Issues in Political Economy, Vol 27(2), 2018, 79-101

Resource Curse in Appalachia: Entrepreneurship and Coal Dependence

Nathaniel Edenfield, American University

I. Introduction

There has been a recent surge of interest in the concept of the resource curse, a phenomenon where countries rich in natural resources, such as minerals and fossil fuels, tend to have slower economic growth than those that possess few resources. The majority of earlier empirical literature on the resource curse, starting with Sachs and Warner (1995, 1997, 2001), study the curse at the international level. However, these studies have been plagued by endogeneity concerns and heterogeneous samples when working with very different countries and economic systems. In response, later literature has turned to within-country analysis, which has been noted as effective way to better to mitigate these issues (Van der Fleog 2011; Badeeb, Lean, Clark 2017). Following the trend of subnational analysis, this study will look at the correlation between coal dependence and real personal income per capita in counties of the Appalachian region of the United States from 1980-2007.

Several scholars have studied the resource curse in Appalachia, many of which have found evidence for its existence (Deaton and Nimon 2012; Partridge, Betz, and Lobao 2013). Moreover, others have examined the ways in which resource dependence hinders economic growth, such as disincentives to human capital formation (Douglas and Walker 2017). This study seeks to build upon this literature by examining the degree in which the crowding out of entrepreneurship explains the negative correlation between dependence on the coal industry and income growth. Scholars of Appalachian history have posited that the coal industry has had adverse negative effects on entrepreneurial spirit of the region as it has been subjugated to "internal colonialism" and a culture of "dependency" (Caudill 1964; Salstrom 1994). Betz et al. (2015) found evidence that an increase in mining employment was associated with a decrease in the share of proprietors to total employment, a common proxy of entrepreneurship. Likewise, increased entrepreneurship has been shown to be a factor of economic growth in rural America and Appalachia (Rupasingha and Goetz 2011, 2013; Stephens and Partridge 2011, Stephens, Partridge & Faggian 2013). These findings would imply that the crowding out of entrepreneurship is indeed a channel of the resource curse in the region. This study seeks to empirically test whether this implication is true.

In order to determine whether the connection between resource extraction, entrepreneurship, and economic growth holds and to what degree reduced entrepreneurship acts as a channel of the resource curse, we employ a simultaneous equation model with instruments to mitigate endogeneity concerns and estimate a more specified relationship between growth and its determinants. Through this model, the study aims to determine the association between coal dependence and economic growth and then to what degree the crowding out of entrepreneurship correlated with coal dependence explains this association. It will consider economic growth, measured as the percent growth in real personal income per capita, over two main periods: 1980-2000 and 1990-2007.

Government leaders at the local, regional, and national level in places with an abundance of natural resources must learn long term management strategies to ensure the benefits of their resource endowment are sustainable and lead to diversified growth. In regards to the development of new, local businesses - a key component in this process - this study can shed light on whether regions with a large coal industry are at greater risk for reduced levels of entrepreneurship. Information on where funds can best be applied would be crucial to efficient and effective policymaking. Moreover, while coal resources are typical seen as declining in importance for a modern economy, places like Southeast Asia are turning to coal production to meet growth in energy demand much like United States during the 20th century (IEA 2017). Recognizing the implications of increased coal dependence on factors of the economy, such as entrepreneurship, is necessary for these regions to develop their resources sustainably.

The paper will continue as follows. We first present a review of the various channels of the resource curse, then turn to work specifically done on the resource curse within Appalachia. Next, we will cover the conceptual framework of our model, the data used, and then the empirical model. We interpret the results and conclude with policy implications.

II. The Resource Curse and its Channels

Since the times of Adam Smith and David Ricardo, it has been thought that an abundance of natural resources would lead to higher incomes and greater financial investments, thus producing faster growth and greater economic development. Towards the latter half of the 21st century, scholars began to recognize that natural resources did not imply faster, equal, or sustainable growth. Sachs and Warner (1995, 1997, 2001), looking at cross national panel data from 1965 onward, were the first to find a statistically significant relationship between resource production and long run economic growth. After Gylfason (2001) investigated possible links between resource dependence and factors of economic growth, such as human capital formation and savings, others followed and began to investigate possible channels of the resource curse.

The channels of the resource curse can be broken into two categories: economic and political. One economic channel is volatile energy prices in global markets. Market instability in energy based economies can restrict a government's ability to perceive natural resource revenue and lead to volatile output growth (David and Tilton 2005; Glyfason et al. 1999; Moradbeigi and Law 2016). Another channel is economic mismanagement, or that excess revenue for resource rents can allow policymakers to delay developing other stimulants of economic growth, such as urban policy, funding for higher education, or infrastructure (Ross 2007, Iimi 2007). Likewise, lucrative pay in extractive industries has been found to be a disincentive to accumulate human capital, such as education (Glyfason 2001, Black et al. 2005a). On the other hand, there are also political channels to the resource curse, particularly the role of institutions in terms of governance, renting seeking behavior, economic freedom and other factors that can possibly determine whether a resource endowment is be used effectively for long run growth (Mehlum, Moene, and Torvik 2006; Alexeev and Conrad 2009).

Finally, there is the concept of the Dutch Disease. Typically studied at the macro and cross national level, the Dutch Disease represents the appreciation of a country's currency – thus making the country's tradable goods less competitive – due to an influx of foreign currency from the sale of newfound reserves of natural resources. At the local level, Dutch Disease represents a shift of capital and labor within a region to the growing, lucrative extractive industry. Increased demand for local labor and capital increases the prices of those inputs for other tradable sectors like manufacturing, making them less competitive to similar industries in other regions and restricting diversified economic growth (Cordon and Neary 1983; Sachs and Warner 1995, 1999; Gillis et al. 1996; Gylfason 2001). Sachs and Warner (2001) expand this idea, proposing that the crowding out of entrepreneurs due to the shift of capital and labor to the extractive industry prevents balanced development and therefore is a possible mechanism of the resource curse.

