experienced gains in power industry ecosystem related employment. This indicates that the change in PIE related employment is not uniformly negative.

PIE risk measures the degree to which a county's economy is at risk of further negative impacts when the fossil fueled power industries continue to decline. When there is a power plant closure in a county, both the county and surrounding counties face the risk of job loss. While the county where there is a closure (host county) suffers direct risk of declining power industry, the neighboring counties also suffer the spillover risk if they are near the host county. PIE risk score is the combination of the regionwide dependence score, county's own dependence score, county's own risk measure, and county's spillover risk (Jackson and Jarosi, 2021).

Class	Dependence	Impact	Risk
1	High	High	High
2	High	High	Low
3	High	Low	High
4	Low	High	High
5	High	Low	Low
6	Low	High	Low
7	Low	Low	High
8	Low	Low	Low

After calculating dependence score, impact score, and risk score for each county, Jackson and Jarosi (2021) then combine the information for each county and classify them into eight classes as follow:

Table 1: PIE score combination and classification

Among 8 classes, counties in classes 1, 3, and 6 are counties that need more attention. Class 1 counties are *depressed* counties, they are highly dependent in fossil – fueled power industries, they experienced high negative impact from the decline in power industry and are expected to suffer further negative impact in the future. Class 3 counties are *vulnerable* counties, they are highly dependent in fossil – fueled power industries, they have not yet experience high negative impact in employment but are at risk of suffering high negative impact if the power industry continues to decline. Class 6 counties are *hardship* counties, they used to be dependent in fossil – fueled power industries but experienced high negative impact in employment and lost most of their PIE related jobs,

therefore, they are no longer PIE dependent. Class 6 counties are not expected to suffer further impact of the decline in power industry.

Among 420 counties in the Appalachian Mountain Area, Lawrence County is ranked 146<sup>th</sup> in term of PIE dependence, 249<sup>th</sup> in term of PIE impact, 85<sup>th</sup> in term of PIE risk, and is classified as a "Class 3" county – *vulnerable* county. Lawrence County is more dependent on PIE industries compared to an average county in the Appalachian area. On average, Lawrence County has not experienced a large negative impact from the decline in coal-fired power industry, but the county is at high risk for future job loss since its' economy is still highly dependent in PIE industries.

Scioto County is ranked 329<sup>th</sup> in PIE independence among 420 Appalachian counties, 230<sup>th</sup> in PIE impact, 160<sup>th</sup> in PIE risk, and is classified as a "Class 7" county. Scioto's degree of dependence to PIE industries is low and the county has not experienced large negative impact in PIE related employment, but its' economy is facing a high risk of a larger negative impact in the future.

Figure 1 shows the topology map of Ohio's Appalachian counties. The map shows that Lawrence County and Scioto County are surrounded by PIE *depressed* (Class 1) counties and PIE *vulnerable* (Class 3) counties.



Figure 1: Map of PIE topology for Ohio's Appalachian counties Source: Based on Jackson and Jarosi (2021)'s PIE topology classification

#### Lawrence's industry PIE scores

According to NexisUni database, in 2020, there are 56 companies in 11 coal supply chain industries including: mining equipment manufacturer, natural gas extraction, fuel wholesaler, coal wholesaler, chemical wholesaler, gum & wood chemicals, primary smelting and refining of copper, plastics material and resin manufacturing, utility, transportation, and water transportation. Of these 11 industries, the top 4 industries in term of annual revenue are

coal wholesaler (\$50-\$75 million), mining equipment manufacturer (\$55.1 million), water transportation (\$24.2 million), and trucking transportation (\$6.4 million).

