The Short-Run and Long-Run Effects of Resources on Economic Outcomes: Evidence From the United States 1936-2015

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This paper draws on new state-level panel datasets spanning 1936-2015 covering the three most valuable natural resources during the period – oil & gas, coal, and agricultural land – and a model of domestic Dutch disease to examine the short-run and long-run effects of resources on state economies. Using a flexible shift-share estimation approach, we find that different resources have different short-run effects in different time periods, across increases and decreases in resource employment, and across different outcomes. Using long differences, we find that resource endowments either have a very small positive effect or have no effect on long run growth in per capita income. Long-run population growth has been an important margin of adjustment – states with larger coal and agricultural endowments per square mile experienced significantly slower population growth than states with smaller endowments per square mile.

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1. Introduction

What are the short-run and long-run effects of resources on economic outcomes? The effects of resources on outcomes are widely debated, because these relationships have implications for welfare and for policies that would restrict or promote development or address specific effects of development. A substantial number of countries and smaller geographic units such as states and counties have substantial endowments of natural resources, and thus the relationships are particularly salient. This salience has led to a large amount of research exploring the relationship between resources and outcomes in a variety of settings, including the United States. One challenge is that these literatures are large, and different papers reach different conclusions about the relationships between resources and economic outcomes.[1]

To address this question for the United States, we use new state-level panel datasets spanning 1936-2015 and the three most valuable natural resources during the period – oil & gas, coal, and agricultural land and Allcott and Keniston's (2017) model of domestic Dutch disease. The model provides short-run and long-run predictions regarding population, wages and employment. The analysis examines these outcomes and per capita income, which is often an outcome of interest when examining resources. The long time period is valuable, because it can be used to examine the effects of resources during different stages of U.S. economic development. The use of three resources facilitates comparisons across resources with declining and increasing employment and across non-renewable and renewable resources. Over the sample period, coal and agriculture had declining employment, while oil & gas had increasing

[1] Sachs and Warner (1995, 1997), Sala-i-Martin and Subramanian (2003), Papyrakis and Gerlagh (2004) and other papers find evidence of a curse, and Alexeev and Conrad (2009) and Cavalcanti, Mohaddes and Raissi (2011) do not. Within the United States context, Black et al (2005), Papyrakis and Gerlagh (2007), Goldberg et al (2008), James and Aadland (2011) and Jacobsen and Parker (2014) find evidence of a resource curse, but Boyce and Emery (2011), Michaels (2011), Weber (2012, 2014), Feyrer et al (2016) and Allcott and Keniston (2015) do not find evidence of a curse.

employment. Because agricultural land is renewable and thus can be used to produce different products at different times, the effects of agricultural land may differ from the effects of non-renewable resources.

To examine the short-run relationships between resources and outcomes, we use a flexible shift-share approach, where the share is state endowment of a resource per square mile and the shift is changes in national employment for that resource. Our primary measure of endowment is endowment in 1935 based on 1935 knowledge of reserves, but we present results for alternative measures of endowment including endowment in 1935 based on 2015 knowledge of reserves. Our estimation approach is flexible in that it allows for different effects across increases and decreases in resource employment. Our main results focus on short-run effects over 5-year time intervals, rather than 1-year time intervals that are more common in the literature, to allow time for spillovers to develop.

For the short-run effects of resources on outcomes, the paper has four main findings. First, different resources have different short-run effects in different time periods, across increases and decreases in resource employment, and across different outcomes. Second, growth in population is somewhat responsive to changes in resource employment. Third for growth in population and for growth in per capita income, the coefficients for a given resource in a given time period are not necessarily the same in sign or significance. This is relevant, because growth in population and growth in per capita income are frequently used as proxies for welfare. Fourth, across a hypothetical boom-bust cycle, in many cases states could be worse off in terms of relative growth in population or per capita income after the cycle than before the cycle.

For the long-run effects of resources on outcomes, we use long differences to show that the primary margin of long-run adjustment has been larger long run relative population declines

in states with larger coal and agricultural endowments. For states with larger coal endowments, population fell in both sub-periods. For states with larger agricultural endowments, population fell in the later period. As a result, resources either had a very small positive effect or had no effect on growth in state per capita income. This is true both for the full sample period and for the 1936-1974 and 1975-2015 sub-periods.

This paper contributes to the U.S. literature on the relationship between resources and economic outcomes by examining effects of multiple resource sectors on multiple outcomes over an 80-year time period and using a flexible estimation approach that allows increases and decreases in resource employment to have different effects. Our findings on the effects of increases and decreases in resource employment are related to Black et al (2005) and Jacobsen and Parker (2015), who examine coal and non-coal counties in Appalachia over the period 1970-1989 and oil and non-oil counties in the Western United States over the period 1969-1998, and find negative effects of boom-bust cycles. Our analysis is also related to Allcott and Keniston (2017), which examines the effects of oil & gas on county outcomes from 1969-2014. They find over the boom-bust cycle of the 1970s and 1980s that there is no long-term effect of oil and gas endowment on a range of county outcomes. The analysis complements time series work by other scholars at the U.S. county level, which tends to focus on individual resources, shorter time periods, and 1-year time intervals over which resources affect outcomes.

The paper also contributes to the literature in American economic history that examines the long run role of resources on economic outcomes during the mid- and late twentieth century. Our finding that there were no long run effects of resources on per capita income and that population was the primary margin of adjustment are most closely related to Mitchener and McLean (2003), Hornbeck (2012), Michaels (2011), and Matheis (2016). Mitchener and McLean

(2003) find that state resources, as measured by the share of the workforce in mining, were related to worker productivity through 1940 but not in 1960 or 1980. Matheis (2016) studies the short and long run effects of coal production on county population and manufacturing. He finds large positive effects of coal production in the previous decade on population pre-1930 and smaller effects in later periods. Hornbeck (2012) finds that population loss was the primary margin of adjustment to erosion in Dust Bowl counties from 1930 to 1940 and that population declines continued through the 1950s. Michaels (2011) examines southern counties with and without oil in Texas, Louisiana, Oklahoma, and nearby states using data from 1940-1990. He finds population increases in oil counties relative to counties without oil and higher but declining differences in per capita income and median family income.

Our results speak indirectly to the economic history literature on the importance of resources during the nineteenth and early twentieth centuries. The short run effects of coal from 1936-1974 were positive during increases in national employment and had no effect during decreases. This is consistent with Habakkuk (1962), Wright (1990), and Wright and Czelusta (2004), who argue that mineral resources had important benefits for the American economy during the nineteenth and early twentieth centuries.[2] And it is consistent with the European literature on coal and economic development (Pomeranz 2001, Allen 2009, and Fernihough and O'Rourke 2014).

2. Resources

[2] The Canadian literature also emphasizes the importance of resources (Chambers and Gordon 1966, Lewis 1975, and Keay 2007).

This section briefly discusses the literature on the relationship between natural resources and growth in the United States, measures of resources used by different authors, and the measures of resources used in this paper.

Resources and Economic Outcomes in the United States

A large number of papers have examined the effects of resources on outcomes. Nearly all papers that apply cross sectional analysis find that resources had a negative effect on outcomes – Boyce and Emery (2011), Goldberg, Wibbles, and Mvukiyehe (2008) James and Aadland (2011), and Papyrakis and Gerlagh (2007). An important exception is Mitchener and McLean (2003), which examines earlier time periods and focuses on price adjusted income per worker. They find the resources are positively related ot outcomes in 1880, 1900, 1920 and 1940 and have no effect in 1960 and 1980.

The results are somewhat mixed for the time series analysis. Using state data, Goldberg, Wibbles, and Mvukiyehe (2008) find resources are negatively related to growth. Boyce and Emery (2011) find resources are negatively related to growth, but positively related to income. Using county data Allcott and Keniston (2017) and Michaels (2011) find that oil and gas are positively related to a range of outcomes. Feyrer et al (2016) and Weber (2012, 2014) examine the recent effects of hydraulic fracturing and find positive effects on outcomes. Using county data, Black et al (2005) and Jacobsen and Parker (2014) find that the boom is smaller than the bust, leaving coal and oil and gas counties worse off after the boom-bust cycle than before.

A strand within economic history argues that natural resources were important drivers of long-run growth. Some examples include Habakkuk (1962), Wright (1990), Pomeranz (2001), Wright and Czelusta (2004), Mitchener and McLean (2003), Keay (2007), Allen (2009), and Fernihough and O'Rourke (2014). Other authors such as Mokyr (1976, 1992), Clark and Jacks

(2007), McCloskey (2010) have argued that natural resources were not key drivers of growth, instead stressing other factors. In contrast to the broader literature, however, they generally do not argue that resources had a negative effect on outcomes.

Measures of Resources in the Literature

The definition of resources varies considerably across papers. For example, in their study of the United States, Papyrakis and Gerlagh (2007) use "The share of the primary sector's production (agriculture, forestry, fishing, and mining) in GSP for 1986." In their study of U.S. counties, James and Aadland (2011) use percent earnings from agriculture, forestry, fisheries, and mining. Other papers focus primarily on oil and natural gas. In United States context, Mitchener and McLean (2003) use mining (which includes oil, coal and other minerals); Black et al (2005) use coal; Goldberg et al (2008) use oil and coal; Michaels (2011) uses oil and natural gas; Boyce and Emery (2011) use mining; Weber (2012, 2014) uses natural gas; Jacobsen and Parker (2014) use oil and natural gas; Feyrer et al (2015) use natural gas; and Allcott and Keniston (2017) use oil and natural gas.

Measures of resource intensity vary. Some use the value of resources produced or employment divided by income or population or workforce. Others classify geographic units based on reserves (Michaels 2011) or reserves per square mile (Alcott and Keniston 2017) or use cutoffs to identify high and low coal counties (Black et al 2005), or high and low oil and gas counties (Jacobsen and Parker 2014). Reserves are generally more exogenous than current production or employment. Further, to the extent that a denominator is used, it will be more exogenous if it does not change in response to future discoveries or production and has not been influenced by historical discoveries or production.

