

**A Study on the Current Economic Impacts  
of the Appalachian Coal Industry and its Future in the Region**

**Appendices**

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**Appendix A: 118 Major Coal-Producing Counties in the ARC Region**

<b>Alabama</b>	<b>Kentucky</b>	<b>Maryland</b>	<b>Ohio</b>	<b>Pennsylvania</b>	<b>Tennessee</b>	<b>Virginia</b>	<b>West Virginia</b>
Bibb	Bell	Allegany	Belmont	Allegheny	Anderson	Buchanan	Barbour
Blount	Breathitt	Garrett	Carroll	Armstrong	Campbell	Dickenson	Boone
Cullman	Clay		Columbiana	Beaver	Claiborne	Lee	Braxton
Fayette	Floyd		Coshocton	Blair	Fentress	Russell	Brooke
Jackson	Harlan		Gallia	Butler	Marion	Tazewell	Clay
Jefferson	Johnson		Guernsey	Cambria	Morgan	Wise & Norton	Fayette
Marion	Knott		Harrison	Carbon	Scott		Gilmer
Shelby	Knox		Holmes	Centre	Sequatchie		Grant
Tuscaloosa	Lawrence		Jackson	Clarion			Greenbrier
Walker	Leslie		Jefferson	Clearfield			Harrison
Winston	Letcher		Meigs	Columbia			Kanawha
	Magoffin		Monroe	Elk			Lincoln
	Martin		Morgan	Fayette			Logan
	Owsley		Muskingm	Greene			McDowell
	Perry		Noble	Indiana			Marion
	Pike		Perry	Jefferson			Marshall
	Whitley		Tuscarawas	Lackawanna			Mineral
			Vinton	Lawrence			Mingo
				Luzerne			Monongalia
				Lycoming			Nicholas
				Mercer			Preston
				Northumberland			Raleigh
				Schuylkill			Randolph
				Somerset			Tucker
				Sullivan			Upshur
				Venango			Wayne
				Washington			Webster
				Westmoreland			Wyoming

## Appendix B: Mathematical Derivation of IMPLAN Multipliers

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Multipliers used in this analysis are developed using the Micro IMPLAN model. These multipliers serve the purpose of breaking down the stimuli of economic activity into three components: direct effects, indirect effects, and induced effects. These effects are defined as follows<sup>23</sup>:

- *Direct effects* are defined as the economic activity changes that occur in the industry to whom a final demand change was made.
- *Indirect effects* are the changes that occur as a result of the inter-industry purchases as the directly affected industry responds to the direct change.
- *Induced effects* reflect the changes in household spending due to changes in income or population as a result of the changes in production.

These multipliers were generated in the economic activity categories of income, employment, and value-added. The process of developing the multipliers begins with a matrix of input-output transactions of industries. Columns of this matrix represent purchases by that industry to produce its goods and services. Rows of the matrix represent demanders of the column industry's goods. With the Type II multiplier, the household income row and household expenditures column are treated as an industry. Thus they are included in the Leontief inversion explained below. A coefficient matrix is derived by dividing each industry column element by the column total. This is referred to as the A matrix of coefficients. The matrix of coefficients can be rewritten as a series of linear equations as is shown in the following example:

$$X_1 = 0.272 \cdot X_1 + 0.312 \cdot X_2 + 0.124 \cdot X_3 + Y_1$$

$$X_2 = 0.123 \cdot X_1 + 0.324 \cdot X_2 + 0.313 \cdot X_3 + Y_2$$

$$X_3 = 0.211 \cdot X_1 + 0.111 \cdot X_2 + 0.123 \cdot X_3 + Y_3$$

Or, in matrix notation:

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} 0.272 & 0.312 & 0.124 \\ 0.123 & 0.324 & 0.313 \\ 0.211 & 0.111 & 0.123 \end{bmatrix} * \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

The above can also be written in matrix notation as:

$$X = X * A + Y$$

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<sup>23</sup> From IMPLAN user's guide, analysis guide, and data guide.

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This notation implies that output, designated as  $X_i$ , is equal to transactions ( $A \cdot X_i$ ) plus final demand ( $Y_i$ ). Subtracting transactions from both sides of the above equation yields:

$$X - X \cdot A = Y$$

Using the property of the identity matrix, we can obtain:

$$X \cdot (I - A) = Y$$

Now, after solving for  $X$  by multiplying both sides of the above equation by the inverse of the  $(I-A)$  matrix, we have:

$$X = (I - A)^{-1} \cdot Y$$

What results is the predictive multiplier model. The verbal interpretation of the above equation is that the change in total industry output,  $X$ , is equal to  $(I-A)^{-1}$  times the change in final demand. So, the inverse of the  $(I-A)$  matrix is the matrix of multipliers.