III. Appalachia as a Case Study

The Appalachian mountain region of the United States is well suited to test for the resource curse and its mechanisms with its near homogenous cultural history and long history of resource extraction (Drake 2003). Its most widespread and well known resource is coal, which has been mined across Appalachia at different times and intensities for over 100 years (Milici and Polyak 2014). At the same time, Appalachia has faced severe economic difficulties. Poverty in Appalachia was once near ten percentage points higher than the national average in 1960 and is still up to five points higher than the national average in areas like Central Appalachia (PARC 1964; ARC 2015). With both intense coal extraction and economic disparity, Appalachia provides an excellent "natural laboratory" to further explore the impact of resource production with economic growth (Douglas and Walker 2017).

The presence of the resource curse in Appalachia has received attention from several scholars. Deaton and Niman (2012) employ a panel dataset to test poverty rates against level of contemptuous coal production and lag of production of decennial data from 1960-1990 and find that increased coal production in Appalachian counties decreased poverty in the short run but increased poverty levels in future periods. Similarly, Partridge, Betz, and Lobao (2013) look at changes in technology and conditions in the coal industry since 1990 and find that increased production had a weak positive effect on poverty levels between 1990 and 2000 but a negative effect from 2000 to 2010, suggesting a reversal of the resource curse in Appalachia.

Most recently, Douglas and Walker (2017) test real income growth against the coal dependence in Appalachia from 1970-2010 through a fixed effects model grouped by state. They find that a one standard deviation increase in their measure of coal dependence decreased annual real income growth by 0.5 to 1.0 percentage points, which compounded over 40 years would result in an 18% to 33% difference from the average income. In addition, they use a simultaneous equation model to estimate the degree in which the resource curse operates through disincentives to education and find education explains approximately 13% of the curse.

There have also been several studies done on the association between entrepreneurship and economic growth in Appalachia, as well as between entrepreneurship and resource dependence. However, no study has combined the two to estimate the possible indirect impact of resource dependence on growth through entrepreneurship: a gap this study seeks to fill.

Stephens and Partridge (2011) estimate the impact of the share of non-farm proprietors to total employment in 1990 on the change in employment and per capita income growth. Instrumenting the share of non-farm proprietors in 1990 with the deep lag share of non-farm proprietors and population density in 1960, they find that a one percentage point increase in the share of non-farm proprietors is associated with a four percentage point growth in employment. This study was subsequently followed up by Stephens, Partridge, and Faggian (2013) where they run a similar model to determine which factors, such as entrepreneurship, human capital, and creativity, contribute to economic growth in lagging regions such as Appalachia. Using a propensity score matching technique to pair Appalachian counties with similar non-Appalachian counties, they find that only entrepreneurship and the percent of people in creative class occupations have a significant, positive correlation with employment growth.

Betz, Partridge, Farren, and Lobao (2015) estimate the correlation of the intensity of coal mining, measured by the percentage of the workforce employed in coal mining at the county level, with various economic indicators. Using the quality of coal as an instrument for the initial share of mining in each county, they find little evidence for the resource curse from 1990-2010. However, they do find that initial share of mining is negatively correlated with proprietor share of total employment. They suggest "one avenue by which coal mining could foster a natural resource curse – by restraining entrepreneurial spirits and small business start-ups" (113). This study seeks to determine whether this claim is true for Appalachian counties between 1980-2007.

IV. Conceptual Framework

This work relies in part on the same theoretical model described by Stephens and Partridge (2011). Based on the traditional endogenous growth model of Romer (1986, 1990), Braunerhjelm et al. (2010) introduces the Schumpeterian entrepreneur, or an entrepreneurship focused on innovation, into the model. Here Schumpeterian entrepreneurship acts as mechanism to convert general knowledge into economic knowledge, and hence greater entrepreneurial spirit corresponds to increased growth. Entrepreneurial capital is often subject to government policy, institutions, infrastructure, and other factors that are seen to be correlated with economic growth. Because of these influences, many scholars focus on entrepreneurs in a local economy to test the role they play in economic growth such as Acs and Audretsch (2007), Shrestha, Goetz, and Rupasingha (2007), and Stephens and Partridge (2011). From their work, entrepreneurship has been shown to have a positive effect on economic growth in a given locality.

Focusing on the determinants of entrepreneurship, individuals will maximize utility through a choice of career between the expected value of entrepreneurial activity, based on their entrepreneurial ability, economic conditions, and the expected returns to becoming an entrepreneur, and wage-salary employment. In addition, other factors such as education and availability of capital have also been shown to influence an individual's choice to pursue entrepreneurial activity (Goetz and Rupasingha 2009). And in a place like Appalachia, where coal mining jobs can attract $60,000 or more without a college degree, a growing extractive sector will attract potential entrepreneurs to wage and salary jobs and potentially crowd out entrepreneurs from starting independent businesses. (BLS 2017). Hence when the coal industry has a large presence in a given locality - attracting both potential entrepreneurs and capital that could be used by entrepreneurs to the coal industry – it restricts the number of new businesses, proprietorships, and overall entrepreneurial spirit. Since entrepreneurship is a significant component of economic growth and development, greater coal dependence would then decrease income growth indirectly through a reduction in entrepreneurial activity. Together, this suggests that entrepreneurship is a potential channel of the resource curse.

V. Data

The dataset used in this study contains decennial panel data from 1970-2007 on 409 counties defined as Appalachian by Douglas and Walker (2013), who select counties based on shared history and culture to create a more homogenous sample of Appalachian counties.[i] Table 1 describes each variable used in our regressions. Most economic data were collected from the Bureau of Economic Analysis and US Census websites, while data on coal production were obtained from the US Geological Survey and Energy Information Agency.
While other studies on Appalachia use poverty rates when measuring the resource curse, such as Deaton and Niman (2012) and Partridge, Betz, and Lobao (2013), this study will follow Douglas and Walker (2017) and use annualized growth rate of real per capita income minus transfers as the dependent variable.[ii] The variable for coal dependence comes from Douglas and Walker (2017) and is measured as the ratio between coal production revenue and total personal income in a county. This measure gives a sense of how significant the coal industry is relative to the county's economy, and overall, an approximation of coal dependence.