NAICS Code	Coal Supply Chain Industry	Annual	PIE score	PIE score
		Revenue	2005	2018
<u>333131</u>	Mining equipment manufacturers	\$55,112,832	1.75	0.74
211130	Natural gas extraction	NA	61.8	14.21
454310, 423520	Fuel wholesalers	\$1,461,874	1.39	1.03
423520	Coal wholesalers	\$75,000,000	1.39	1.03
424690	Chemical wholesalers	\$74,023	1.39	1.03
325194	Gum & Wood chemicals	\$150,000	0.96	1.32
<u>331410</u>	Primary smelting and refining of	\$111,000	NA	NA
	copper			
<u>325211</u>	Plastics Material and Resin	NA	0.35	0.32
	Manufacturing			
221	Utilities	\$446,386	100	100
484	Transportation	\$6,480,303	0.69	1.53
4832	Water Transportation	\$24,283,163	2.9	4.95

Of the 11 coal supply chain industries, the industries with highest PIE score are utility (100.00), natural gas extraction (14.20), and water transportation (4.95). These industries are highly PIE oriented, hence, are expected to be highly affected when there are coal-fired power plant closures in Adam County.

Table 2: Lawrence County's coal supply chain industries' PIE scores

Among the industries with highest revenue in Lawrence County, coal wholesalers have not had a high PIE score, the industry was more dependent on PIE in 2005 and became slightly less PIE dependent in 2018 (see table 2). The mining equipment manufacturers industry used to be more dependent on PIE in 2005 and became less dependent on PIE in 2018 (see table 2). Hence, we do not expect to see a high impact on coal wholesalers and mining equipment manufacturers as coal fired power plants closed in Adam County in 2018.

Water transportation has always been on of the top industries with highest PIE score, this industry has always been highly PIE oriented. In 2018, water transportation industry became even more independent on PIE compared to 2005 (see table 2). Truck transportation became much more dependent on PIE in 2018 compared to 2005 (see table 2). Which means truck transportation industry and water transportation industry are now at much greater risk of negative impacts when there are power plant closures in Adam County.

#### Scioto's industry PIE scores

In 2020, there were 61 businesses in 9 coal supply chain industries including: natural gas extraction, fuel wholesaler, coal tar wholesaler, chemical wholesaler, asphalt paving mixtures & blocks, gum & wood chemicals, coal product manufacturing, utilities, and truck transportation. Of these 9 industries, the top 4 industries in term of annual revenue are coal product manufacturing (\$75 million), fuel wholesaler (\$12.9 million), truck transportation (\$12.2 million), and asphalt paving mixtures & blocks (\$5 million)

NAICS Code	Coal Supply Chain Industry	Annual	PIE Score	PIE Score
		Revenue	2005	2018
211130	Natural gas extraction	NA	61.8	14.21
454310, 423520	Fuel wholesalers	\$12,915,095	1.39	1.03
423320, 424690	Coal tar wholesalers	\$3,211,227	1.39	1.03
424690	Chemical wholesalers	\$1,000,000	1.39	1.03
324121	Asphalt Paving mixtures & blocks	\$5,000,000	NA	NA

325194	Gum & Wood chemicals	NA	0.96	1.32
324199	Coal products manufacturing	\$75,000,000	7.16	5.31
221	Utilities	\$35491	100	100
484	Transportation	\$12,237,548	0.69	1.53

Table 3: Scioto County's coal supply chain industries' PIE scores

Coal product manufacturing, the top revenue industry, has always been highly PIE dependent, the industry had PIE score of 7.16 in 2005 and 5.31 in 2018. Although the coal product's manufacturing industry became less dependent on PIE in 2018, it still faces a great risk of negative impact when PIE declines.

Fuel wholesaler became slightly less dependent on PIE in 2018 compared to 2005. Truck transportation became more independent on PIE compared to 2005. However, these two industries still have a relatively small PIE score, hence, we do not expect a great risk to these businesses when there are power plants closed in neighboring counties.

## Lawrence County's and Scioto County's CIE dependence, Impact, and Risk

Similar to the PIE dependence and risk analysis, Jackson and Jarosi (2018) also developed a county level coal industry ecosystem (CIE) analysis to examine the impact of the decline in coal production on supply chain industry for all counties in the Appalachian area. In this analysis, Jackson and Jarosi (2018) also develop topology analysis to classify counties into groups with high risk and low risk using three primary dimensions: Dependence, Impact, and Risk. They found that not all counties in the Appalachian area are negatively affected by the decline on coal production.

