The Canary in the Coal Decline: Appalachian Household Finance and the Transition from Fossil Fuels

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Research Question: How does a transition away from fossil fuels affect household finances and local labor markets in communities dependent on the fossil fuel extraction industry?

Importance: Though swift and major carbon emission reductions are essential to limiting effects of climate change, these same reductions pose risks to fossil fuel firms, financial stability, and communities dependent on the fossil fuel industry (see Carney (2015) and Morris, Kaufman, and Doshi (2019)). In this proposal, we focus on the latter. Communities dependent on the fossil fuel industry include those mining coal in Appalachia and Wyoming, extracting oil in North Dakota and West Texas, refining oil along the Gulf Coast, and extracting natural gas in western Pennsylvania. Fossil fuel extraction provides well-paying jobs, important local tax revenue, and demand for local services. The negative effects of transitioning away from fossil fuels may be felt most acutely in lower-income rural communities where there may be few alternative employment opportunities paying comparable wages. Understanding what happens to individuals in these communities is critical to designing equitable CO_2 mitigation policies that protect those who bear some of the highest costs and may understandably be resistant to policies aimed at mitigating climate change.

Project Summary: In this paper, we examine how the transition away from fossil fuels impacts resource extraction communities by studying how recent shifts in demand for coal have impacted Appalachian households. We use exogenous variation in coal demand to estimate causal impacts on individual-level credit outcomes and local macroeconomic outcomes. We further examine heterogeneities in responses, for example how age and baseline creditworthiness (and therefore access to credit) affect economic resilience to coal-based economic shocks. We also examine how those who remain in these counties fare relative to those who migrate out. These heterogeneity analyses can help inform transition policies that look to target aid for declining industries to those who need it.

We focus on Appalachia because the region has persistently higher rates of poverty than the rest of the country, and a long-running economic reliance on coal mining, making these communities particularly vulnerable to a transition away from coal (Bollinger, Ziliak, and Troske 2011, Black, McKinnish, and Sanders 2005). Furthermore, in recent years Appalachia has experienced large coal demand shocks. Over 90 percent of U.S. coal is used for electricity generation, and coal power has faced increasingly strong competition from natural gas generators fueled by low-cost fracked natural gas. Annual Appalachian coal production declined 43 percent over the next decade after 2008. Coal mining employment in Appalachia has followed a similar pattern, dropping 41 percent over the same period.

Project Contribution to Literature: Our paper will provide important insights on the distributional effects of the decline of the coal industry. The individual panel data allows us to take county-level variation in coal demand and investigate its distributional consequences. Coal mining plays a significant role in Appalachia, but different residents within the region may be differentially affected by the industry's decline. We build on existing literature that examines the coal boom and bust of the 1970s and 1980s using Appalachian county-level data (Black, Daniel, and Sanders (2002) and Black, McKinnish, and Sanders (2005)). Our key contributions will include examining individual level data allowing for heterogeneity analysis and examining causal effects of the transition away from fossil fuel extraction in low income communities whose economies have for generations centered on that industry.

Although our findings focus on Appalachian coal mining communities, they provide insights for other fossil fuel producing communities. If petroleum and natural gas extraction are phased out, those extraction communities may experience similar reductions in economic conditions. The costs could be higher for those living in more rural and isolated regions that have fewer alternative employment opportunities. Additional research is needed to better understand the costs and distributional consequences of carbon mitigation policies to those living in fossil fuel producing regions, and to understand the policies that might best alleviate the harm.

Our paper will also contribute to the literature examining how energy sector shocks have affected consumer credit in other settings. Much of this literature has focused on the recent shale boom (see Brown (2018) and Cookson, Gilje, and Heimer (2020).) In examining temporary energy booms, Jacobsen, Parker, and Winikoff (2021) show benefits to households during the boom periods and losses to households during the busts yield net negative impacts. While these analyses focus on areas where fossil fuel extraction activity was relatively recent and reflected a shift *toward* the energy sector, we are examining a low income area whose economy has for generations relied on coal extraction and is shifting *away* from historical energy technology. This shift is particularly important in understanding implications of decarbonization and its potential impact on inequality.