Of keen interest to this study is the impact of entrepreneurship on growth. Since there is no one measure of entrepreneurship, we will use the share of non-farm proprietors to total employment – proprietor employment share – to indicate entrepreneurship in our model. This proxy has also been used by Stephens and Partridge (2011), Goetz & Rupasingha (2014), Betz et al. (2015) and others to assess rural entrepreneurship levels. Entrepreneurship represents the willingness and ability of residents in an area to take risks and turn their knowledge into economic activity for the community. The share of non-farm proprietors represents the percentage of those willing and able to take these risks as an entrepreneur within their local economic conditions. Thus a high share of proprietors would suggest that there is a high entrepreneurial spirit in the county, while a low share would imply the opposite.

Table 1. Variable Descriptions and Descriptive Statistics (for 1980)

Variable	Description	Mean	Std. Dev.	Min	Max
Income Growth	Annualized growth rate of real per capita personal income net of transfers (1980-2000; 1990-2007) (BEA)	2.3176	0.9091	-0.3231	8.4372
Initial Income	Natural log of real per capita income net of transfers in initial year of period (BEA)	9.650203	0.216176	8.938157	10.55082
Proprietor Employment Share	Share of nonfarm proprietors to total county employment (BEA)	0.133596	0.040679	0.0074002	0.365017
Coal Dependence	County coal revenue divided by total personal income, initial year of period (EIA, USGS)*	0.064893	0.278848	0	3.996943
Oil Price Control	Percent change in real oil prices for initial decade in coal producing counties (EIA)*	-0.147728	0.342272	-0.94	0
Education	Percent with bachelor's degree or higher (US Census)	0.100524	0.050999	0.0280066	0.428055
Natural Amenities	Index of natural amenity quality (USDA)*	-0.199966	1.17809	-3.98	3.55
Pop Density 1960	Population density in 1960 (US Census)	0.386434	3.131623	0.003688	78.57755
Change in Pop	Percent change in population 10 years from initial year of period (US Census)	0.137695	0.126083	0.2321548	0.941853
Metro Designation	=1 if Beale Code ≤ 3 (Metro Area) (BEA)*	0.291866	0.454837	0	1
Rural Designation	= 1 if Beale Code ≥ 7 (Pop < 20,000; not adjacent to an urban area) (BEA)*	0.428438	0.495084	0	1
Coal Quality	Coal heat content per ton ash created (USGS)*	41.17047	104.4184	0	736.665
Coal Mine Presence	= 1 if county ever produced coal (USGS)*	0.174928	0.380089	0	1
Proprietor Earnings	Real Earnings (millions) per nonfarm proprietors (BEA)	21.580	6.643	6.902	110.837
Percent Owner Occupied	Percentage of owner occupied homes (US Census)	73.42675	7.939249	7.8	87.9

Data Sources: Bureau of Economic Analysis (BEA); US Geological Survey (USGS); US Energy Information Agency (EIA); US Department of Agriculture (USDA); US Census Bureau
* Variables complied by Douglas and Walker (2017) and utilized with their permission

VI. Empirical Model

From our conceptual framework, we propose a simultaneous equation model that predicts income growth and three of its key determinants: natural resource dependence, education, and entrepreneurship. We will focus on two periods of growth, 1980-2000 and 1990-2007, in part from data availability, but also to compare the impact of changes in the coal mining industry and macroeconomic conditions. We define our base growth model as:

$$g_i = \beta + \beta_1 Intial\ Income_i + \beta_2 Proprietor\ Employment\ Share + \beta_3 Coal\ Dependence + \beta_4 Education_i + X\beta_5 + v_s + \epsilon \quad (1)$$

As in most endogenous growth models, Temple (1999) for example, we include the log of initial income as a control variable, where a negative coefficient implies convergence towards steady state growth across counties. Control variables in the vector X pull from those of Douglas and Walker (2017) and Stephens and Partridge (2011). They include measures of metropolitan and nonmetropolitan status to account for different demographic conditions; quality of natural amenities,[iii] which has been found to be correlated with economic growth (Henderson & McDaniel 2005); a control for oil prices to control for price fluctuations in energy sector, and population density in 1960 to control for long term historical agglomeration that would influence economic development.

In the equation, coal dependence, education, and proprietor employment share are endogenous regressors. To compensate for this bias, we predict values of each with their own equation and exogenous instruments. They are run simultaneously such that the predicted values of proprietor employment share, coal dependence, and education derived from their respective equations are used in the base growth model.

As in Douglas and Walker (2017), we also recognize that there is a likely a causal link in the correlation between coal dependence and omitted variables such as capital formation, institutional quality, age, population etc. Accordingly, and to mitigate concerns of endogeneity and multicollinearity, these factors are not included in the base model. Instead, we consider the coefficient of our measure of coal dependence as a reduced form coefficient that captures the direct and indirect impacts of increased coal dependence.

Recognizing the concerns of Brunnschweiler & Bulte (2008), we do not assume our proxy for coal dependence to be exogenous, as the location of mines and production intensity may be a product of high income growth in a region. Replicating other works on the resource curse in Appalachia, such as Betz, Partridge, Farren, and Lobao (2015) and Douglas and Walker (2017), we instrument coal dependence with measures of coal quality and historical mining. The best quality coal is likely to be mined the most intensively at any point in time, so we use USGS data on the amount of heat derived from the coal per ton of ash produced as an instrument for coal dependence. [iv] With Appalachia's long history of coal mining, if coal was able to be mined it was likely mined at some point. Thus we also include a dummy variable to control for the exogenous location of coal producing areas. Altogether, we have equation 2:

$$Coal\ Dependence_i = \phi_0 + \phi_1 Coal\ Quality_i + \phi_2 Coal\ Mine\ Presence_i + \mu \quad (2)$$

Another component of economic growth and possible channel of resource dependence is education. Education, as measured by the percentage of residents with a bachelor's degree or higher, is endogenous with income growth as higher incomes stimulate higher educational attainment and greater education correlates to higher paying jobs. We select the percentage of workers in a given county employed in educational service as proxy for a resident's proximity to educational services within a county. A closer proximity to educational services within the county encourages human capital formation, which then influences economic growth. On the other hand, the level of employment in education itself does not directly impact economic growth. A similar method of using proximity to education to instrument education has also been used in Moretti (2003), Higgins (2006), and is most similar to Douglas and Walker (2017). Using this exogenous instrument in conjunction with other predicative variables, we have equation 3:

$$(3) \qquad Education_i = \omega_0 + \omega_1 Employed\ in\ Education_i + \omega_2 Coal\ Dependence + W\omega_3 + \varepsilon$$

with W a vector of controls including the natural logarithm of income in the initial year of the period, as well as rural and metropolitan rankings.