Measures of Resources in this Paper

This paper examines three resources: oil & gas, coal, and agriculture. Why do we focus on these three resources? Table 1 shows agricultural production and the distribution of non-renewable resource production in the U.S. in 1936 and 2015, the first and last years of our sample.[3] Oil & gas and coal were the largest nonrenewable sectors in 1936 and in 2015, and agriculture was the largest renewable sector in those years. We treat oil & gas as a single resource, because disaggregated employment is not available for every year. Examining these three resources facilitates comparisons along two dimensions: i) sectors with declining vs. increasing employment and ii) non-renewable vs. renewable resources. Coal and agriculture had declining employment over the sample period, while oil & gas had increasing employment. Coal and oil & gas deposits can only produce coal or oil & gas. In contrast, agricultural land is renewable and thus can be used to produce different agricultural products at different times in response to changing market conditions.

State endowments of oil & gas, coal, and agriculture are measured in 1935. Why do we use 1935 and not an earlier measure of endowments? One issue is the low frequency of data on outcomes for earlier periods. As we discuss further in the identification section, the other issue is endogeneity.[4] During much of the nineteenth century, endowments are likely to be related to the timing of settlement of states and state investments in discovery of resources. By 1935, the location and characteristics of oil & gas and coal deposits in the United States were relatively well understood, so this is much less important than it might have been earlier.[5] There continued to be resource discoveries and changes in understanding of known deposits that would occur

[3] The sample includes the 48 contiguous states. In particular, it excludes Alaska, Hawaii, and the District of Columbia. Alaska and Hawaii enter the sample late (1960), and Alaska is an extreme outlier in terms of resource intensity. The federal government dominates economic activity in the District of Columbia.

[4] See Wright 1990, David and Wright 1997, Mitchener and McLean 2003, and Clay 2011.

[5] Mitchener and McLean 2003 argue that state level mining can be considered exogenous in 1880. "There were no barriers to the flow of capital and technology across state boundaries, and firms and individuals could take their investment and talents wherever they saw the opportunity for the highest potential return."

between 1935 and 2015. For oil & gas and coal, we construct an alternative measure that is based on endowment in 2015 and adds back production between 1935 and 2015. For agriculture, the alternative measure of endowment is based on the land value in 2015. The two measures can be thought of as endowment in 1935 based on knowledge available in 1935 and endowment in 1935 based on knowledge available in 2015.

We construct α_{ir}, a scaled measure of endowment per square mile in 1935 (based on available knowledge in 1935) in state *i* for resource *r*.[6] This approach is similar to Allcott and Keniston (2017), which also uses endowment per square mile. Oil & gas and coal reserves are from the *Minerals Yearbooks*.[7] State values of farmland are from the *1935 Census of Agriculture*.[8] We divide endowment by the area of the state in square miles, because states differ both in their endowments and in other attributes such as their area. For example, the same endowment in Texas, which is 268,580 square miles and in Rhode Island, which is 1,545 square miles would potentially have very different impacts on the state economy. The endowments are then rescaled so that the state with the highest endowment of resource *r* per square mile has $\alpha = 1$. States with the lowest endowment have $\alpha = 0$. The lowest endowment is zero for oil & gas and coal. The lowest endowment is positive for agriculture. The alternative measure, endowment per square mile in 1935 (based on available knowledge in 2015), is constructed similarly. The

[6] Reserves are used because they are more exogenous than production. Reserves are not divided by population or workforce or income, because all of these are likely to change in response to increases in production. Reserves are divided by area to address variation across geographic units in area. Some studies examine counties that are roughly similar in size and so simply use reserves.

[7] Coal reserves in 1935 are constructed using recoverable reserves in 1950 and coal production from 1935-1950 assuming past losses are equal to production.

[8] We use 1935 average *state* value of farmland multiplied by the number of acres to measure endowment. An alternative approach is to use 1935 average *national* value of farmland multiplied by the number of acres to measure endowment. This treats all acres as having equal value, wherever they are located. We present specifications in which each acre has equal value in the Appendix Tables A5.1 and A5.2.

correlation between this alternative measure and our primary measure is 0.92 for oil and gas, 0.55 for coal, and 0.78 for agriculture.

The first three panels of Figure 1 present the distribution of agriculture, oil and natural gas, and coal across states in 1935 (based on available knowledge in 1935). There is considerable variation in resource endowments. Top oil & gas states are Louisiana, Texas, and Oklahoma. Top coal states are North Dakota, West Virginia and Colorado. Top agriculture states are Connecticut, Iowa, Illinois.

Figure 2 plots the national employment by resource sector over time, and Figure 3 plots resource income in constant 2010 dollars over time. We see a general decline in the agricultural employment and in coal mining employment over time. Oil and gas employment was increasing through the early 1980s, declined into the mid-2000s, but has been increasing since then. For most of the time period, agriculture has the highest employment and coal has the lowest. In Figure 3 throughout the time period, agriculture has the highest income and coal has the lowest.[9]

We examine two sub-periods: 1936-1974 and 1975-2015. The first sub-period, 1936-1974, is a period of relative income stability for all three sectors. There is a short boom in the very early period for agricultural income. Employment is also changing relatively smoothly, particularly for oil & gas and coal. The second sub-period, 1975-2015, is much more volatile in terms of income. The boom-bust-boom cycle in income is evident for all three sectors. Employment changes more smoothly, but the boom-bust-boom cycle is clear, especially for oil & gas employment.

3. Conceptual Framework

[9] An important factor in the divergence of resource employment and resource income has been improvements in efficiency driven largely by technology and mechanization.

Allcott and Keniston (2017) use a Moretti (2010) version of the Rosen–Roback spatial equilibrium framework to investigate the local welfare effects of resource booms. The model compares two geographic units, one with a resource endowment and one without, across three periods. In the online appendix, they show the results hold for many geographic units. In their context the geographic units are counties; in our context the geographic units are states. In period 0, the geographic units are symmetric and neither produces resources. In period 1, the unit with the endowment experiences a (temporary) resource boom, in which production is positive. In period 2, the boom is over and neither produces resources. In addition to the resource sector, there are two other sectors that require local labor – a tradable sector and a non-tradable sector. There is also a housing sector that does not require local labor.

In equilibrium, firms and consumers optimize and markets clear. Firms maximize profits and demand labor. There are two possible types of spillovers across firms over time – learning by doing spillovers and agglomeration spillovers. Learning by doing spillovers mean that current productivity is influenced by prior sectoral employment. Agglomeration spillovers mean that current productivity is influenced by past population. In every period, individuals decide where to live, supply one unit of labor, and make consumption decisions about housing, tradable goods, and non-tradable (local) goods subject to the budget constraint.

The model generates predictions regarding the contemporaneous and long run effects of a resource boom. *Contemporaneously, the model predicts that the resource boom will increase population and wages.* The boom will also increase local sector employment, decrease tradable sector employment, and increase local sector prices.

Allcott and Keniston (2017) examine the long-run relative welfare effects. They first ask whether the boom increases cumulative social welfare in geographic unit A vs. geographic unit

B. *In the long run, the model predicts that the relative welfare effects can be signed by examining relative population.* They state: "Intuitively, people vote with their feet by migrating to the county with higher welfare. This equation will be useful empirically, as it will allow us to sign the relative welfare effect even without a direct estimate of how the resource boom affects local prices and amenities." "If there are no productivity spillovers … then the two counties have equal productivity, population, and wages after t=1, and a resource boom unambiguously increases relative welfare. If there are productivity spillovers, then local sector relative productivity will increase, and the signs of both tradable sector relative productivity and relative welfare will depend on the relative strengths of the learning-by-doing versus agglomeration spillovers." [10]

While the model considers a single resource sector, empirically one might expect the relationship between resources and outcomes to be heterogeneous across a variety of dimensions. Changing production technology, transportation costs, capital markets and other factors, could alter the relationships over time. [11][12] If there are adjustment costs, the effects over a one-year

[10] Allcott and Keniston (2017) also examine the long-run absolute welfare effects (i.e. whether the boom increases cumulative social welfare in geographic unit A relative to the counterfactual in which A has but does not produce resources). The relative and absolute effects differ, because the general equilibrium effects differ.

[11] There is a literature on the 'cleansing' effects of recessions (Davis and Haltiwanger 1990, 1992, 1999, Caballero and Hammour 1994, 1996). There is also large macroeconomic literature on oil prices and recessions. See Hamilton (2011, 2012) and Kilian and Vigfusson (2014). Kilian and Vigfusson (2014) discuss nonlinearity of the relationships. In unreported regresssions, we did not find statistically significant differential effects during periods of recession.

[12] Political institutions can affect growth, particularly if countries or states with weak institutions are unable to realize gains from resources (Mehlum et al 2006, Cabrales and Hauk 2011, van der Ploeg 2011, Berkowitz and Clay 2011). In the U.S. context Southern states are viewed as having had weaker institutions during certain time periods. From the turn of the century through roughly 1970, a single party dominated state politics in the former Confederate states. Following the Voting Rights Acts of 1965 and its 1970 amendment, political competition began to increase in Southern states. Besley et al (2010) find that these changes led to increases in per capita income. If stronger institutions led to changes in resource production or use of resource income, then the relationship between resources and growth may have changed. In unreported regresssions, we did not find statistically significant differential effects for the South.

period may differ from the effects over a five-year period. Increases and decreases in resources may have asymmetric effects.[13]

4. Data on Outcomes

The data on resource endowments, employment and income were discussed in Section 2. This section considers data on outcomes including per capita income and employment in various sectors.

Figure 4a shows the evolution of per capita income in 2010$ over time. Data on state personal income are available annually beginning in 1929 from the Bureau of Economic Analysis.[14] One can see the effects of major events including the Great Depression, WWII, and the Great Recession. Figure 4b plots the distribution of the five-year annualized income growth rate. The average growth rate is around 2.5% per year.