CIE dependence score measures the degree of concentration of CIE related industries in an industry or in a county. An industry with higher CIE score is highly CIE oriented. A county with a larger value of CIE dependence score means that county is heavily dependent in CIE related industry. CIE dependent score lies between 0 and 1. An industry with a CIE dependence score of 1 is 100% coal dependent. Similarly, a county with CIE dependence score of 1 is 100% coal dependence score means that the county's economy is more diverse, hence, more resilient to the change in coal production.

According to Jackson and Jarosi (2018), the top 10 industries with highest CIE dependence score in 2015 are coal mining (1.00), mining and oil and gas field machinery (0.29), primary smelting and refining copper (0.16), rubber and plastics hoses and belting manufacture (0.13), ground or treated mineral and earth manufacturing (0.1), stone mining and quarrying (0.07), commercial and industrial machinery and equipment rental and leasing (0.06), oil and gas extraction (0.06), water transportation (0.06), and construction machinery manufacturing (0.05).

Jackson and Jarosi (2018) also report that the maximum county's CIE dependence score used is 0.422, which means 42.2% of the entire economy in that county are dependent on coal. However, in 2015, the maximum county's CIE dependence score dropped to 0.224, which implies that the Appalachian area is recently less dependent on coal than it used to be. However, the distribution of county's CIE dependence scores is heavily skewed with less than 17% of all 420 counties have a dependence larger than 0.1.

Lawrence county used to be low coal dependent in 2005 (below Appalachian median). However, the county switched to high coal dependent in 2015 (above Appalachian median). Scioto county, on the other hand, stayed low coal dependent in both years, 2005 and 2015.

After developing the CIE dependence score to measure the concentration level of CIE-related industries in all counties, Jackson and Jarosi (2018) then developed the second measure: CIE impact measures, which measures the impact of the decline in coal production on Appalachian counties' economies. This measure is to understand the level of job-loss in coal-oriented industries in each county when the decline in coal production occurred. A negative impact score means a county suffered job loss from 2005 to 2015. The larger the negative score means the bigger number of job losses in a county. Surprisingly, the impact of coal decline is not uniformly negative. In fact, Jackson and Jarosi (2018) found that 40% of all counties in the Appalachian area actually experienced a gain in employment.

Lawrence county has tan impact score of 0.11 (Table 6). This means the county experienced a positive impact and a gain in employment in coal-oriented industries from 2005 to 2015 when there was a decline in coal production. Which makes Lawrence one of the counties with a positive impact, or "low impact" category. Scioto on the other hand has an impact score of -0.06, which means the county suffered job loss in coal-oriented industry and is classified as county with high impact (above Appalachian median).

CIE risk is the third measure Jackson and Jarosi (2018) developed to quantify the degree to which counties in the Appalachian area are at risk of facing further negative impact from the decline in coal production. Counties with low productivity coal mines and counties with most of their employment centered in CIE employment face the higher direct risk and risk through supply chain linkages, respectively. Lawrence County has the CIE risk score of 0.32, which is higher than the average CIE risk score for all Appalachian counties, hence why the county is classified as a county with high risk. We expect to see further negative impact on the county's economy in the future. Scioto County, on the other hand, has a CIE risk score of 0.17, which is lower than the Appalachian average. Scioto is classified as a "low risk" county; therefore, we do not expect to see further damage to its economy when coal production continues to decline.