The last equation in the model estimates entrepreneurship. We include coal dependence to estimate what impact natural resource dependence has on proprietor employment share. We also include the lagged value of coal dependence to see what long run effects coal dependence may have on entrepreneurship. Education is also known to be positive influence on an individual's willingness to pursue a career in entrepreneurship (Goetz & Rupasingha 2014) and is included as a control in vector of variables Z.

Out of concerns of endogeneity, we also include in vector Z four instruments for proprietor employment share that align with our conceptual framework. First, we include the 10-year lag of proprietor share, accounting for the past pool of entrepreneurs from which the current proprietor share period is based. Next is proprietor income in thousands per proprietor which controls for the possible returns to entrepreneurship as an incentive to choose entrepreneurship a career. Percent of owner occupied houses is included as a proxy for the available capital in county as a higher percentage of owner occupied homes signals residents are likely able to obtain high value loans and greater amount of income to save. Last, we include the population growth rate of the previous decade to account for the potential growth in pool of entrepreneurial actors. Our last equation then is as follows:

$$(4) \qquad Proprietor\ Employment\ Share_i = \alpha_0 + \alpha_1 Coal\ Dependence + \alpha_2 Lag\ Coal_i + Z\alpha_3 + \lambda_s + \delta$$

We will proceed by running a progressive series of model frameworks, where for each framework Model 1 has annualized real income growth from 1980 to 2000 as the dependent variable and Model 2 has the same for 1990-2007. All other variables are the initial values for the respective period. We begin by running pooled OLS, then test the validity of the selected instruments for each endogenous variable. After, we run a simultaneous equation model (SEM) with equations 1-4 for each period, allowing for a correlation between the errors terms of each equation and the endogenous variables within the base model to be instrumented (Suhr 2006). Last, we run the equations in a conditional mixed-process (CMP) model, which was designed by

David Roodman (2009). While a SEM framework allows for linkages between the error terms of equations, a CMP model allows for clustered standard errors by state. Given counties are grouped under the institutions, laws, policy, culture, and history of each state, clustering errors to account for this possible correlation across the group should provide more accurate estimations. Hence, we expected the CMP model to produce the most accurate estimations.

The hypothesis is that the coefficient of coal dependence in equation 1 will be negative, suggesting the resource curse exists. However, since studies such as Partridge, Betz, Lobao (2013), Betz, Partridge, Farren and Lobao (2015), Douglas and Walker (2017) have found evidence that the resource curse in Appalachia weakens as we approach the modern day, we refine the hypothesis to say the coefficient of coal dependence will be negative for 1980-2000 and weaker or not significant for 1990-2007. Moreover, we expect the coefficient of proprietor employment share to be positive and significant in equation 1, implying that entrepreneurship, at least through proprietors as a proxy, is correctly identified in the theoretical model as a determinant of growth.

We also expect coal dependence to have a significant negative correlation with proprietor employment share, which together with the previous predictions would suggest entrepreneurship is a channel of the resource curse. To determine the magnitude of the channel, we take the coefficient of coal dependence in equation 4, α_1, and multiply it by the coefficient of proprietor employment share in equation 1, β_2. Since equation 4 predicts the value of proprietor employment share in equation 1, the value of $\alpha_1\beta_2$ shows how much of the correlation between coal dependence and income growth is explained through the hypothesized crowding out of entrepreneurship. Also of note is the association of the lag of coal dependence with proprietor employment share. If coal mining were to have a long term effect on the culture surrounding entrepreneurship in an area or have lasting crowding out impacts, then the lag would have a negative correlation. Based on cultural literature of Appalachian coal mining, we expect this statement to be true.
Additionally, since education is theorized to influence entrepreneurship and coal dependence is associated with disincentives to education, we expect coal dependence to be indirectly associated with a decline in entrepreneurship through education. This indirect association would then increase the amount in which the crowding out of entrepreneurship explains the resource curse in Appalachia.

VII. Results and Discussion

The results of the initial OLS estimations with the base growth equation appear in table 2. With the annualized growth rate for each county from 1980-2000 as dependent variable and standard errors clustered by state, model 1 reports a significant positive coefficient for proprietor employment share and negative for coal dependence, which agrees with the hypothesis and suggests further analysis via SEM to control for endogeneity. Model 2 looks at the period from 1990-2007 and reports higher standard errors and smaller coefficients than model 1. In particular, the coefficient of coal dependence becomes insignificant and positive, suggesting the effect of the resource curse has weakened or diminished as we approach the modern day. Models 3 and 4, which look at pooled growth rates and key variables for each decade within the period, show all key variables are significant and of the expected sign for 1980-2000, but the coefficient of coal dependence decreases considerably and proprietor employment share loses its significance for the entire pooled period of 1980-2007.

In order to control for endogeneity between coal dependence, proprietor employment share, education, and growth, we test the validity of exogenous instruments described earlier. Each key variable was instrumented in a separate 2SLS regressions with growth for each period. Results, reported in Table B of the Appendix, for the instruments of each endogenous variable do not reject instrument exogeneity and F statistics for the validity of the instruments are highly significant.[v] With this assurance, we proceed to run the equations as a simultaneous equation model.