The last panel of Figure 1 presents the average per capita income in 1929-1934, which is the baseline income. There is substantial regional variation in income, which reflects regional differences in economic development. Many states in the Northeast are in the top quartile, and many states in the South are in the bottom quartile.

Appendix figure A2.1 plots the average state total employment and population. Both have been increasing over our study period. Figure A2.1 also shows the average logged state wages per worker in mining, agriculture and manufacturing sectors. Wages in all sectors have been increasing.

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[13] Carrington (1996), Black et al (2005), and Jacobsen and Parker (2014) examine booms and busts created by construction of the Alaskan pipeline and the Appalachian coal boom and the Western oil boom in the 1970s and 1980s. Recent papers on natural gas such as Feyrer et al (2016), Weber (2012, 2014) only observe the boom and not the bust. Henderson et al (2011) discuss boom-bust in agriculture.

[14] Data were adjusted to 2010 dollars using the US CPI data from Officer and Samuelson's website Measuring Worth. Population values by state are from the decennial Censuses of Population. These values were linearly interpolated for intervening years.

Appendix figure A2.2 plots the average state employment in non-resource sectors: manufacturing, construction, transportation, wholesale, and retail over 1970-2015.[15] Employment data are taken from the Bureau of Economic Analysis (BEA). Manufacturing employment was fairly constant until 2000, with small ups and downs in 1970-1980. During 2000-2010 manufacturing employment slowly decreases. Number of people employed in other sectors, however, almost doubled during the study period. Average state retail employment was almost 300,000 in 1970, and it has increased to almost 600,000 in 2015. Number of people employed in wholesale, transportation and construction sectors has increased from around 100,000 to almost 200,000.

Tables 2a and 2b present the summary statistics for the main variables used in the analysis. Summary statistics for other variables are available in the Appendix Table A1.

5. Identification

The Allcott and Keniston (2017) model has implications for states with higher and lower endowments if there is variation over time in resource employment such as we observe in Figure 2. The relative effects are denoted τ_r, where τ_r is the effect of an increase in resource employment on the average difference in outcomes between states with higher and lower endowments. τ_r captures spillovers from learning by doing and agglomeration and any other general equilibrium effects.[16]

To investigate the empirical relationship between resources and various economic outcomes we estimate the following reduced form equation:[17]

$$\Delta lnY_{it} = \tau_r \alpha_{ir} \Delta lnE_{rt} + \omega_t lnY_{i0} + \varphi_{dt} + \theta_i + \varepsilon_{it} \quad (1)$$

[15] State specific employment by sectors is not available prior to 1969.

[16] Allcott and Keniston (2017) also estimate τ_a, the treatment on the treated. This is possible, because they use county data and so can measure spillovers. Empirically they find that $\tau_r > \tau_a$.

[17] The regression could also be estimated using fixed effects, but differencing is more efficient if errors are serially correlated.

Y_{it} is an outcome in state *i* in year *t*. α_{ir} is endowment of resource r in the baseline period. E is national employment or income for resource *r* in time *t*. Y_{i0} is a baseline value of the outcome for state *i*. φ_{dt} are census division-year fixed effects, and θ_i are state fixed effects. Economic outcomes may be moving for reasons other than shifts in resource. To address this, we interact baseline values with year fixed effects, as well as control for state fixed effects and census division by year fixed effects. We use robust standard errors that are clustered by state.[18]

The variables Y and E are logged, so $\Delta \ln Y_{it}$ is approximately equal to the growth rate in the outcome variable, and $\Delta \ln E_{rt}$ is approximately equal to the growth rate in national resource employment. The changes are measured over one year (from t to t-1) or five years (from t to t-5).

The variable $\alpha_{ir}\Delta \ln E_{rt}$ is similar to shift share approach used in Allcott and Keniston (2017). Here the share in in the shift share comes from the cross-sectional variation in the resource endowment in the baseline year (1935). The construction of α_{ir}, the endowment in state i of resource r, was described in section 2. Recall that α_{ir} is scaled so the top value is 1, and states with no endowment of a resource are 0. The estimated τ_r is similar to elasticity, where τ_r is the differential effect of a one percent increase in national resource employment in the state with the largest resource endowment per square mile.

If increases and decreases in resource employment are uncorrelated with unobserved economic trends, conditional on baseline outcomes interacted with year and census-division year fixed effects, Equation 1 will produce unbiased estimates of τ_r. Figure 2 shows that the three resources follow different time paths. Any confounder would have to follow one of the three time trends and differentially affect states with higher endowments of that resource.

[18] As a robustness check, we have bootstrapped the standard errors for some specifications. Bootstrapping does not change the statistical significance of the results.

One limitation of equation (1) is that it restricts the effects to be similar for the increases and decreases in resource employment. A number of papers including Black et al (2005), and Jacobsen and Parker (2014) suggest that there may be differential effects of increases and decreases in resource. To allow the effects to differ during booms and busts, we estimate the following equation:

$$\Delta lnY_{it} = \tau_r^- \alpha_{ir} 1(\Delta lnE_{rt} < 0)\Delta lnE_{rt} + \tau_r^+ \alpha_{ir} 1(\Delta lnE_{rt} \geq 0)\Delta lnE_{rt} + \omega_t lnY_{i0} + \varphi_{dt} + \theta_i + \varepsilon_{it} \quad (2)$$

where $1(\Delta lnE_{rt} < 0)$ and $1(\Delta lnE_{rt} \geq 0)$ are dummy variables indicating a decline and an increase in sectoral r employment E_{rt} between t and t-5, respectively. The coefficients of interest τ_r^- and τ_r^+ show the differential effects of resources during boom and bust periods respectively.

The economic history literature has stressed the endogenous nature of resources. As we discussed in section 2, by 1935 the location and characteristics of oil & gas and coal deposits in the United States were relatively well understood. *Shares* of resources held by different states were generally stable and so can be treated as the endowment in 1935. The *level* of economically recoverable reserves would change, of course, with national changes in technology and economic conditions. If these changes in levels caused shares to shift between 1935 and 2015, the relationship between 1935 endowment shares interacted with changes in national employment and outcomes may become more attenuated over time. We explore this issue in Appendix Tables A2 and A3 where we compare estimates based on the 1935 endowment based on 1935 knowledge with the 1935 endowment based on 2015 knowledge.

6. Results

Short-Run Effects of Resources on Population and Growth in Per Capita Income

Table 3 presents the estimates of the relationship between natural resources and growth in population. Columns 1 and 2 of Table 3 report the estimates of equation (1) for 1-year and 5-year time periods assuming the symmetric effect across increases and decreases in resource employment. The 1-year difference specification (column 1) assumes that changes in resource employment immediately translate into growth in population, while 5-year differences (column 2) allow the effects to develop over a longer time period. In columns 1 and 2, oil & gas and coal are both positively but not significantly related to growth in population. Agriculture is negatively and statistically significantly related to population. Increases in agricultural employment are associated with relative declines in overall population. Columns 3-5 of Table 3 present the results for the more flexible boom-bust specification from equation (2) and examine the effects across different sub-periods. The results from the columns 3-5 tell a more nuanced story in which different resources have different effects in different time periods.

Table 4 presents the coefficients for the same specifications, where the dependent variable is growth in per capita income. We are interested in growth in per capita income, because in parts of the literature it is used implicitly or explicitly as a measure of welfare. As in Table 3, the symmetric results in columns 1 and 2 and the asymmetric results in the columns 3-5 have different implications.

Figure 5 plots by resource the effects implied by estimates in Tables 3 and 4 of a one standard deviation increase in employment for the state with the highest endowment across periods, increases and decreases in resource employment, and population and growth in per capita income. Recall that the endowment of the top state is equal to 1, so a state with X% the endowment per square mile of the top state would experience an effect that is X% of that of the top state.

Figure 5 highlights four points. First, different resources have different short-run effects in different time periods, across increases and decreases in resource employment, and across different outcomes. For example, for 1935-1975, increases in oil and gas employment have no effect on population growth or income per capita, while increases in coal employment have positive and statistically effects on both and increases in agricultural employment have statistically significant negative effects on population growth but no effect on per capita income.

Second, growth in population is somewhat responsive to changes in resource employment. For increases, the coefficients on coal over 1936-1974 and oil & gas over 1975-2015 are positive and statistically significant, and the coefficient on oil & gas over 1936-1974 is positive but not significant. The remaining coefficients are negative but not significant or negative and statistically significant. If spillovers are small or zero, the model predicts that population would decrease during decreases in resource employment. For decreases in natural resource employment, the coefficients on oil & gas over 1936-1974 and coal and agriculture over 1975-2015 are negative and statistically significant. The remaining coefficients are extremely small and not significant or negative and statistically significant.

Third, the coefficients for growth in population and for growth in per capita income for a given resource in a given time period are not necessarily the same in sign or significance. This is relevant, because growth in population and growth in per capita income are frequently used as proxies for welfare. For example, during declines in oil & gas employment in 1975-2015, the effect on population is small and not significant, while the effect on per capita income is negative and significant. For coal, the measures agree – positive and significant for employment increases during 1935-1974, insignificant during employment decreases during 1935-1974 and increases during 1975-2015. For agriculture the measures disagree – growth in per capita income is

insignificant during employment increases and decreases in both periods. Growth in population is negative and statistically significant even during employment increases.

Fourth, across a hypothetical boom-bust cycle, states could be worse off in relative terms after the cycle than before the cycle. In many cases the coefficient on the decline is bigger in magnitude than the coefficient on increase in resource employment. The differences in some cases are statistically significantly different and in some cases are not. For population growth the coefficients on declines are statistically different from the coefficients on increases in 1975-2015 for all resources, and for coal and agriculture in 1936-1974. For growth in per capita income, the coefficient on the decline for oil and coal from 1936-1974 and coal from 1975-2015 is statistically significantly bigger in magnitude than the coefficient on increase in resource employment.