Data

We use a highly granular dataset, the NY Fed / Equifax Consumer Credit Panel (CCP), to study the impacts of changing coal demand on individuals living in coal mining communities. This dataset is a nationally representative 5 percent anonymized random sample of adult consumers with Social Security numbers and a credit history. We have over a million observations in our regressions. With quarterly observations spanning 2002-2018, the CCP includes data on where an individual lives, their age, their Equifax Risk Score, and other outcomes like bankruptcies and outstanding debts. We show summary statistics in Table 1, a time series of the median Equifax Risk Score in Figure 1, and in Figure 2 a map of the median Equifax Risk Score by county within our sample. Together, these exhibits show that Equifax Risk Scores generally rose even as coal was declining and that there is some spatial heterogeneity in the distribution of Equifax Risk Scores. We use this data to track how an individual's credit changes over time, a proxy for their financial wellbeing.

For our exogenous coal demand measure, we use data from the US Energy Information Administration (EIA). We use the publicly available EIA Form 923, which tracks the coal consumed at powerplants in the US. By combining that with data on the US rail network, we can determine the coal burned within 200 miles of each coal producing county. Figure 3 depicts the change in coal production in active Appalachian coal-mining counties between 2008 and 2018. Large declines in coal production are scattered across the region, affecting at least one county in nearly every Appalachian state.

We supplement the coal and credit data with employment data from Bureau of Labor Statistics and demographic data from the US Census Bureau.

Identification strategy

We identify the causal impacts of coal mining demand shocks in Appalachia using exogenous electricity generation shifts away from coal and towards natural gas. These shifts are exogenous shocks to the economic conditions in coal mining communities because they are driven by technological developments and market forces downstream of the coal mining sector (Linn and McCormack 2019; Coglianese,

Gerarden, and Stock 2019). We capture these exogenous demand shifts by computing the amount of coal burned at electricity generators within 200 miles of a coal mine measured via the rail network. This metric captures a good portion of demand for Appalachian coal because transportation costs—which account for about 40 percent of delivered costs—limit the set of electricity generators a given Appalachian mine can sell its coal to. We restrict our analysis to active coal mining counties, which allows us to compare coal counties that have seen a large reduction in demand for their coal to other similar counties that have seen a smaller reduction.

We identify causal impacts of changes in coal activity using a panel fixed effect specification that compares individuals in counties with large declines in coal demand to those in counties with smaller declines. We use the following specification

$$Y_{ict} = \beta_1 + \beta_2 Coal200_{ct} + \delta_{it} + \gamma_i + \eta_c + \mu_t + \varepsilon_{ict}, \quad (1)$$

where Y_{ict} is our outcome of interest for individual i, in county c, in year t. $Coal200_{ct}$ is our exogenous annual measure of the amount of coal burned within 200 miles of a county, which reflects the boom in coal in the first part of our sample and the shift away from coal towards natural gas in the latter part. In addition to fixed effects for the individual (γ_i), county (η_c), and year-of-sample (μ_t), we include an individual time trend (δ_{it}) which is linear when examining just the pre- or post-Great Recession time periods and quadratic when examining a sample spanning from 2002 to 2018. This choice reflects that a quadratic time trend would absorb too much variation for the shorter time periods and that a linear time trend fails to capture potential parabolic confounders during the boom and bust of coal that occurs over the longer sample. We cluster our standard errors at the county level.

Our coefficient of interest is β_2, which estimates the response to a change in demand for coal burned at powerplants within 200 miles of a county by rail. It shows how an exogenous reduction in locally produced coal, caused by changes in the power sector, affects individuals living in coal producing counties.

We will examine a range of outcomes. Our main outcome is the Equifax Risk Score, which is a proprietary summary measure of an individual's overall creditworthiness but also affects the individual's ability to access credit and the cost of credit when accessed. Additional individual outcomes in our data that we would like to examine include bankruptcy and foreclosure indicators, delinquencies on credit card lines, third party collection indicators, student loan borrowing, and migration. We also plan to examine whether the reduction in coal demand affects the local economy through measures such as county unemployment.