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**Appendix C: Data Sources**

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Energy Information Administration, *Coal Industry Annual*,  
[www.eia.doe.gov/cneaf/coal/page/database.html](http://www.eia.doe.gov/cneaf/coal/page/database.html)

Energy Information Administration, *Coal Program, 1997, Annual Report*

U.S. Census Bureau, Bureau of Economic Analysis, *Gross Product by Industry for the United States and States*, and the *Regional Economic Information System 1969 to 1997 (REIS)*.

1996, 1997, and 1998 Income Tax Paid, [www.bea.doc.gov/bea/regional/spi/pi.htm](http://www.bea.doc.gov/bea/regional/spi/pi.htm)

U.S. Census Bureau, [www.census.gov/govs/www/state.html](http://www.census.gov/govs/www/state.html).

Unpublished Data, Energy Information Agency

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**Appendix D: References**

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Black, Dan, Kermit Daniel, and Seth Sanders, 1996. "How Much Does Local Economic Growth Help the Poor?" Working Paper (January).

Black, Dan, Terra McKinnish, and Seth Sanders, 1999. "How the Availability of High-Wage Jobs for Low-Skilled Men Affects AFDC Expenditures: Evidence from Shocks to the Coal and Steel Industries." Working Paper (June).

Energy Information Agency, United States Department of Energy, 1999. *1999 Annual Energy Outlook*. Washington, D.C.: United States Government Printing Office (or [www.eia.doe.gov](http://www.eia.doe.gov))

Energy Information Administration, United States Department of Energy, 1998. *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*. D.C.: United States Government Printing Office (or [www.eia.doe.gov](http://www.eia.doe.gov)).

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**Appendix E: Baseline and Multiplier Data by County**

COUNTY	Indirect Output Multiplier	Coal Mining Earnings 1997 (Millions of \$)	Total Earnings All Industries 1997 (Millions of \$)	Total Coal Mining Employment	Total County Employment	Earnings per Job, Coal Mining	Subsurface Production In Tons, 1997	Surface Production In Tons, 1997	Coal Produced In Tons, 1997	Coal Mining Gross "County" Product, 1997 in \$
Bibb, AL	0.000000	344	121644	49	5285	82595	0	21199	21199	683123
Blount, AL	0.160408	1535	309483	49	11260	82595	0	5765	5765	3048173
Cullman, AL	0.097319	94	838399	38	28722	82595	0	74266	74266	186667
Fayette, AL	0.217151	9296	175890	375	7682	82595	1992408	0	1992408	18460715
Jackson, AL	0.117716	1197	572308	53	18510	82595	0	44716	44716	2377639
Jefferson, AL	0.257315	135971	14991912	2052	416260	82595	9068777	1300783	10369560	270014791
Marion, AL	0.225860	2274	374093	43	14102	82595	0	129653	129653	4515759
Shelby, AL	0.249306	6164	1574264	87	55611	82595	853292	0	853292	12241527
Tuscaloosa, AL	0.330238	136846	2444828	1750	85133	82595	6074704	581669	6656373	271751795
Walker, AL	0.370409	99221	626770	750	21300	82595	515403	3562306	4077709	197035243
Winston, AL	0.094868	3944	336519	53	12298	82595	0	243118	243118	7831133
Bell, KY	0.365478	38663	272745	750	9849	60307	3325120	1638298	4963418	76974248
Breathitt, KY	0.262317	6160	91953	10	3765	60307	0	4311949	4311949	12263808
Clay, KY	0.248489	3066	135463	10	5552	60307	0	330451	330451	6104032
Floyd, KY	0.360768	41349	372950	1553	12765	60307	2897926	3460561	6358487	82320814
Harlan, KY	0.368982	71677	266699	1086	8262	60307	9026494	1577883	10604377	142700162
Johnson, KY	0.340763	8481	191828	162	6566	60307	1327652	307587	1635239	16884636
Knott, KY	0.316787	63901	132241	976	3343	60307	5119285	7004536	12123821	127219095
Knox, KY	0.033762	6877	204670	175	7861	60307	444268	115604	559872	13691268
Lawrence, KY	0.196157	964	85142	10	3295	60307	60326	174262	234588	1919206
Leslie, KY	0.286295	12860	131376	255	2247	60307	7354300	2580274	9934574	25603513
Letcher, KY	0.333496	44646	176528	998	6238	60307	6061261	2971004	9032265	88884739
Magoffin, KY	0.026253	10238	68928	175	3092	60307	0	1330763	1330763	20382780
Martin, KY	0.304672	48501	109214	750	3109	60307	7093081	5436740	12529821	96559501
Owsley, KY	0.116985	688	17395	12	1015	60307	0	113279	113279	1370032
Perry, KY	0.388361	56063	360864	1750	11640	60307	4841069	6638687	11479756	111614593
Pike, KY	0.370909	244039	817771	4241	23569	60307	22129237	12823451	34952688	485851876
Whitley, KY	0.296630	6224	328555	152	14430	60307	247641	173950	421591	12391225
Allegany, MD	0.253142	4882	928478	175	31161	N/A	0	561223	561223	10737270
Garrett, MD	0.297661	21501	315783	375	10832	N/A	3300861	297594	3598455	47288414
Belmont, OH	0.271386	39749	589798	622	23638	71854	5101746	1634796	6736542	64358942
Carroll, OH	0.100147	470	190423	10	7064	71854	0	58322	58322	761001
Columbiana, OH	0.165839	8592	1036431	133	35995	71854	336566	442585	779151	13911596