Short-Run Effects of Resources on Wages and Employment

Table 5 explores the effects of resources on mining (all resource extraction), agricultural, and manufacturing wages for 1975-2015.[19] In Panel A, the coefficients on oil & gas and coal for mining wages and the coefficients on agriculture for agricultural wages are positive, but not always statistically significant. This is consistent with the model's prediction that increases in resource employment would lead to increased wages. In Panel B, there are small and not statistically significant effects of increases in oil & gas employment and coal employment for mining wages and increases in agricultural employment for agricultural wages. For decreases in oil & gas employment and coal employment for mining wages, the effects are positive and statistically significant. For decreases in employment for agricultural wages, the coefficient is positive but not statistically significant. Manufacturing wages are of interest, because shifts in employment in resource sectors may have effects on wages in other sectors. The coefficients are

[19] Over this period, separate series are not available for oil & gas and coal.

positive but only increases in coal employment are positively and significantly related to manufacturing wages.

Table 6 explores employment effects for total employment, retail, manufacturing, construction, and transportation for the same period. Panel A shows the symmetric results. All but one of the coefficients on resource employment are positive and two-thirds are statistically significant. As was the case in previous tables, the results in Panel B are quite different from the results in Panel A. Many of coefficients on employment increases in resources are negative, although only one is statistically significantly negative. All of the coefficients on employment declines in resources are positive, and most coefficients are statistically significant. Thus, in all but one instance, the coefficients on employment declines are bigger than on employment.

Overall, the short run effects of resources on wages and employment are in line with key findings from the previous subsection. Different resources have different short-run effects across increases and decreases in resource employment and across wages, total employment, and employment in other sectors. Further, the effects of declines in resource employment on wages, total employment, and employment in other sectors are almost always bigger than the effects of increases. Thus, across a hypothetical boom-bust cycle, wages and employment may be lower after the cycle than before the cycle.

Long-Run Effects of Resources

Table 7 examines the long-run relationship between resource endowments and growth in population and growth in per capita income over the period 1936-2015. All columns include controls for initial levels of the outcome, which is either average population or income per capita over 1929-1934.

Panel A shows that states with higher coal endowments and agricultural endowments experienced slower long run relative population growth. The coefficients on coal endowments and agricultural endowments are negative, statistically significant, and sizeable relative to the mean. For the top state in coal endowment relative to the state with the lowest endowment, the implied effect is 108% of the mean in 1936-2015. In 1936-1975, it is 131% of the mean and in 1975-2015, it is 100% of the mean. For the top state in agricultural endowment relative to the state with the lowest agricultural endowment, the effect is 92% of the mean in 1936-2015. In 1936-1975, it is 54% of the mean and in 1975-2015, it is 210% of the mean.

Strikingly, Panel B shows that endowments have little long run relationship to per capita income. The coefficients on endowments are small and positive. Only the coefficient on agriculture over 1936-2015 is statistically significant, implying the difference in income per capita growth between top endowment state compared to the bottom endowment state of about 21% of the mean income per capita growth. Population growth appears to have been an important margin of adjustment.

7. Conclusion

What are the short-run and long-run effects of resources on economic outcomes? For the short-run, different resources have different short-run effects in different time periods, across increases and decreases in resource employment, and across different outcomes. Short-run effects may differ for the same resource due to changing production technology, transportation costs, and spillovers. In line with the finding of the model, growth in population is somewhat responsive to increases in resource employment. States with large endowments see positive impacts for coal in 1936-1974 and oil & gas in 1975-2015. Although growth in population and

growth in per capita income are frequently used as proxies for welfare, the effects of short-run changes in resource employment are not necessarily the same in sign or significance for these outcomes. Per capita income reflects both income and movements in population, so the two may occur over different time frames. Across a hypothetical boom-bust cycle, in many cases states could be worse off in terms of relative growth in population or per capita income after the cycle than before the cycle. This is consistent with the findings of Black et al (2005) and Jacobsen and Parker (2015).

For the long-run, the primary margin of adjustment has been larger relative population declines in states with larger coal and agricultural endowments. For states with larger coal endowments, population fell in both sub-periods. For states with larger agricultural endowments, population fell in the later period. This builds on and extends Matheis (2016) and Hornbeck (2012)'s findings on population over the long-run for coal counties and for high erosion counties in the Dust bowl. As a result of the adjustments in population, resources either had a very small positive effect or had no effect on growth in state per capita income.

From a very long-run welfare perspective, having high coal or agricultural endowments was likely to have been welfare enhancing when considered at the outset in the eighteenth or nineteenth century. One thing to keep in mind is that coal and agricultural employment peaked before the start of our sample period. The issue is that many states experienced the long bust over our sample period, so the current generations only experience decline. There were some smaller periods of booms and busts within the long decline. The short-run results suggest there may have been some welfare gains over some shorter periods for coal during 1936-1974. The very long-run perspective captures the early benefits of resources that Wright (1990) and Wright

and Czelusta (2004) discuss in the United States context and other authors discuss in the European context.

In contrast to coal and agriculture, oil & gas employment is at or near an all time high now. Thus, states with oil & gas endowment have experienced a long boom, albeit with some shorter periods of booms and busts within the long boom. Although we do not find long-run effects of oil & gas endowment on population or per capita income, from the perspective of the beginning of the boom, there may be positive welfare effects associated with the long boom. When Allcott and Keniston (2017) examine the average wage effects over the cycle, they find positive average effects suggesting there are positive welfare benefits that eventually disappear with population inflows. The positive short-run population effects we find for oil & gas in 1975-2015 tell a similar story. Over the very long run, all three resources were likely to have been welfare enhancing, but oil & gas is at a different point in the boom-bust cycle than either coal or agriculture.

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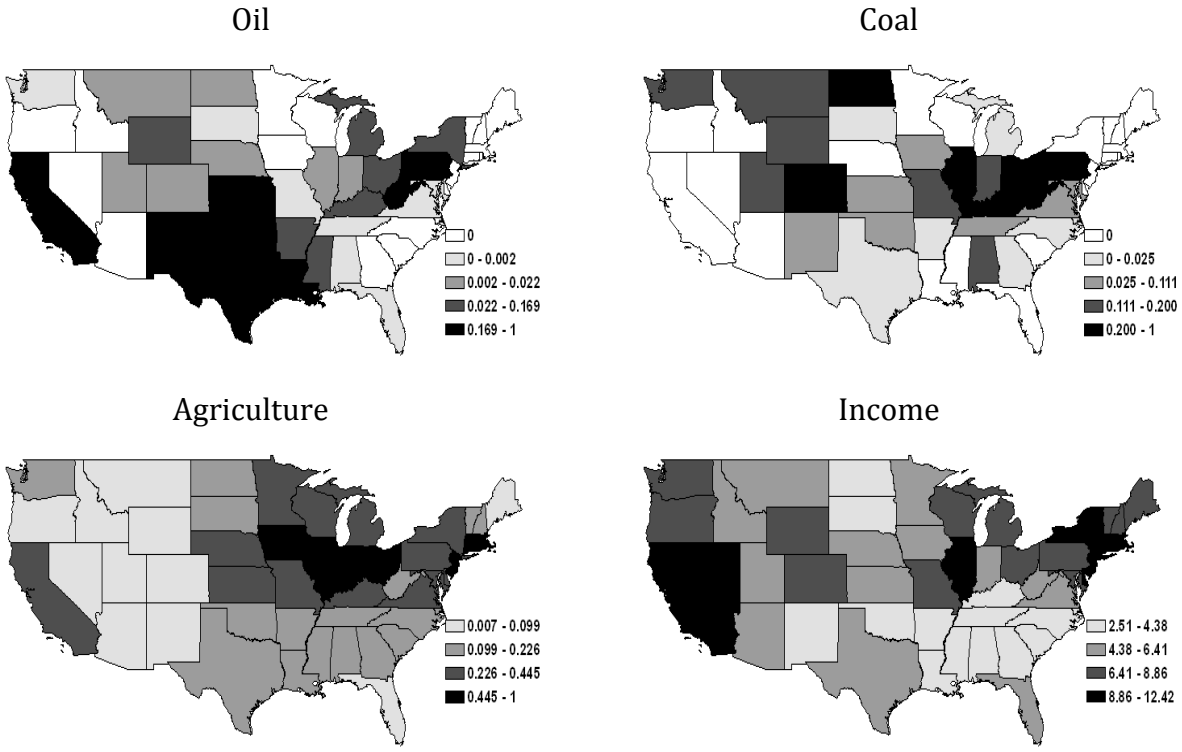
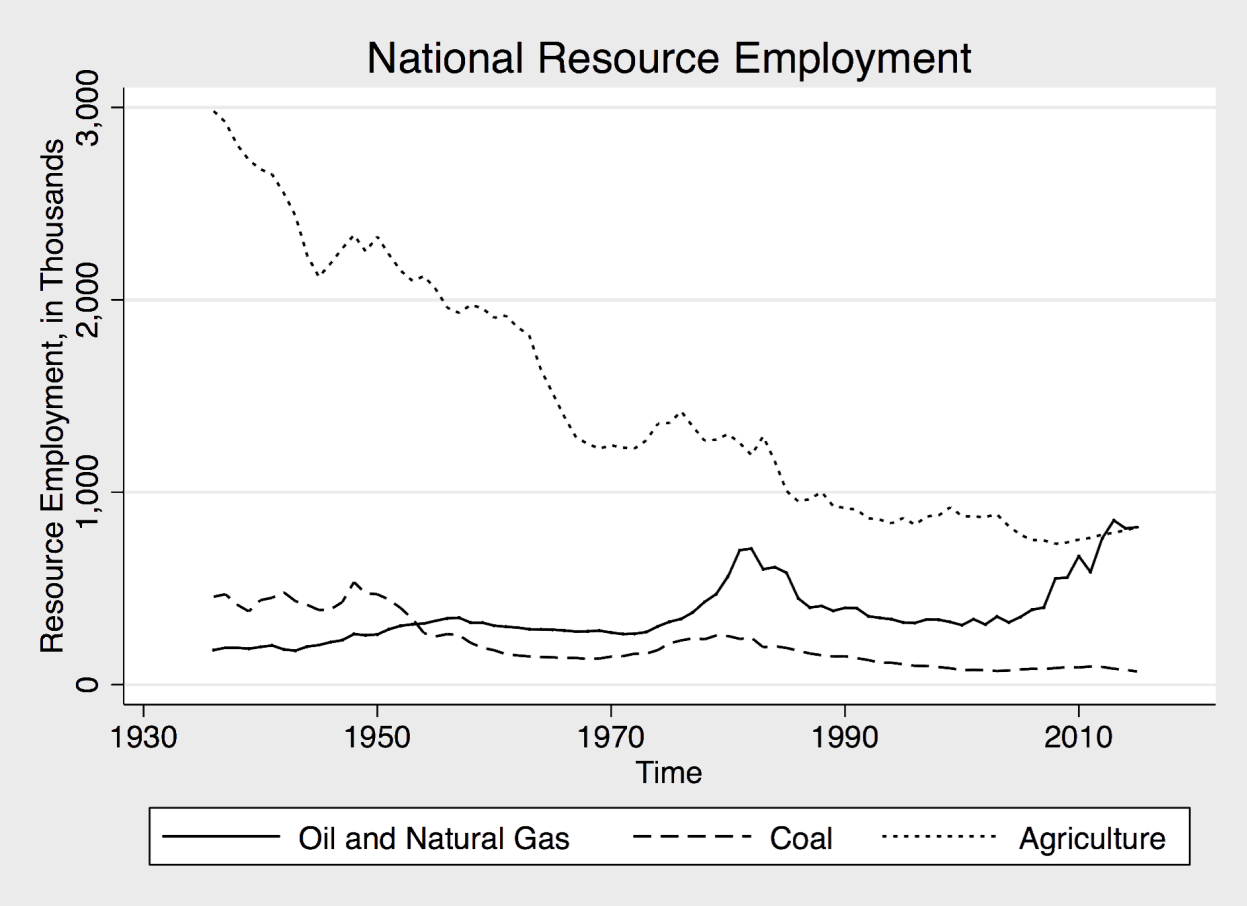
Figure 1 - Resource Endowments in 1935