Heterogeneity

We build on our baseline specification by examining heterogeneity of outcomes based on a range of individual and local characteristics. Specifically, we interact $Coal200_{ct}$ in equation (1) with other variables of interest measured during a baseline period, including age of individual, Equifax Risk Score, an indicator for whether the individual has an open mortgage (proxy for homeownership), and other credit characteristics such as loans in delinquency or individual bankruptcy. We also plan to use census tract level Census data including baseline median household income as a proxy for household characteristics to examine how reductions in coal demand differentially affect lower income and more rural households.

Preliminary results

In Table 2, we present preliminary results showing the impact of coal demand changes on Equifax Risk Scores. Column 1 shows that between 2002 and 2018, a 1 million ton increase in coal consumed within

200 miles of a county by rail causes a 0.103 increase in the Equifax Risk Score of an individual living in that county. The relationship also works in reverse, showing that as coal demand declines, Equifax Risk Scores also decline. We find similar results in column 2 when we omit 2008 through 2011, which are the most impactful years of the Great Recession. These results show a direct link between coal demand and the financial health of individuals living in those counties. While this result is weaker both in terms of magnitude and statistical significance when we examine just the six years prior to the Great Recession, when coal was booming, it is still significant and not too different when we look at 2012-2018, the period after the Great Recession when coal demand was declining for Appalachian counties.

To put these numbers in perspective, between 2012 and 2018, coal demand within 200 miles of our studied counties declined on average by 56.8% from 33.3 to 14.4 million tons of coal per year. This translates to a net Equifax Risk Score decline of 1.6 points using our estimates in Table 2. In that same period, average Equifax Risk Scores in our sample increased by 5 points, which suggests that the decrease in coal demand suppressed the increase in Equifax Risk Scores for individuals living in coal regions, materially impacting both the creditworthiness and the access to credit of households in these communities.

To best understand the distributional effects within the Appalachian coal region, we plan to study heterogeneity in our results by several factors. Our analysis is still in progress. In Table 3, we present preliminary results that suggest that individuals with higher baseline Equifax Risk Scores see smaller average reductions in Equifax Risk Scores due to the decline in coal demand that occurred from 2012-2018. This suggests that higher Equifax Risk Score individuals are less affected by the coal decline than lower Equifax Risk Score individuals. In the long run this could lead to larger inequality in coal-producing regions as the coal industry continues to decline. We plan to greatly expand our heterogeneity analysis to investigate how individuals are being affected by the continued decline of the Appalachian coal industry. Our findings may provide insights that could help with the targeting of policy intervention to help individuals in declining fossil fuel extraction communities.

Tables and Figures

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Millions of short tons consumed w/in 200 miles (by rail)	35.897	23.092	0.042	105.093	2022
One-year change in Millions of short tons consumed w/in 200 miles (by rail)	-1.853	4.737	-23.198	10.898	1899
Age at First Observation	38.9	11.366	25	61	293180
Average Age when entering dataset	28.263	7.94	25	61	75573
Number of Quarters in a Coal County	48.73	18.256	16	68	293180
Median Equifax Risk Score	675.145	97.147	320	835	292718
One year Change in Equifax Risk Score	3.355	47.543	-472	356	3392922
Is Ever Bankrupt	0.128	0.334	0	1	293051
Is Ever Foreclosed	0.044	0.205	0	1	293051
Ever Has Mortgage	0.381	0.486	0	1	293180
Average Number of Trades Currently 60 DPD	0.025	0.052	0	1.893	293180
Average Number of Trades Currently Severe Derogatory	0.217	0.463	0	13.125	293180
Average Number of Times First Mortgage 60 DPD	0.002	0.013	0	0.632	293180
Average Number of Open Sales Finance Accounts	0.302	0.457	0	5.688	293051
Average Number sales finance accounts worst rating 30 DPD w/in 3 months	0.004	0.017	0	1.188	293051
Average Number 3rd party collections	1.926	3.511	0	85.44	293051