After developing three measures to quantify the degrees of CIE dependence, impact, and risk, Jackson and Jarosi (2018) then combined the three measures to develop an eight-way classification scheme as follows:

Class	Dependence	Impact	Risk
1	High	High	High
2	High	High	Low
3	High	Low	High
4	Low	High	High
5	High	Low	Low
6	Low	High	Low
7	Low	Low	High
8	Low	Low	Low

Table 4: CIE score combination and classification

Counties in classes 1, 3, 6, 8 are highly populated counties. "Class 1" counties are *depressed* counties, these counties are highly dependent on coal, experienced large negative impact as coal production declined, and are facing higher risk as coal production continues to decline. "Class 3" counties are *vulnerable* counties, their economy is still highly coal dependent, they have not experienced a large negative change in CIE related employment, but their economy is at high risk if coal production keeps declining. "Class 6" counties are *hardship* counties, their economy used to be dependent on coal in the past, but they are now no longer coal-dependent since they lost most of their CIE related jobs. Therefore, we don't expect to see further damage to their economy as coal production continues to decline. "Class 8" counties are the least affected counties when there is a change in coal production.

Lawrence County– as mentioned– used to be low coal dependent in 2005, but the county experienced a gain in CIE related employment in the period from 2005 to 2015. Hence, in 2015 the county switched to highly coal-dependent (higher than Appalachian average). This switch puts Lawrence County's economy at high risk of having a negative impact in the future as coal production continues to decline. The combination of high CIE dependence, low CIE impact, and high CIE risk makes Lawrence County one of the "Class 3" counties – *vulnerable* counties.

Scioto County has a low CIE Dependence score, a high CIE Impact score, and a low CIE Risk score; hence, the county is classified as a *hardship* county – "Class 6" county. Scioto experienced a high negative impact in CIE related employment as coal production declined, which caused the county to lose most of its CIE related jobs. Therefore, the county is no longer highly coal-dependent, and we do not expect to see further negative impact to its economy in the future if coal production continues to decline.

Figure 2 shows the topology map of Ohio's Appalachian counties. According to the topology map, most of Ohio's Appalachian counties are CIE *depressed*, or CIE *vulnerable*, or CIE *hardship*. There are only 4 counties in the Ohioan Appalachian region are classified as "CIE low affected", which are Clermont County, Pike County, Ross County, and Hocking County. The map shows that Lawrence County is surrounded by PIE *depressed* (Class 1) counties and PIE *hardship* (Class 7) counties, while Scioto is neighbored by one CIE *depressed* county, one CIE *vulnerable* county, one CIE *hardship* county, and 1 CIE *low affected* "Class 8" county.



Figure 2: Map of CIE topology for Ohio's Appalachian counties Source: Based on Jackson and Jarosi (2018)'s CIE topology classification

FIPS	County	Class	PIE Dependence Rank	PIE Impact Rank	Total PIE Risk Rank	Region Dependence	Local PIE Dependence	PIE Impact Score	County PIE Risk	Total Risk
39001	Adams	3	33	312	20	2.8	2.2	0.1	75.9	5.8
39007	Ashtabula	4	279	130	127	0.9	0.2	-0.2	44.4	1.8
39009	Athens	8	229	313	275	1	0	0.1	0	1.1
39013	Belmont	3	138	369	147	1.3	0	0.3	0	1.6
39015	Brown	3	16	417	19	3.8	0	3	0	5.9
39019	Carroll	3	127	400	49	1.3	0.3	0.7	51.3	3
39025	Clermont	1	82	116	70	1.6	0.4	-0.3	56.6	2.5
39029	Columbiana	4	302	73	209	0.8	0	-0.5	0	1.4
39031	Coshocton	1	24	20	14	3	2.4	-1.6	83.5	7.8
39053	Gallia	1	9	10	5	5.2	2.9	-2	58.3	10.5
39059	Guernsey	8	300	237	244	0.8	0	0	0	1.2
39067	Harrison	3	73	317	76	1.6	0	0.1	0	2.4
39071	Highland	6	237	102	223	1	0	-0.3	0	1.3
39073	Hocking	6	404	192	405	0.6	0	-0.1	0	0.6
39075	Holmes	3	169	358	81	1.2	0	0.2	0	2.4
39079	Jackson	1	202	140	171	1.1	0	-0.2	0	1.5
39081	Jefferson	1	13	71	11	4.2	4.1	-0.5	76.2	8.3
39087	Lawrence	3	146	249	85	1.3	0.3	0	52.1	2.3
39099	Mahoning	6	239	189	229	1	0	-0.1	0	1.3
39105	Meigs	1	105	158	125	1.4	0	-0.2	0	1.8
39111	Monroe	6	295	57	282	0.9	0	-0.7	0	1.1
39115	Morgan	1	63	70	99	1.7	0	-0.5	0	2.1
39119	Muskingum	3	157	331	101	1.2	0.4	0.2	44.2	2.1
39121	Noble	8	312	238	314	0.8	0	0	0	1
39127	Perry	2	208	156	240	1.1	0	-0.2	0	1.2
39131	Pike	3	180	236	149	1.2	0	0	0	1.6
39141	Ross	8	256	243	250	0.9	0.1	0	25.6	1.2
39145	Scioto	7	329	230	160	0.8	0.3	-0.1	61.3	1.6
39155	Trumbull	6	254	127	286	0.9	0	-0.2	0	1.1
39157	Tuscarawas	7	219	362	62	1	0.3	0.3	85.1	2.6
39163	Vinton	6	339	11	338	0.8	0	-2	0	0.9
39167	Washington	3	128	328	88	1.3	0.5	0.1	49.9	2.2