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Coshocton, OH	0.223226	7784	435978	240	18654	71854	0	368363	368363	12603336
Gallia, OH	0.099470	97	344736	60	12078	71854	0	333421	333421	157056
Guernsey, OH	0.138719	9188	417498	347	16503	71854	0	480672	480672	14877008
Harrison, OH	0.276512	14573	101975	175	4465	71854	1385512	704207	2089719	23595634
Holmes, OH	0.120365	2059	460963	60	14986	71854	0	121907	121907	3333796
Jackson, OH	0.249945	16834	317511	146	12328	71854	0	1147401	1147401	27256495
Jefferson, OH	0.222801	3743	703510	63	24071	71854	477480	429286	906766	6060417
Meigs, OH	0.292440	53932	171445	750	5421	71854	6404517	0	6404517	87323256
Monroe, OH	0.234861	20394	198236	375	5699	71854	3243474	0	3243474	33020017
Morgan, OH	N/A	11183	133727	203	3710	71854	0	0	1543498	18106889
Muskingum, OH	0.180242	4356	1066421	60	38702	71854	0	701407	701407	7052193
Noble, OH	0.179742	2337	94547	60	3973	71854	0	869978	869978	3784707
Perry, OH	0.187071	2958	204714	49	7158	71854	0	1234156	1234156	4789397
Tuscarawas, OH	0.230656	18419	1078122	434	38453	71854	0	1316504	1316504	29822822
Vinton, OH	0.275758	10149	66427	175	2817	71854	0	1809362	1809362	16432775
Allegheny, PA	0.183288	128658	29446380	175	752310	99072	330	41057	41387	156469727
Armstrong, PA	0.282739	49141	669096	762	21256	99072	4391584	1557903	5949487	59763706
Beaver, PA	0.156137	3853	2057147	79	58234	99072	0	88661	88661	4686247
Blair, PA	0.147570	759	1853043	10	57994	99072	0	35796	35796	922743
Butler, PA	0.225061	12827	2245150	60	67807	99072	0	111577	111577	15599785
Cambria, PA	0.262487	64364	1832020	361	60400	99072	105923	1322972	1428895	78277429
Carbon, PA	0.126434	1692	464348	53	16801	99072	0	0	318312	2057756
Centre, PA	0.119504	1192	2196554	159	75151	99072	0	387960	387960	1449672
Clarion, PA	0.264750	20909	501537	158	16257	99072	0	683180	683180	25428854
Clearfield, PA	0.337290	38197	982068	750	32683	99072	163374	4438218	4601592	46453964
Columbia, PA	0.100809	512	794225	123	28253	99072	174513	748807	923320	622678
Elk, PA	0.131244	1770	581150	86	17347	99072	0	642795	642795	2152617
Fayette, PA	0.219710	13724	1157213	299	39830	99072	0	388437	388437	16690688
Greene, PA	0.279462	183358	464288	2183	11961	99072	35324489	37580	35362068	222994110
Indiana, PA	0.310788	159666	1111502	1105	32078	99072	3940553	879413	4819966	194180661
Jefferson, PA	0.274739	33328	526697	237	16082	99072	613650	929015	1542665	40532443
Lackawanna, PA	0.134524	1540	3109264	4	103146	99072	0	82951	82951	1872899
Lawrence, PA	0.186184	3775	1082132	60	33857	99072	0	16648	16648	4591034
Luzerne, PA	0.202409	14736	4617495	154	142846	99072	0	896633	896633	17921450
Lycoming, PA	0.163746	1511	1639209	60	54723	99072	0	406519	406519	1837630
Mercer, PA	0.144334	530	1511430	4	51374	99072	0	3972	3972	644569