Source: Federal Reserve Bank of New York / Equifax Consumer Credit Panel Data

Table 2: Regression Results (Mixed Time Trends)

	(1)	(2)	(3)	(4)
Equifax Risk Score	2002-2018	2002-2007 & 2012-2018	2002-2007	2012-2018
Coal Consumed	0.103***	0.115**	0.0668	0.0862**
	(3.33)	(2.51)	(1.37)	(2.15)
Constant	673.0***	672.1***	669.0***	678.4***
	(533.05)	(376.40)	(278.99)	(572.51)
Fixed Effects	Year, County, Individual Quadratic Time Trends		Year, County, Individual Linear Time Trends	
Observations	3336796	2501392	1205335	1275982

t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Federal Reserve Bank of New York / Equifax Consumer Credit Panel Data

Note: Standard errors clustered at the county level

Table 3: Regression Results by Equifax Risk Score Quartile

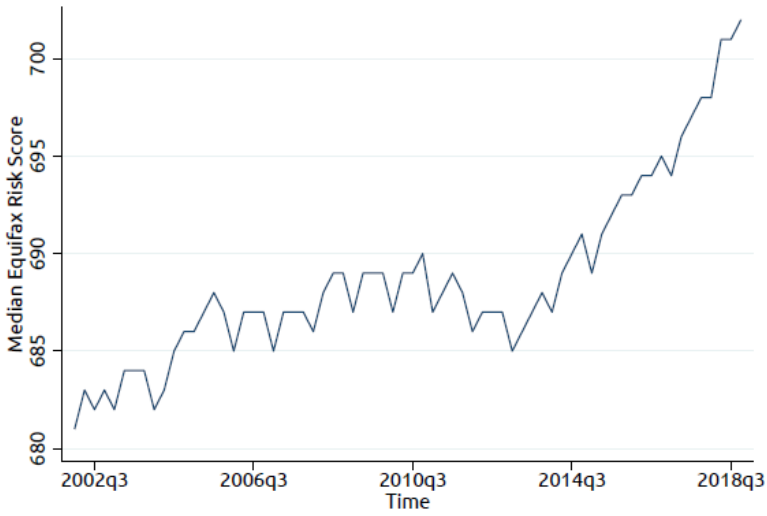
	Baseline period for Equifax Risk Score Quartiles	
	(1)	(2)
Equifax Risk Score	2004-2007	2008-2012
Coal * First Quartile	0.127*	0.107
	(1.71)	(1.00)
Coal * Second Quartile	0.143**	0.134*
	(2.48)	(1.83)
Coal * Third Quartile	0.070	0.123***
	(1.38)	(2.70)
Coal * Fourth Quartile	0.051*	0.045
	(1.73)	(1.56)
Constant	687.497***	680.998***
	(667.89)	(522.59)
Years	2012-2018	2012-2018
Fixed Effects	Year, County, Individual Linear Time Trends	
Observations	1,051,999	1,207,515

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Federal Reserve Bank of New York / Equifax Consumer Credit Panel Data

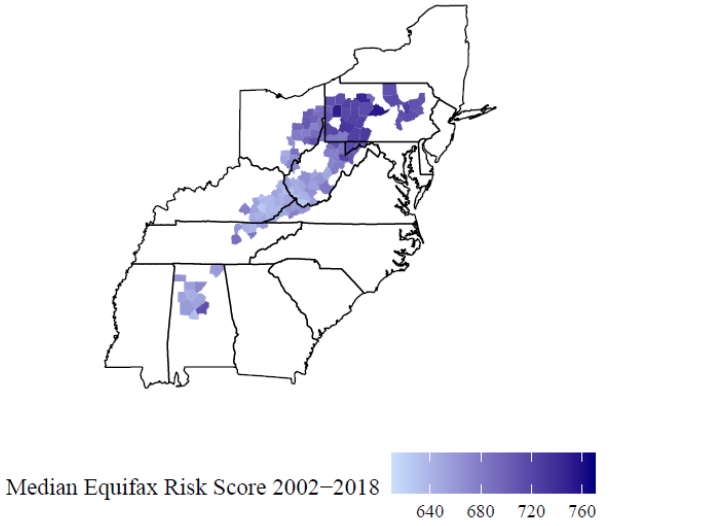
Note: Standard errors clustered at the county level. Model titles indicate how quartiles are formed. First quartile represents individuals whose 2004-2007 (or 2008-2012) median Equifax Risk Score is in the bottom 25% of the sample.