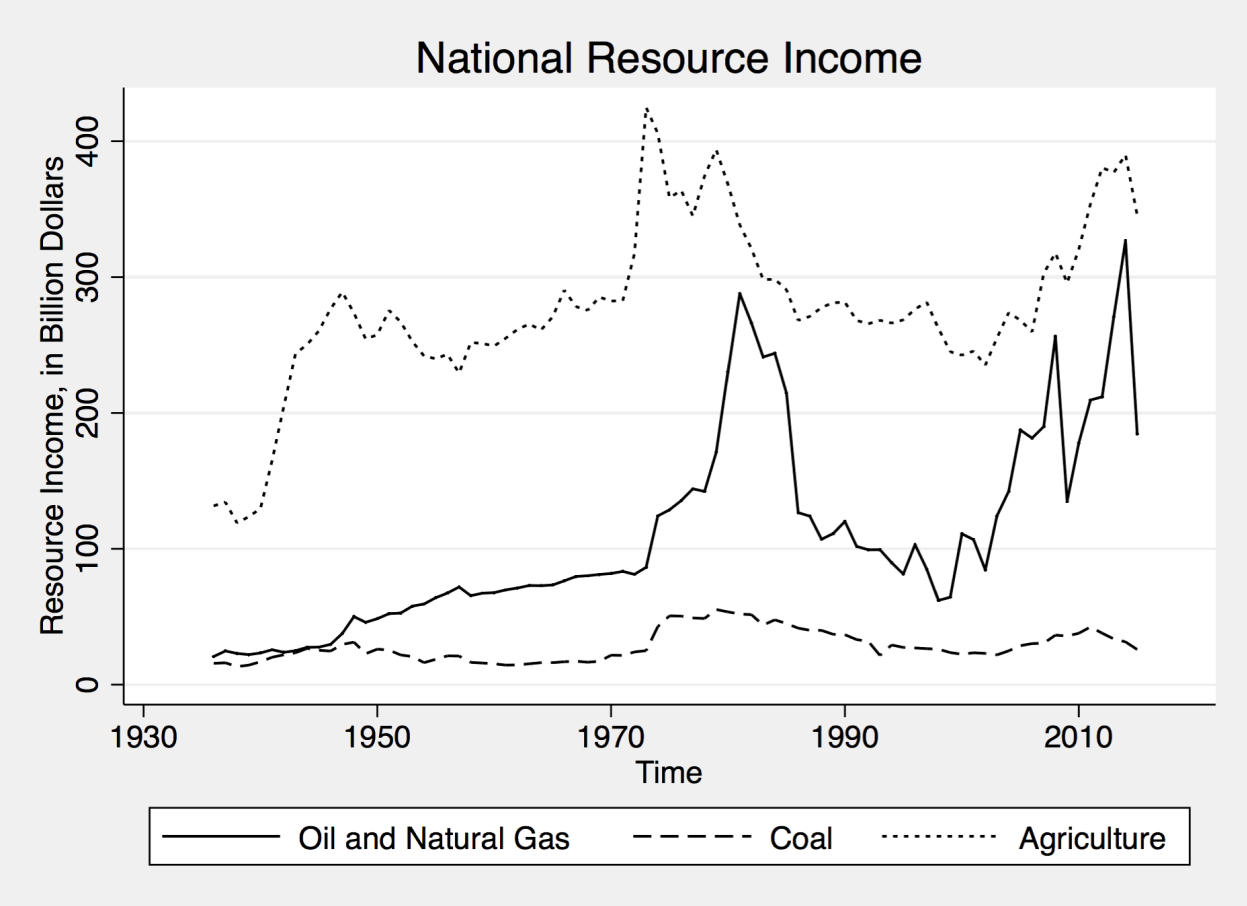
Notes: This figure maps the resource endowments as of 1935 and average income per capita. The gradients are based on percentiles, conditional on nonzero value of resources and income ((0-25, 25-50, 50-75, 75-100)). Oil & gas map plots the dollar value of oil & gas reserve in 1935, using 1935 oil prices and natural gas prices. Coal map shows the dollar value of recoverable coal reserves in 1935 using average coal price in 1935. Agriculture map plots the farm value (value of land and buildings in farms) used in agriculture in 1935. Income PC is the average income per capita in 1929-1935, in 2010 dollars. Oil & gas and coal data are from Minerals Yearbooks. Agriculture data are from United States Department of Agriculture (USDA), Census of Agriculture. Income data are from the Bureau of Economic Analysis (BEA).

Figure 2 – Employment: Resource Sectors



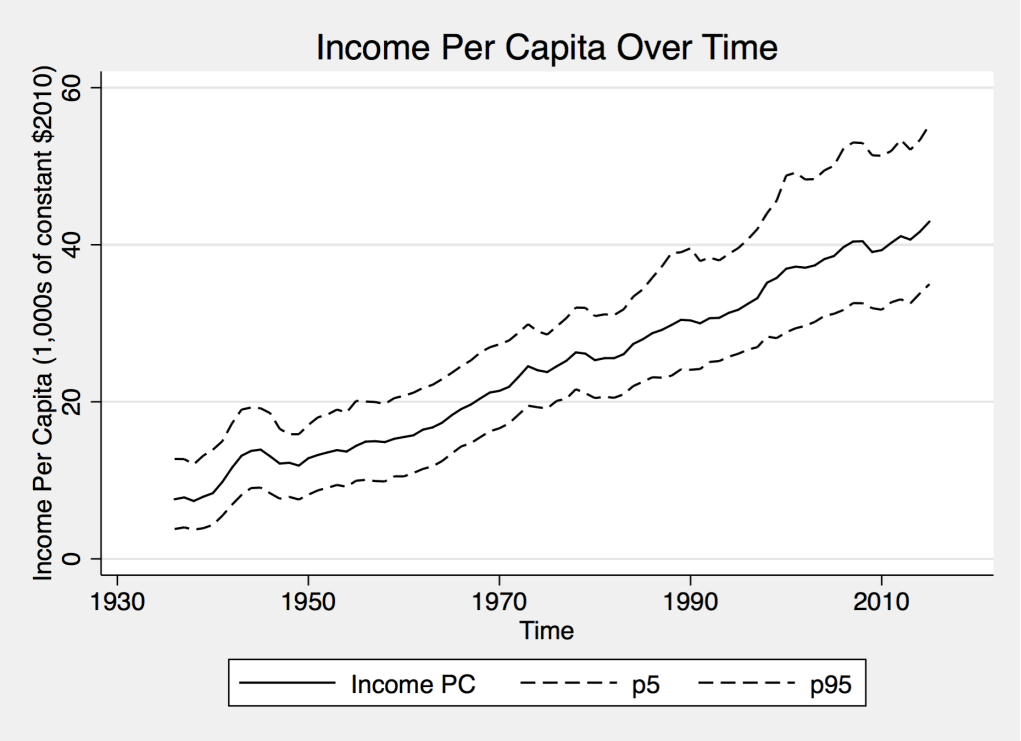
Notes: National Employment (in thousands) over time (1935-2015) in different sectors based on 1987 Standard Industrial Classification (SIC) for 1935-2001 and based on North American Industry Classification System (NAICS) for 2002-2015: Agriculture, Oil and Gas extraction. National employment statistics for oil & gas and agriculture sectors for 1935-2015 are taken from the Bureau of Economic Analysis. National coal mining employment is taken from U.S. Bureau of Labor Statistics.