Table 2. Base OLS on Average Income Growth

	(1)	(2)	(3)	(4)
	1980-2000	1990-2007	1980-2000	1990-2007
Initial Income	-2.86***	-1.76***	-3.11***	-3.52***
	(0.327)	(0.313)	(0.307)	(0.281)
Proprietor Employment Share	0325***	0.0172*	0.0293***	-0.00431
	(0.0112)	(0.00974)	(0.00922)	(0.00634)
Coal Dependence	-0.278***	0.0753	-0.256***	-0.187**
	(0.0701)	(0.121)	(0.0688)	(0.0772)
Oil Price Control	0.198**	-1.04	0.705***	0.799***
	(0.0837)	(0.772)	(0.0983)	(0.0708)
Education	6.14***	2.29***	5.77***	5.38***
	(1.28)	(0.814)	(1.13)	(0.879)
Change in Pop	0.110	0.446	-0.403	-0.0804
	(0.428)	(0.467)	(0.358)	(0.333)
Pop Density 1960	0.463***	0.339***	0.419***	0.397***
	(0.114)	(0.129)	(0.0971)	(0.106)
Metro Designation	0.228***	0.143**	0.277***	0.234***
	(0.0774)	(0.0683)	(0.0761)	(0.0671)
Rural Designation	0.0332	-0.0273	-0.0107	-0.0726
	(0.0794)	(0.0670)	(0.0743)	(0.0681)
Natural Amenities	0.0359	0.0888**	0.0326	0.0820***
	(0.0363)	(0.0348)	(0.0337)	(0.0310)
Constant	28.6***	18.1***	31.5***	36.0***
	(3.14)	(3.08)	(2.95)	(2.68)
State Fixed Effects	X	X	X	X
Time Fixed Effects			X	X
Observations	409	409	818	1,227
R-squared	0.549	0.251	0.417	0.429

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3a. SEM on Average Income Growth

	(1)	(2)
	1980-2000	1990-2007
Initial Income	-2.41***	-1.30***
	(0.268)	(0.281)
Proprietor Employment Share	0.0342***	0.0197**
	(1.17)	(0.850)
Coal Dependence	-0.527***	-0.0684
	(0.111)	(0.0966)
Oil Price Control	0.0860	-1.43**
	(0.0889)	(0.658)
Education	1.61	0.436
	(1.18)	(0.867)
Metro Designation	0.253***	0.165**
	(0.0904)	(0.0796)
Rural Designation	0.0117	-0.0287
	(0.0850)	(0.0744)
Pop Density 1960	0.351***	0.249**
	(0.125)	(0.117)
Natural Amenities	0.0460	0.0823***
	(0.0305)	(0.0285)
Constant	24.5***	13.8***
	(2.61)	(2.76)
State FE	Yes	Yes
R squared	0.5134	0.2307
Observations	409	409
Chi squared	445.5	119.22

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3b. SEM Proprietor Employment Share

	(1) 1980-2000	(2) 1990-2007
10-yr. Lag Proprietor Employment Share	0.705***	0.78***
	(0.0353)	(0.0491)
Coal Dependence	-0.821	7.03
	(1.66)	(6.31)
10-yr. Lag Coal Dependence	0.527	-3.84
	(2.29)	(4.81)
Education	6.65	-5.43
	(5.38)	(5.52)
Proprietor Earnings	0.119***	-0.254**
	(0.0369)	(0.109)
Percent Owner Occupied Homes	0.145***	0.154***
	(0.0354)	(0.0517)
Change in Pop	2.87**	6.06***
	(1.41)	(2.05)
Constant	-6.63**	-3.44
	(2.98)	(4.79)
State FE	Yes	Yes
R squared	0.7705	0.5419
Observations	409	409
Chi squared	966.85	673.84

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4a. CPM Average Growth

	(1) 1980-2000	(2) 1990-2007
Initial Income	-2.53***	-1.12***
	(0.328)	(0.394)
Proprietor Employment Share	0.0306*	0.0203*
	(0.0159)	(0.0118)
Coal Dependence	-1.46***	0.355
	(0.213)	(0.341)
Oil Price Control	-0.152***	-0.554
	(0.0468)	(0.513)
Education	1.73***	0.0197
	(0.656)	(1.17)
Metro Designation	0.276***	0.161***
	(0.0548)	(0.0494)
Rural Designation	0.0160	-0.0322
	(0.0623)	(0.0803)
Pop Density 1960	0.319***	0.228**
	(0.116)	(0.106)
Natural Amenities	0.0457	0.0862**
	(0.70)	(.0391)
Constant	26.3***	12.2***
	(3.13)	(3.38)
State FE	Yes	Yes
Observations	409	409

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4b. CPM Proprietor Employment Share

	(1) 1980-2000	(2) 1990-2007
10-yr. Lag Proprietor Employment Share	0.707***	0.796***
	(0.0500)	(0.0475)
Coal Dependence	-1.83**	-0.416
	(0.732)	(1.64)
10-yr. Lag Coal Dependence	1.13***	1.94***
	(0.403)	(0.381)
Education	5.47	-5.08
	(9.20)	(4.66)
Proprietor Earnings	-11.0***	-13.8***
	(3.72)	(4.89)
Percent Owner Occupied Homes	13.9**	0.177***
	(0.0654)	(0.0498)
Change in Pop	3.09*	5.13*
	(1.75)	(3.04)
Constant	-6.07	-6.84
	(5.71)	(4.31)
State FE	Yes	Yes
Observations	409	409

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The SEM results for equation 1 and 4 are reported in Table 3a and 3b and support the results found in the OLS regression.[vi] In particular, proprietor employment share and coal dependence both have expected signs for 1980-2000, demonstrating that entrepreneurship is positively correlated with economic growth and that coal dependence dampens economic growth. Like the OLS model, both become insignificant for the period 1990-2007. At the same time, there is no statistically significant correlation of contemporary or lagged coal dependence with entrepreneurship. This result suggests entrepreneurship is not a channel of the resource curse. Education, which is negatively correlated with coal dependence, is not significantly correlated with proprietor share in either model and consequently coal dependence does not have an indirect impact on entrepreneurship through education. However, the SEM model fails to take into account standard errors clustered by state. We next run the equations through a Conditional Mixed-Process Model to cluster standard errors by state and obtain the most accurate estimations of model.