Figure 1: Median Equifax Risk Score from 2002-2018



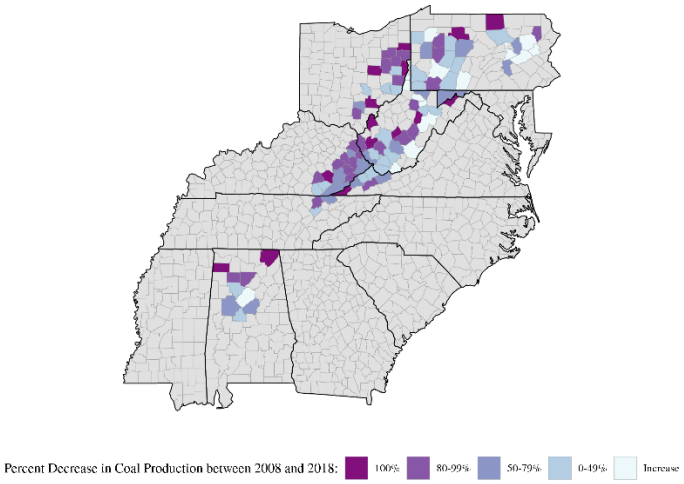
Source: Federal Reserve Bank of New York / Equifax Consumer Credit Panel Data

Figure 2: Median Equifax Risk Score by County (2002-2018)



Source:Federal Reserve Bank of New York / Equifax Consumer Credit Panel Data

Figure 3: Change in Appalachian coal production



References

Agerton, M., Hartley, P. R., Medlock III, K. B., & Temzelides, T. (2017). Employment impacts of upstream oil and gas investment in the United States. *Energy Economics*, *62*, 171-180.

Black, D., Daniel, K., and Sanders, S. 2002. "The Impact of Economic Conditions on Participation in Disability Programs: Evidence from the Coal Boom and Bust." American Economic Review, 92 (1): 27-50.

Black, D., McKinnish, T. and Sanders, S. (2005), The Economic Impact Of The Coal Boom And Bust*. The Economic Journal, 115: 449-476.

Bollinger, Christopher, James P. Ziliak, and Kenneth R. Troske (2011). "Down from the Mountain: Skill Upgrading and Wages in Appalachia." Journal of Labor Economics, 29(4): 819-857.

Brown, J. (2018). Response of consumer debt to income shocks: The case of energy booms and busts. *Journal of Money, Credit and Banking, forthcoming*.

Carney, M. (2015) "Breaking the Tragedy of the Horizon –climate change and financial stability", speech given at Lloyd's of London, September 2015.

Coglianese J, Gerarden T, Stock JH. The Effects of Fuel Prices, Regulations, and Other Factors on U.S. Coal Production, 2008-2016. The Energy Journal. 2020;41 (1).

Cookson, J. A., Gilje, E. P., & Heimer, R. Z. (2020). *Shale Shocked: Cash Windfalls and Household Debt Repayment* (No. w27782). National Bureau of Economic Research.

Jacobsen, G. D., Parker, D. P., & Winikoff, J. B. (2021). Are Resource Booms a Blessing or a Curse? Evidence from People (not Places). *Journal of Human Resources*, 0320-10761R1.

Linn, J. and McCormack, K. (2019), The roles of energy markets and environmental regulation in reducing coal-fired plant profits and electricity sector emissions. The RAND Journal of Economics, 50: 733-767.

Morris, A., Kaufman, N. and Doshi, S. (2019) The Risk of Fiscal Collapse in Coal-Reliant Communities. New York City and Washington, DC: Columbia University and Brookings Institution.