Figure 3- Income: Resource Sectors



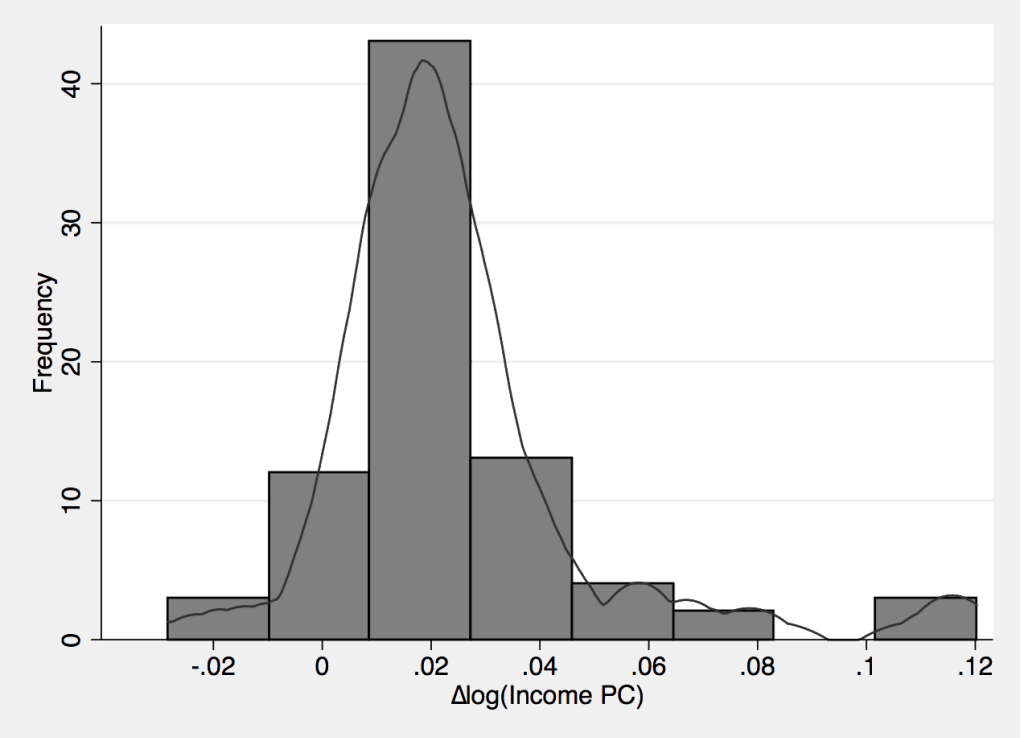
Notes: Income (in millions) from resource sectors, in 2010 dollars. Oil& natural gas from Alaska excluded from oil & gas income. Coal and oil & gas income data are from the U.S. Bureau of Mines, Minerals Yearbooks and U.S. Energy Information Administration (EIA), Annual Energy Review. Agriculture income data are taken from the United States Department of Agriculture (USDA).

Figure 4a - Income Per Capita Over Time



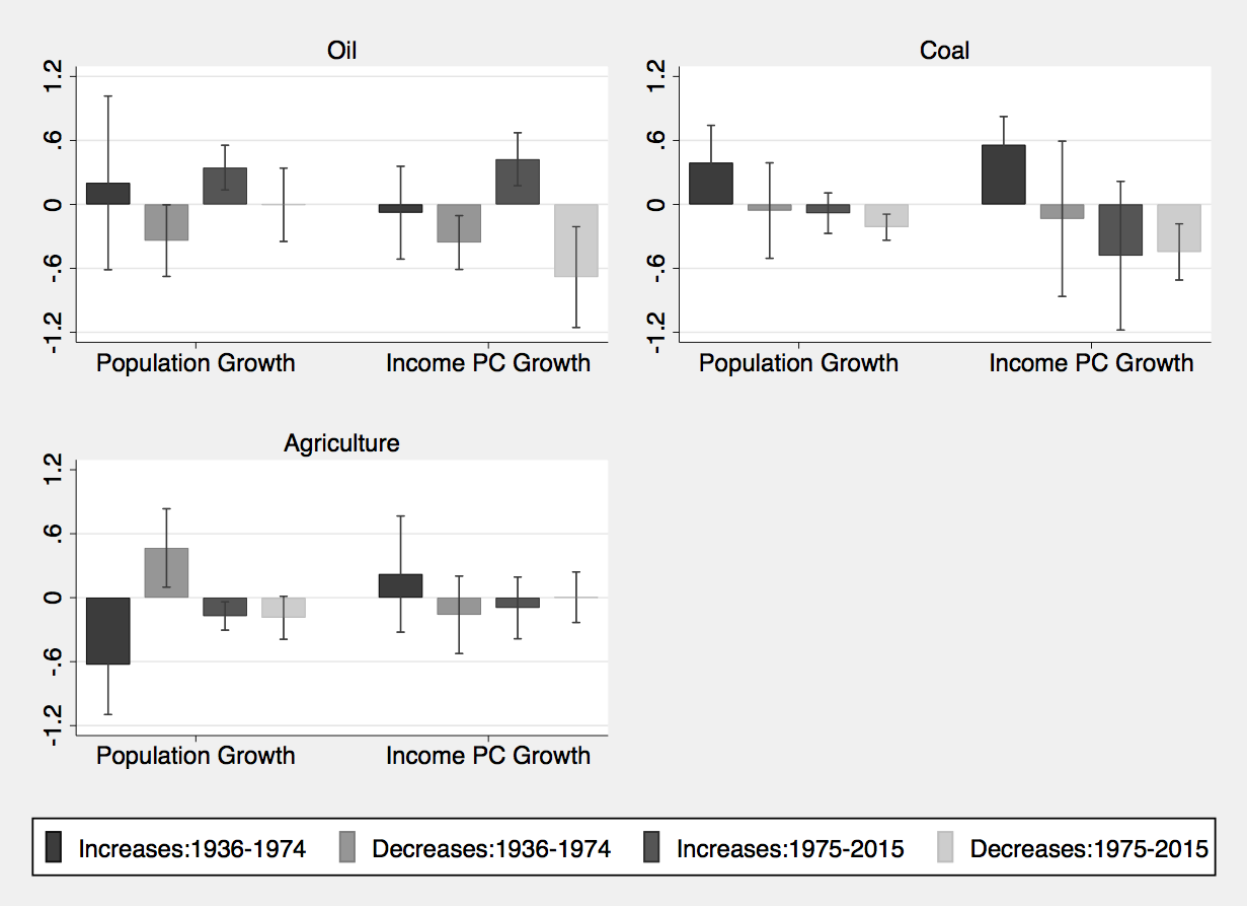
Notes: Graph plots Income Per Capita 1936-2015 in 2010 dollars and 5th and 95th percentile. Data are taken from the Bureau of Economic Analysis (BEA).

Figure 4b - Income Growth



Notes: Graph plots the distribution of the main dependent variable: annualized five-year difference in log of income per capita.

Figure 5 – Effects of a One Standard Deviation Increase in Resource Employment on Population Growth and Income Per Capita Growth



Notes: The figure is based on Tables 3 and 4 and shows the effects of a one standard deviation increase in oil, coal and agriculture employment on population growth and income per capita growth. Vertical bars show the 95% confidence intervals.

Table 1 - Resource Production in 1936 and 2015

	1936	2015
Agricultural Output	**132**	**345**
Fossil Fuels Total	**36**	**211**
Coal (Bituminous, Lignite and Anthracite)	16	26
Oil and Natural Gas	21	185
Total Metals	**9**	**24**
Iron Ore	2	4
Copper	2	7
Lead	0.6	0.7
Zinc	0.8	1.6
Gold	2	7
Silver	0.8	0.5
Molybdenum	0.2	0.9
Total Nonmetal Minerals	**9**	**48**
Cement	3	9
Clay Products	1	1
Lime	0.4	2
Sand and Gravel	1	7
Crushed Stone (including Slate)	2	12
Phosphate Rock	0.2	2
Salt	0.4	2
Sulfur	0.6	0.86

Notes: Value of production/sales in 2010 dollars (in billion). Data for 1936 are from U.S. Bureau of Mines, Mineral Resources of the United, U.S. Bureau of Mines, Minerals Yearbooks U.S. Geological Survey, Minerals Yearbooks (U.S. Department of the Interior). Data for 2015 are from U.S. Department of the Interior, U.S. Geological Survey, Mineral Commodity Summaries.

Table 2a –Summary Statistics: Resource Endowments and Employment

Variable	Obs.	Mean	Std. Dev.
Panel A: State Resource Endowments in 1935			
Oil Endowment	3,840	0.082	0.191
Coal Endowment	3,840	0.095	0.178
Ag Endowment	3,840	0.257	0.209
Panel B: Changes in National Resource Employments 1936-2015			
ΔOilEmp	3840	0.022	0.054
ΔCoalEmp	3840	-0.020	0.050
ΔAgEmp	3840	-0.016	0.022
Panel C: Changes in National Resource Employments 1936-1974			
ΔOilEmp	1872	0.019	0.036
ΔCoalEmp	1872	-0.024	0.051
ΔAgEmp	1872	-0.021	0.022
Panel D: Changes in National Resource Employments 1975-2015			
ΔOilEmp	1,968	0.025	0.067
ΔCoalEmp	1,968	-0.016	0.049
ΔAgEmp	1,968	-0.011	0.021

Notes: Panel A reports summary statistics for state level variables used in the analysis. OilEnd, CoalEnd and AgEnd are oil, coal and farm endowments in 1935 scaled so that the state with largest endowment is coded as 1. Oil & gas endowment is the dollar value of oil & gas reserve in 1935, using 1935 oil prices and natural gas prices. Coal endowment is the dollar value of recoverable coal reserves in 1935 using average coal price in 1935. Agriculture endowment is the farm value (value of land and buildings) used in agriculture in 1935. Oil & gas and coal data are from Minerals Yearbooks. Agriculture data are from United States Department of Agriculture (USDA), Census of Agriculture. Panels B- C reports the summary statistic for national changes in resource employments for the whole sample 1936-2015 (Panel B) and two subsamples: 1936-1974 (in Panel C) and 1975-2015 (in Panel D). ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively.