The results of the CMP framework are found in Table 4a and 4b.[vii] Model 1 has significant and expected signs for both proprietor employment share and coal dependence, although with increased standard errors as expected from clustering errors by state. For 1980-2000, model 1 estimates that a one standard deviation in the share of proprietors (4.067) is correlated with an increase in total growth by 2.5 percentage points over the period, while a one standard deviation increase in coal dependence implies a decrease in total growth by 8.14 percentage points. This estimation for the coefficient of coal dependence is substantially greater than the SEM framework and also in line with Douglas and Walker (2017), who found a one standard deviation increase in coal dependence was associated with a decrease in total growth by 6.2 percentage points for 1980-2000. For 1990-2007, all key variables lose their significance, again indicating there may be economic changes going into the 2000s that have weakened or eliminated the resource curse.

Looking to see if the resource curse acts through entrepreneurship as a channel, Table 4b estimates the share of proprietors through the CMP framework. Unlike the SEM estimates, contemporary coal dependence has a significant, negative correlation with proprietor share. In order to find the indirect impact of coal dependence through our proxy of entrepreneurship, we multiply the coefficient of coal dependence in model 1 by the coefficient of proprietor employment share in model 1. In turn, we find that a one standard deviation increase in coal dependence decreases annual growth by 0.05 percentage points, or 0.31 percentage points for the total period through the entrepreneurship channel. A one standard deviation increase in coal dependence is thus, in total, correlated with an 8.45 percentage point decrease in income growth from 1980-2000. The crowding out of entrepreneurship accounts for approximately 4% of this negative association, at least with proprietor share as a proxy. This result is smaller than expected. However, the significance of the estimate shows that the crowding out entrepreneurship due to coal dependence is indeed associated with reduced economic growth.

At the same time, the results show lagged resource dependence has a positive significant correlation with proprietor share for 1980-2000. Model 1 in Table 4b estimates that a one standard deviation increase of the lag of coal dependence (0.159) increases income annually by 0.005 percentage points, or by 0.109 percentage points for the total period through an increase in the share of proprietors. While this small, but significant correlation may be the result of statistical noise, this finding suggests that there may be long run benefits to increased coal dependence as it is correlated with an increased share of proprietors and subsequently income growth.

For 1990-2007, the results in model 2 show that the coefficient of coal dependence loses its significance while the lag remains positive and significant. These results signal that the resource curse has weakened into the 2000s but that intensive coal mining may have continued to produce some limited long run benefits by encouraging entrepreneurship development. Like the SEM framework, education is not significant in predicting proprietor share and thus not a way in which coal dependence could further reduce entrepreneurship.

While there is evidence of a resource curse and entrepreneurship as a channel from 1980-2000, this period also corresponded to a steady decline in coal prices and production. This period of economic downturn is partially accounted for by the inclusion of the control of the change in oil prices between the initial year and ten years in the future, as oil's dominance in the energy market makes it a large determinant of other energy resource prices and demand such as coal. However, it may not fully account for the changes that occurred during this period. We can only say that evidence for the resource curse and entrepreneurship as a channel is present during a period of decline for the coal industry. Likewise, the period 1990-2007 saw changes to the coal industry in terms of technology, as well as strong nationwide economic growth leading up the 2008 financial crisis. These changes could have weakened the resource curse. Another explanation could be that local governments or community leaders have begun to recognize the impacts of coal dependence and sought to mitigate its impacts through reinvesting rents or sustainable economic planning. Further research should investigate what weakened the resource curse from 1990-2007.

VIII. Conclusion

Coal has been a fixture in Appalachian life for over 100 years and continues to produce a substantial amount of coal to feed world demand. With this legacy, Appalachia is a prime location to test for evidence of the resource curse on the subnational level. Our results suggest an increase in coal dependence is associated with a decrease in income growth for the period 1980-2000, with the most robust model estimating that a one standard deviation increase in the ratio between coal revenue and total income in a county decreases income growth by 8.45 percentage points over the period. Moreover, our results indicate that entrepreneurship is a channel of the resource curse, but only accounts for approximately 4% of the negative correlation of coal dependence on growth. At the same time, they also suggest that entrepreneurship may be the channel of long run positive outcomes to coal dependence, but this correlation is too small to draw any definite conclusions. Furthermore, insignificant estimates for key variables for the period 1990-2007 signal that the resource curse has weakened in Appalachia over time. Further research must be conducted to determine what may have caused this change.

This study has its limits. It does not imply the validity of the resource curse everywhere, but only in Appalachia during a period of declining coal production. Moreover, it only considers one aspect of economic growth. Other studies should consider poverty, population, and employment when testing for entrepreneurship as a channel of the curse. Likewise, it considers one proxy of entrepreneurship and only certain determinants. Future research should look at income share of proprietors, firm birth and death, the distinction between necessity and opportunity entrepreneurships, and other proxies, as well as different proxies for education when testing entrepreneurship to confirm the results found here.

Finally, this study presents important policy implications for Appalachia and other areas of intense coal development. A heavy reliance on the coal industry appears to crowd out entrepreneurs from entering the job market, which in turn reduces the potential for economic growth. Government leaders should not only focus on reinvesting resource rents towards sustainable economic development, but specifically create an environment for entrepreneurs to develop new businesses alongside the coal industry. Doing so can mitigate the contemporary negative impacts of coal dependence. At the same time, policymakers should also take advantage of the potential long run increase in entrepreneurship as a result of coal industry by working with entrepreneurs to ensure their business ventures allow for sustainable capital inflow into the community. Implementing these policies in coal dependent areas can mitigate the adverse effects of the industry on income growth and possibly turn the resource curse into a resource blessing.

IX. References

Badeeb, R. A., Lean, H. H., & Clark, J. (2017). The evolution of the natural resource curse thesis: A critical literature survey. *Resources Policy*, 51, 123-134.

Betz, M. R., Partridge, M. D., Farren, M., & Lobao, L. (2015). Coal mining, economic development, and the natural resources curse. *Energy Economics, 50*, 105-116. doi:http://dx.doi.org/10.1016/j.eneco.2015.04.005

Bragg, Linda J., Joanne K. Oman, Susan J. Tewalt, Charles L. Oman, Noreen H. Rega, P. M. Washington, and Robert B. Finkelman. 1998. U.S. Geological Survey Coal Quality Database, Version 2.0. Open-File Report 97–134. [CD-ROM] Available at: http://pubs.usgs.gov/of/1997/of97-134/.