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Northumberland, PA	0.170379	8603	968055	52	29935	99072	35767	281858	317625	10462692
Schuylkill, PA	0.286212	62129	1616800	1024	51951	99072	208702	2221723	2430425	75559294
Somerset, PA	0.305836	94145	868573	781	26910	99072	2097040	3508069	5605109	114496125
Sullivan, PA	0.098035	225	53144	2	1951	99072	0	16760	16760	273257
Venango, PA	0.164736	2981	697586	9	21306	99072	0	67689	67689	3625396
Washington, PA	0.304702	107168	2530798	1566	78668	99072	7772833	690823	8463656	130334279
Westmoreland, PA	0.169719	14359	4589451	96	143713	99072	0	872073	872073	17462955
Anderson, TN	0.162269	5660	1447732	175	41506	115868	173389	260192	433581	3827192
Campbell, TN	0.272839	13683	277756	60	10644	115868	592873	283102	875975	9252204
Claiborne, TN	0.115886	3783	225579	100	11293	115868	231407	441026	672433	2557998
Fentress, TN	0.186252	801	136399	59	5734	115868	0	288016	288016	541622
Marion, TN	0.171973	3028	184978	28	7119	115868	0	52525	52525	2047193
Morgan, TN	0.117502	1038	119950	53	3938	115868	55744	0	55744	701877
Scott, TN	0.107869	1866	148597	148	7386	115868	107646	0	107646	1261756
Sequatchie, TN	0.221260	4262	72229	117	2971	115868	235420	578731	814151	2881889
Buchanan, VA	0.351391	137528	328065	2991	9898	54113	13219254	1201231	14420485	213647107
Dickenson, VA	0.288905	24806	104583	360	3117	54113	1845209	1212458	3057667	38535645
Lee, VA	0.303049	21590	153560	270	6731	54113	1233966	237380	1471346	33539650
Russell, VA	0.329305	28771	253905	686	10112	54113	897367	236044	1133411	44695196
Tazewell, VA	0.351906	24899	437473	617	17521	54113	1704625	0	1704625	38680118
Wise & Norton, VA	0.373467	122971	553380	2225	13091	54113	8028878	6020272	14049150	191033087
Barbour, WV	0.298138	13145	82061	175	4106	66440	1291963	78763	1370726	29554307
Boone, WV	0.311253	226185	356705	2904	7713	66440	18712172	11890107	30602280	508537775
Braxton, WV	0.089818	2962	102722	45	4209	66440	412769	0	412769	6658976
Brooke, WV	0.212676	11043	285890	168	8376	66440	1539002	0	1539002	24827876
Clay, WV	0.305958	25139	61812	375	2055	66440	0	6901924	6901924	56520504
Fayette, WV	0.305613	35239	379677	1604	14212	66440	861865	2844474	3706339	79228925
Gilmer, WV	0.202508	1604	53930	9	1990	66440	15460	0	15460	3606322
Grant, WV	0.313163	14672	142626	375	5039	66440	1253750	663120	1916870	32987086
Greenbrier, WV	0.258599	6037	360732	80	13519	66440	501160	27018	528178	13573172
Harrison, WV	0.274947	37375	1016105	707	34396	66440	5143801	148411	5292212	84031360
Kanawha, WV	0.274101	85614	3956987	591	114892	66440	4245978	4650637	8896615	192488584
Lincoln, WV	0.191950	1713	81530	8	2840	66440	46818	0	46818	3851390
Logan, WV	0.329049	112345	432456	1341	12725	66440	5275793	15191113	20466906	252588712
McDowell, WV	0.356964	34695	168181	750	6141	66440	4825795	1846966	6672761	78005259



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Marshall, WV	0.289783	57919	416277	863	9449	66440	10131444	0	10131444	130221066
Mineral, WV	0.226783	1614	176068	9	6740	66440	0	121862	121862	3628125
Mingo, WV	0.327372	178542	383631	1750	9544	66440	17327072	5097023	22424096	401421459
Monongalia, WV	0.288770	81424	1178636	1213	44677	66440	6365490	1269183	7634673	183069081
Nicholas, WV	0.387196	38016	232981	473	8514	66440	2103904	500868	2604772	85472540
Preston, WV	0.361968	13742	180549	221	7648	66440	1608206	134528	1742734	30895993
Raleigh, WV	0.340815	103019	902465	1238	29977	66440	12812100	1070148	13882248	231620780
Randolph, WV	0.292708	6783	297994	175	11200	66440	625654	0	625654	15249381
Tucker, WV	0.156741	1383	66998	21	3419	66440	0	192696	192696	3108659
Upshur, WV	0.285924	8566	205855	82	8048	66440	1314665	269892	1584557	19259201
Wayne, WV	0.296382	26998	299479	464	11008	66440	3715297	678838	4394135	60700475
Webster, WV	0.327176	27208	75454	522	2640	66440	2548071	2775952	5324023	61172582
Wyoming, WV	0.315483	74947	194139	1750	5960	66440	9038805	775256	9814061	168505641