Table 2b - Summary Statistics: Outcome Variables

	Obs.	Mean	Std. Dev.
Panel A: 1936-2015			
ΔIncPC	3,840	0.025	0.029
ΔPop	3,840	0.012	0.012
Panel B: 1936-1974			
ΔIncPC	1,872	0.036	0.036
ΔPop	1,872	0.013	0.014
Panel C: 1975-2015			
ΔIncPC	1,968	0.014	0.012
ΔPop	1,968	0.010	0.010
ΔTotEmp	1,968	0.017	0.014
ΔMnfEmp	1,966	0.046	0.023
ΔTransportationEmp	1,960	0.014	0.016
ΔConstructionEmp	1,962	0.015	0.039
ΔRetailEmp	1,968	0.016	0.017
ΔWholesaleEmp	1,968	0.016	0.023

Notes: Summary statistics for the main outcome variables used in the analysis for the whole sample 1936-2015 and two subsamples: 1936-1974 and 1975-2015. Δ is five-year difference in logged variables. Data are from BEA.

Table 3- Effects of Natural Resources on Population Growth

VARIABLES	(1) 1936-2015 ΔPop D1	(2) 1936-2015 ΔPop D5	(3) 1936-2015 ΔPop D5	(4) 1936-1974 ΔPop D5	(5) 1975-2015 ΔPop D5
OilEnd X ΔOilEmp	0.023	0.053			
	(0.020)	(0.040)			
CoalEnd X ΔCoalEmp	0.018	0.078			
	(0.026)	(0.049)			
AgEnd X ΔAgEmp	-0.074**	-0.203***			
	(0.036)	0.053			
(OilEmpDecline=0) X OilEnd X ΔOilEmp			0.027	0.070	0.087***
			(0.067)	(0.144)	(0.027)
(OilEmpDecline=1) X OilEnd X ΔOilEmp			0.112**	0.438*	0.001
			(0.053)	(0.221)	(0.051)
(CoalEmpDecline=0) X CoalEnd X ΔCoalEmp			0.103**	0.246**	-0.029
			(0.043)	(0.112)	(0.034)
(CoalEmpDecline=1) X CoalEnd X ΔCoalEmp			0.064	0.015	0.151***
			(0.055)	(0.059)	(0.044)
(AgEmpDecline=0) X AgEnd X ΔAgEmp			-0.375***	-0.791**	-0.217**
			(0.111)	(0.301)	(0.085)
(AgEmpDecline=1) X AgEnd X ΔAgEmp			-0.165**	-0.244**	0.126*
			(0.072)	(0.098)	(0.069)
Observations	3,840	3,840	3,840	1,872	1,968
R-squared	0.612	0.740	0.741	0.751	0.852

Notes: This table presents estimates of equation (1) in columns 1 and 2 and equation (2) in columns 3-5. OilEnd, CoalEnd and AgEnd are oil, coal and farm endowments in 1935 constructed as described in the resources section. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. ΔPop is difference in log of population. D1 and D5 represent one and five year differences. Decline is a dummy variable indicating a decline in respective sectoral employment. Estimated effects in columns 3-5 are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for census division by year and state fixed effects. Columns 1-4 also include controls for year interacted with natural log of the average population in 1929-1934, column 5 includes controls for year interacted with natural log of the average population in 1969. The effect of oil during the employment decreases is statistically different from the effect during employment increases over the period 1975-2015. The effect of coal during the employment decreases is statistically different from the effect of coal during employment increases across two sub-periods, but not for the whole time period. The effect of agriculture during the employment decreases is statistically different from the effect during employment increases over the whole time period as well as two sub-periods. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table 4- Effects of Natural Resources on Per Capita Income Growth

VARIABLES	(1) 1936-2015 ΔInc PC D1	(2) 1936-2015 ΔInc PC D5	(3) 1936-2015 ΔInc PC D5	(4) 1936-1974 ΔInc PC D5	(5) 1975-2015 ΔInc PC D5
OilEnd X ΔOilEmp	0.083***	0.130***			
	(0.029)	(0.035)			
CoalEnd X ΔCoalEmp	0.034	0.099***			
	(0.056)	(0.027)			
AgEnd X ΔAgEmp	0.072	0.008			
	(0.061)	(0.075)			
(OilEmpDecline=0) X OilEnd X ΔOilEmp			0.101***	-0.027	0.107***
			(0.027)	(0.077)	(0.032)
(OilEmpDecline=1) X OilEnd X ΔOilEmp			0.195***	0.461***	0.198***
			(0.069)	(0.166)	(0.070)
(CoalEmpDecline=0) X CoalEnd X ΔCoalEmp			0.046	0.351***	-0.169
			(0.130)	(0.085)	(0.125)
(CoalEmpDecline=1) X CoalEnd X ΔCoalEmp			0.129	0.035	0.315***
			(0.099)	(0.096)	(0.095)
(AgEmpDecline=0) X AgEnd X ΔAgEmp			-0.082	0.279	-0.120
			(0.227)	(0.350)	(0.186)
(AgEmpDecline=1) X AgEnd X ΔAgEmp			0.028	0.084	-0.003
			(0.076)	(0.097)	(0.081)
Observations	3,840	3,840	3,840	1,872	1,968
R-squared	0.775	0.914	0.914	0.921	0.756

Notes: This table presents estimates of equation (1) in columns 1 and 2 and equation (2) in columns 3-5. OilEnd, CoalEnd and AgEnd are oil, coal and farm endowments in 1935 constructed as described in the resources section. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. ΔInc PC is difference in log of income per capita. D1 and D5 represent one and five year differences. Decline is a dummy variable indicating a decline in respective sectoral employment. Estimated effects in columns 3-5 are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for census division by year and state fixed effects. Columns 1-4 also include controls for year interacted with natural log of the average income per capita in 1929-1934, column 5 includes controls for year interacted with natural log of the average income per capita in 1969.The effect of oil during the employment decreases is statistically different from the effect during employment increases over the period 1975-2015. The effect of coal during the employment decreases is statistically different from the effect of coal during employment increases across two sub-periods, but not for the whole time period. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table 5 - Effects of Natural Resources on Wages: 1975-2015

VARIABLES	(1) 1975-2015 ΔMinWage D5	(2) 1975-2015 ΔAgWage D5	(3) 1975-2015 ΔMnfctrWage D5
Panel A. Symmetric Effect			
OilEnd X ΔOilEmp	0.311	-0.008	0.058
	(0.206)	(0.106)	(0.044)
CoalEnd X ΔCoalEmp	0.532***	0.046	0.122**
	(0.107)	(0.057)	(0.049)
AgEnd X ΔAgEmp	0.518	0.267	0.098
	(0.564)	(0.206)	(0.093)
Observations	1,928	1,968	1,966
R-squared	0.678	0.617	0.946
Panel B. Boom-Bust			
(OilEmpDecline=0) X OilEnd X ΔOilEmp	0.043	0.006	0.065
	(0.255)	(0.146)	(0.048)
(OilEmpDecline=1) X OilEnd X ΔOilEmp	0.760**	-0.048	0.047
	(0.331)	(0.121)	(0.075)
(CoalEmpDecline=0) X CoalEnd X ΔCoalEmp	-0.289	-0.167	0.137**
	(0.210)	(0.198)	(0.053)
(CoalEmpDecline=1) X CoalEnd X ΔCoalEmp	1.313***	0.249	0.107
	(0.260)	(0.221)	(0.076)
(AgEmpDecline=0) X AgEnd X ΔAgEmp	1.392	0.152	0.205
	(1.319)	(0.632)	(0.139)
(AgEmpDecline=1) X AgEnd X ΔAgEmp	0.227	0.307	0.062
	(0.587)	(0.342)	(0.111)
Observations	1,928	1,968	1,966
R-squared	0.683	0.618	0.946

Notes: This table presents the estimates of equation (1) in Panel A and equation (2) in Panel B. ΔMinWage is the difference in log mining wages, ΔAgWage is the difference in logged wage in agriculture, ΔMnfctWage is the difference in logged manufacturing wages. OilEnd, CoalEnd and AgEnd are oil, coal and farm endowments in 1935 constructed as described in the resources section. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. Estimated effects in Panel B are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for year interacted with the respective dependent variable in 1969, census division by year and state fixed effects. Number of observations is smaller in column 3 because manufacturing wages are not available for Wyoming in 2002. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table 6 - Effects of Natural Resources on Employment Growth: 1975-2015

VARIABLES	(1) 1975-2015 ΔTotal Emp D5	(2) 1975-2015 Δ Retail Emp D5	(3) 1975-2015 Δ Mnfct Emp D5	(4) 1975-2015 Δ Transportation Emp D5	(5) 1975-2015 Δ Construction Emp D5
Panel A. Symmetric Effects					
OilEnd X ΔOilEmp	0.142***	0.112**	0.137	0.287***	0.374***
	(0.048)	(0.045)	(0.093)	(0.052)	(0.124)
CoalEnd X ΔCoalEmp	0.106***	0.109***	0.069*	0.071*	0.371***
	(0.025)	(0.023)	(0.040)	(0.036)	(0.076)
AgEnd X ΔAgEmp	0.064	0.171**	0.161	0.033	-0.022
	(0.080)	(0.070)	(0.103)	(0.083)	(0.198)
Observations	1,968	1,968	1,966	1,960	1,962
R-squared	0.829	0.895	0.851	0.750	0.761
Panel B. Boom-Bust					
(OilEmpDecline=0) X	0.075	0.046	-0.013	0.178***	0.248***
OilEnd X ΔOilEmp	(0.045)	(0.032)	(0.108)	(0.061)	(0.090)
(OilEmpDecline=1) X	0.247***	0.223**	0.411***	0.446***	0.563*
OilEnd X ΔOilEmp	(0.076)	(0.090)	(0.127)	(0.073)	(0.284)
(CoalEmpDecline=0) X	-0.083	0.005	0.126	-0.317***	-0.026
CoalEnd X ΔCoalEmp	(0.088)	(0.061)	(0.149)	(0.098)	(0.282)
(CoalEmpDecline=1) X	0.287***	0.210***	0.018	0.443***	0.755***
CoalEnd X ΔCoalEmp	(0.068)	(0.061)	(0.126)	(0.137)	(0.245)
(AgEmpDecline=0) X	-0.095	-0.086	-0.236	-0.045	-0.645
AgEnd X ΔAgEmp	(0.118)	(0.131)	(0.301)	(0.223)	(0.471)
(AgEmpDecline=1) X	0.122	0.263**	0.302**	0.068	0.196
AgEnd X ΔAgEmp	(0.125)	(0.100)	(0.145)	(0.120)	(0.278)
Observations	1,968	1,968	1,966	1,960	1,962
R-squared	0.832	0.897	0.853	0.759	0.763