Braunerhjelm, P., Acs, Z. J., Audretsch, D. B., & Carlsson, B. (2010). The missing link: Knowledge diffusion and entrepreneurship in endogenous growth. *Small Business Economics*, *34*(2), 105-125. doi:http://dx.doi.org/10.1007/s11187-009-9235-1

Brunnschweiler, C. N., Bulte, E. H. (2008). The resource curse revisited and revised: A tale of paradoxes and red herrings. *Environmental Economics and Management* 55:3, 248-264.

Caudill, H. M. (1963). *Night comes to the Cumberlands: A biography of a depressed area* ([1st ed.].). Boston: Little, Brown.

Deaton, B. J. & Nimon, E. (2012). An empirical examination of the relationship between mining employment and poverty in the appalachian region. *Applied Economics*, 44, 303–312.

Douglas, S. M., & Walker, A. (2013). Sample selection in appalachian research. *The Review of Regional Studies, 42*(2), 143-159.

Douglas, S. M., & Walker, A. (2017). Coal mining and the resource curse in the eastern United States. *The Journal of Regional Studies, 57*(4).

Drake, R. (2003). A History of Appalachia. Lexington: The University Press of Kentucky.

Eregha, P. B., & Mesagan, E. P. (2016). Oil resource abundance, institutions and growth: Evidence from oil producing african countries. *Journal of Policy Modeling*, 38(3), 603.

International Energy Agency (IEA). (2017). *Southeast Asia Energy Outlook.* Paris: OECD/IEA.

Goetz, S. J., & Rupasingha, A. (2009). Determinants of growth in non-farm proprietor densities in the US, 1990-2000. *Small Business Economics*, *32*(4), 425-438. doi:http://dx.doi.org/10.1007/s11187-007-9079-5

Goetz, S. J., & Rupasingha, A. (2014). The Determinants Of Self-Employment Growth: Insights From Country-Level Data, 2000-2009. *Economic Development Quarterly, 28*(1), 42-60.

Gylfason, T. (2001). Natural resources, education, and economic development. *European Economic Review*, 45(4–6), 847-859.

Gylfason, T., Zoega, G. (2001). Natural resources and economic growth: The role of investment. CEPR Discussion Paper No 2743. Center for Economic Policy Research, London.

Henderson, J. R., & McDaniel, K. (2005). Natural amenities and rural employment growth: A sector analysis. *Review of Regional Studies, 35*(1), 80-96. Retrieved from http://proxyau.wrlc.org/login?url=https://search.proquest.com/docview/56504731?accountid=8285

Higgins, Matthew J.,Daniel Levy, and Andrew T. Young. 2006. “Growth and Convergence Across the U.S: Evidence from County Level Data,” Review of Economics and Statistics, 88, 671–81.

Iimi, A. (2007). Escaping from the resource curse: Evidence from botswana and the rest of the world. IMF Staff Papers, 54(4), 663-699.

Maluccio, John. 1998. “Endogeneity of Schooling in the Wage Function: Evidence from the Rural Philippines,” Discussion Paper 54, Food Consumption and Nutrition Division, International Food Policy Research Institute. Washington, DC: International Food Policy Research Institute.

Mavrotas, G., Murshed, S.M., & Torres S. (2011). Natural resource dependence and economic performance in the 1970–2000 period. *Rev. Dev. Econ*. 15(1), 124-138.

Mehlum, H., Moene, K. and Torvik, R. (2006). "Institutions and the Resource Curse," *The Economic Journal*, 116, 1–20.

Milici, R.C., Polyak, D.E. (2014). "Bituminous coal production in the Appalachian Basin; Past, present, and future", chap. D.3 of Ruppert, L.F., and Ryder, R.T., eds., *Coal and petroleum resources in the Appalachian basin; Distribution, geologic framework, and geochemical character*: U.S. Geological Survey Professional Paper 1708.

Ologunla, S. E., Kareem, R. O., & Raheem, K. A. (2014). Institutions and the resource curse in nigeria. *Journal of Sustainable Development Studies*, 7(1), 36.

Papyrakis, E., & Gerlagh, R. (2004). The resource curse hypothesis and its transmission channels. *Journal of Comparative Economics*, 32(1), 181-193.

Partridge, Mark, Mike Betz, and Linda Lobao. (2012). Natural resource curse and poverty in appalachia. *Working Paper MPRA Paper No. 38290*.

Partridge, M. D., Betz, M. R., & Lobao, L. (2013). Natural resource curse and poverty in appalachian america. *American Journal of Agricultural Economics, 95*(2), 449-456. Retrieved from http://proxyau.wrlc.org/login?url=https://search.proquest.com/docview/1347763775?accountid=8285

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, *98*(5), S71-102. Retrieved from http://proxyau.wrlc.org/login?url=https://search.proquest.com/docview/56486457?accountid=8285

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, *94*(5), 1002-1037. Retrieved from http://proxyau.wrlc.org/login?url=https://search.proquest.com/docview/56311969?accountid=8285

Ross, M. (2007) "How Mineral-Rich States Can Reduce Inequality" M. Humphreys, J. Sachs, J. Stiglitz (Eds.), Chapter 9 In Escaping The Resource Curse, Columbia University Press, NY (2007), Pp. 236-25.

Sachs, J. D. and Warner A. M. (1995). Natural resource abundance and economic growth. NBER Working Paper 5398. National Bureau of Economic Research, Inc.: Boston, MA.

Sachs, J. D. and Warner A. M. (1997). Sources of slow growth in african economies. *Journal of African Economies*. 6, 335–376.

Sachs, J. D. and Warner A. M. (2001). The curse of natural Resources. *European Economic Review*. 45, 827–838.

Salstrom, Paul. *Appalachia's Path to Dependency: Rethinking a Region's Economic History, 1730-1940*. 1st ed., University Press of Kentucky, 1994.