Table 5: PIE dependence, impact, and risk scores for Ohio's counties in the Appalachian area.

Source: Jackson and Jarosi (2021)

FIPS	County	Class	Global Dependence	Local Dependence	CIE Impact Score	Mine-productivity Risk	Total CIE Risk
39001	Adams	6	0.22	0	-0.08	0	0.22
39007	Ashtabula	6	0.28	0	-0.04	0	0.28
39009	Athens	1	0.33	0.05	-0.07	30.88	0.43
39013	Belmont	3	3.38	0.35	0.14	13.78	3.86
39015	Brown	3	0.59	0.1	0.37	50	0.89
39019	Carroll	3	1.9	0.47	1.83	68.88	3.23
39025	Clermont	8	0.3	0	0.05	0	0.3
39029	Columbiana	1	0.36	0.02	-0.21	6.51	0.39
39031	Coshocton	1	0.57	0	-0.88	36.15	0.77
39053	Gallia	6	0.17	0	-0.28	0	0.17
39059	Guernsey	3	0.68	0.07	0.37	29.18	0.88
39067	Harrison	3	8.86	1.71	0.03	30.17	11.73
39071	Highland	6	0.24	0	-0.12	0	0.24
39073	Hocking	8	0.28	0	0.06	0	0.28
39075	Holmes	3	0.36	0	0.02	1.69	0.36
39079	Jackson	1	0.6	0.13	-1.09	55.81	0.94
39081	Jefferson	1	0.48	0.08	-0.34	79.02	0.86
39087	Lawrence	3	0.32	0	0.11	0	0.32
39099	Mahoning	3	0.35	0	-0.02	0.38	0.35
39105	Meigs	6	0.24	0	-0.5	6.98	0.25
39111	Monroe	3	0.55	0	0.05	0	0.55
39115	Morgan	3	0.3	0	0.04	0	0.3
39119	Muskingum	6	0.29	0	-0.06	0	0.29
39121	Noble	3	1.87	0	0.1	0	1.87
39127	Perry	1	1.42	0.34	-0.04	80.14	2.56
39131	Pike	8	0.3	0	0.08	0	0.3
39141	Ross	8	0.17	0	-0.02	0	0.17
39145	Scioto	6	0.17	0	-0.06	0	0.17
39155	Trumbull	6	0.29	0	-0.12	0	0.29
39157	Tuscarawas	3	0.94	0.16	0.27	51.28	1.43
39163	Vinton	1	1.14	0.13	-4.27	89.74	2.17
39167	Washington	1	0.41	0	-0.11	0	0.41

Table 6: CIE dependence, impact, and risk scores for Ohio's counties in the Appalachian area. Source: Jackson and Jarosi (2021)