Shrestha, S. S., Goetz, S. J., & Rupasingha, A. (2007). Proprietorship formations and U.S. job growth. *Review of Regional Studies, 37*(2), 146-168. Retrieved from http://proxyau.wrlc.org/login?url=https://search.proquest.com/docview/56810331?accountid=8285

Stephens, H. M., & Partridge, M. D. (2011). Do entrepreneurs enhance economic growth in lagging regions? *Growth and Change*, *42*(4), 431-465. Retrieved from http://proxyau.wrlc.org/login?url=https://search.proquest.com/docview/963634000?accountid=8285

Suhr, D. (2006). The Basics of Structural Equation Modeling. University of Northern Colorado.

Van der Ploeg, F. (2011). Natural resources: curse or blessing?. *Journal of Economic Literature*, 49(2): 366–420.

van Wijnbergen, S. (1984). The ‘dutch disease’: a disease after all?. *The Economic Journal*, 94 (1), 41-55.

Data Sources

Bureau of Economic Analysis. (2017). Local Area Personal Income and Employment. Retrieved from https://www.bea.gov/regional/index.htm.

Bureau of Labor Statistics. (2017). NAICS 212100 - Coal Mining. *Occupational Employment Statistics.* Retrieved from https://www.bls.gov/oes/current/naics4_212100.htm#00-0000.

US Census. (2017). USA Counties Data File Downloads. Retrieved from https://www.census.gov/support/USACdataDownloads.html

US Department of Agriculture. (2017). Natural Amenities Scale. Retrieved from https://www.ers.usda.gov/data-products/natural-amenities-scale.aspx

US Energy Information Service. (2017). Petroleum and Other Liquids. Retrieved from https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=F000000__3&f=A

US Geological Survey. (2017) Coal Databases. Retrieved from https://energy.usgs.gov/coal/assessmentsanddata/coaldatabases.aspx

X. Appendix

Table A1. Correlation Matrix of Key Variables

	Average Growth	Proprietor Emp. Share	Coal Dependence	Education
Average Growth	1			
Prop. Emp. Share	0.020	1		
Coal Dependence	-0.087	0.001	1	
Education	-0.100	-0.030	-0.111	1

Table A2. Instrument Variable Test for Proprietor Employment Share on Income Growth

	(1) 1980-2000	(2) 1990-2007
Proprietor Employment Share	0.0357***	0.0287***
	(0.0122)	(0.00876)
Coal Dependence	-0.00270***	0.000863
	(0.000891)	(0.000847)
Pop Density 1960	0.00455***	0.00328***
	(0.00131)	(0.00120)
Oil Price Control	0.00197**	-0.00893
	(0.000878)	(0.00658)
Initial Income	-0.0284***	-0.0163***
	(0.00265)	(0.00275)
Metro Designation	0.00227**	0.00135*
	(0.000892)	(0.000795)
Rural Designation	0.000305	-0.000486
	(0.000836)	(0.000743)
Education	0.0622***	0.0258***
	(0.00978)	(0.00756)
Natural Amenities	0.000357	0.000915***
	(0.000321)	(0.000291)
State FE	X	X
Instruments		
Lag Proprietor Share	X	X
Earnings Per Prop (000)	X	X
Percent Owner Occupied	X	X
Lag Population Growth	X	X
Cragg-Donald Wald F statistic	114.507	132.939
Sargon Test (p-score)	0.2257	0.8641
Observations	409	409
R-squared	0.549	0.248

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3: Instrument Variable Test for Education on Income Growth

	(1) 1980-2000	(2) 1990-2007
Education	0.00592	-0.000621
	(0.0125)	(0.00882)
Initial Income	-0.0266***	-0.0143***
	(0.00253)	(0.00253)
Coal dependence	-0.00339***	0.000262
	(0.000941)	(0.000846)
Oil Price Control	0.00477***	-0.0124**
	(0.000877)	(0.00618)
Pop Density 1960	0.00450***	0.00310***
	(0.00143)	(0.00120)
Metro Designation	0.00290***	0.00182**
	(0.000988)	(0.000799)
Rural Designation	-0.000137	0.000231
	(0.000923)	(0.000742)
Natural Amenities	0.00137***	0.000743***
	(0.000297)	(0.000249)
Constant	0.278***	0.153***
	(0.0241)	(0.0244)
Instruments		
Education Service	X	X
F Statistic	782.751	922.783
Observations	409	409
R-squared	0.417	0.171

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4: Instrument Variable Test for Coal Dependence on Income Growth

	(1) 1980-2000	(2) 1990-2007
Initial Income	-0.0231***	-0.00782***
	(0.00248)	(0.00204)
Coal dependence	-0.0197***	0.00649***
	(0.00253)	(0.00251)
Constant	0.247***	0.0909***
	(0.0239)	(0.0202)
Instruments		
Coal Quality	X	X
Coal Mine Presence	X	X
F Statistic	73.506	25.435
Sargon p score	0.1384	0.466
Observations	409	409
R-squared	-0.068	-0.012

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

XI. Notes

[i] The end year of 2007 is chosen to avoid confounding effects of the financial crisis of 2007-2008.

[ii] For 1980-2000: $\frac{real\ inc_{2000} - real\ inc_{1980}}{real\ inc_{1980}}$; For 1990-2007: $\frac{real\ inc_{2007} - real\ inc_{1990}}{real\ inc_{1990}}$

[iii] From United States Department of Agriculture (USDA) Natural Amenities Index. Calculated using measures of warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area.

[iv] Data obtained from Douglas and Walker (2017): "Data come from the USGS Coal Quality database, which contains over 13,000 samples of coal and associated rocks (Bragg et al., 1998). Using ArcGIS Kriging, we interpolated a raster from these borehole points. Thanks to Seth Wiggins for preparing this data set" (568).

[v] Using education service as an instrument for education causes a loss of significance for education when used to predict income growth. However, this insignificance is not at sign of a weak instrument, but possibly multi-collinerarity or confounding issues with other controls used to predict income growth in the instrument variable regression. These other variables are properly controlled in for the full SEM and CPM models as in Douglas and Walker (2017) to address this issue and education regains significance in the CPM model.

[vi] Full results of the SEM model can be provided upon request.

[vii] Full results of the CPM model can be provided upon request.