Notes: This table presents estimates of equation (1) in Panel A and equation (2) in Panel B. ΔTotal EmplΔMnfct Emp, ΔRetailEmp, ΔMnfctrEmp ΔTransportationEmp and ΔConstructionEmp are differences in logged total employment, employment in retail, manufacturing, transportation and construction sectors respectively. OilEnd, CoalEnd and AgEnd are oil, coal and farm endowments in 1935 constructed as described in the resources section. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. Estimated effects in Panel B are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for year interacted with the respective dependent variable in 1969, census division by year and state fixed effects. Number of observations is smaller in columns 3, 4 and 5 because BEA employment data are not available for all states and all years to avoid disclosure of confidential information. Specifically, manufacturing employment is not available for Wyoming in 2002, transportation employment is not available for Rhode Island and Wyoming in 2001 and 2002, employment in the construction sector is not available for Rhode Island and Wyoming in 2002 and for Delaware in 2005. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

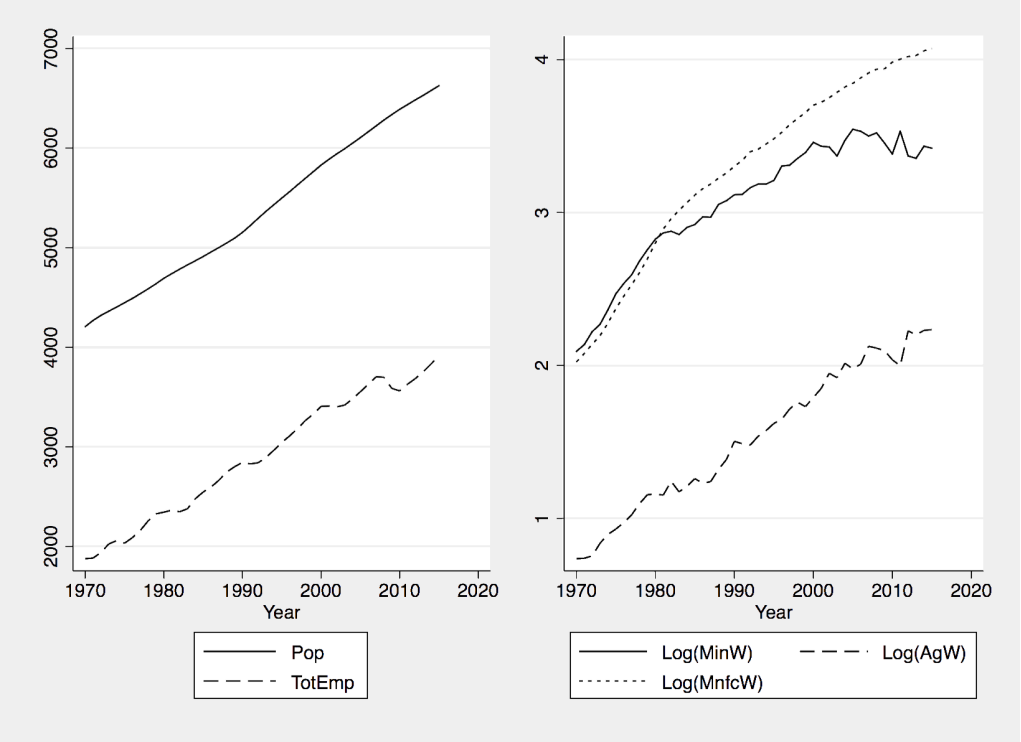
Table 7 - Long Run Effects of Resource Endowments

	(1)	(2)	(3)
VARIABLES	1936-2015	1936-1975	1975-2015
Panel A. Population			
Oil Endowment	-0.001	0.001	-0.006
	(0.005)	(0.006)	(0.005)
Coal Endowment	-0.013***	-0.017***	-0.010**
	(0.004)	(0.005)	(0.004)
Ag Endowment	-0.011**	-0.007	-0.021***
	(0.005)	(0.007)	(0.006)
Observations	48	48	48
R-squared	0.307	0.203	0.379
	(4)	(5)	(6)
VARIABLES	1936-2015	1936-1975	1975-2015
Panel B. Income Per Capita			
Oil Endowment	0.001	0.001	0.001
	(0.001)	(0.002)	(0.001)
Coal Endowment	0.004	0.007	-0.0004
	(0.004)	(0.005)	(0.003)
Ag Endowment	0.003**	0.003	0.004
	(0.002)	(0.002)	(0.003)
Observations	48	48	48
R-squared	0.724	0.816	0.115

Notes: This table presents the estimated long-run effects of resource endowments on population and income per capita growth for the whole time period: 1936-2015 as well as for the two sub-periods: 1936-1975 and 1975-2915. All columns include controls for the initial conditions: average population or income per capita in 1929-1935.

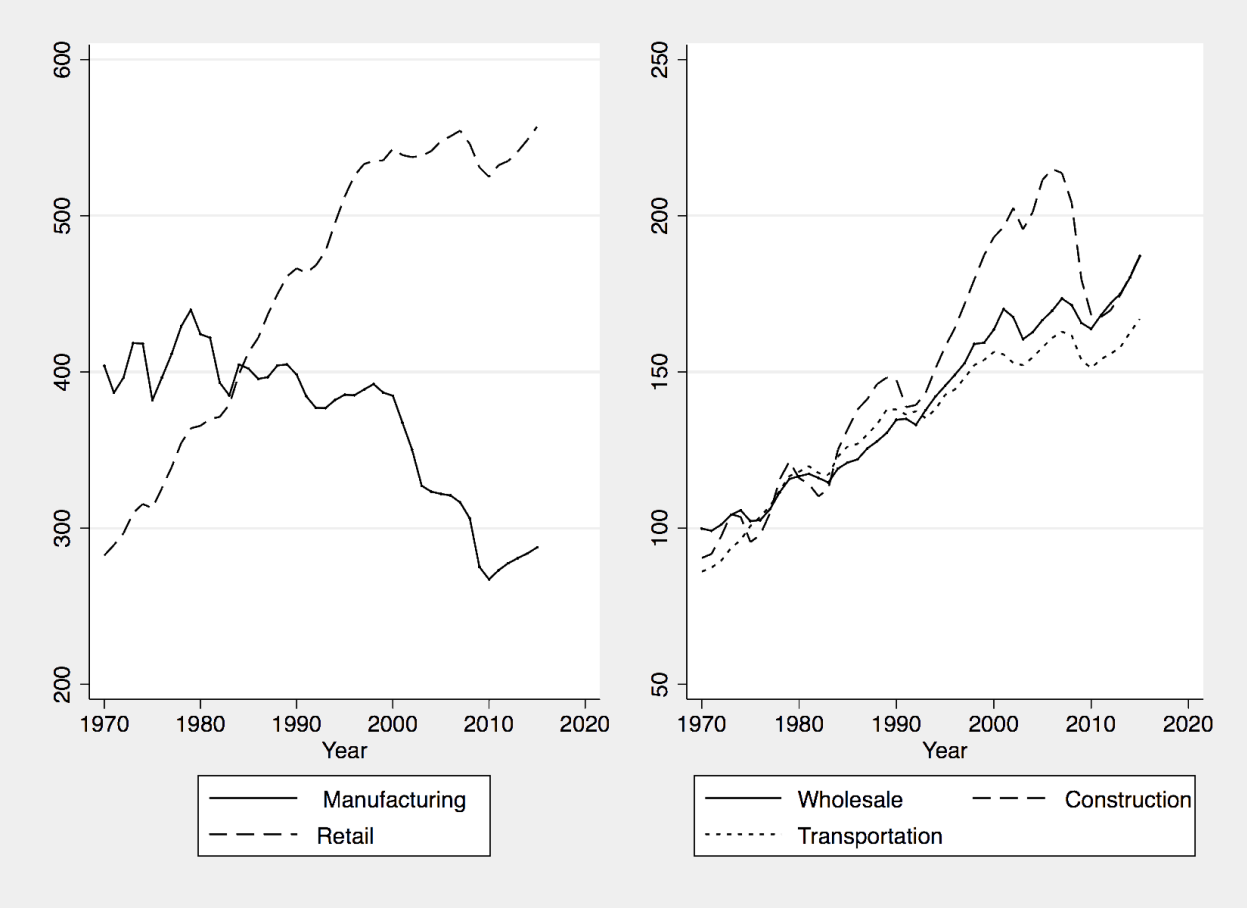
Appendix

Figure A2.1 – Population, Total Employment and Log(Wages)



Notes: Figure shows population and total employment per 1000 and wages in log for mining(MinW), Manufacturing(MnfcW) and agriculture(AgW) sectors over time.

Figure A2.2 – Employment: Non-Resource Sectors



Notes: The average state employment in non resource sectors: manufacturing, construction, transportation, wholesale, and retail over 1970-2015. Employment is based on 1987 Standard Industrial Classification (SIC) for 1970-2001 and is based on North American Industry Classification System (NAICS) for 2002-2015. Data are taken from Bureau of Economic Analysis (BEA).

Table A1 – Summary Statistics

Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A: D1 - One year difference						
	1936-2015		**1936-1969**		**1970-2015**	
ΔOilEmp	0.02	0.089	0.016	0.051	0.023	0.109
ΔCoalEmp	-0.023	0.081	-0.035	0.089	-0.015	0.074
ΔAgEmp	-0.016	0.042	-0.025	0.036	-0.009	0.044
Panel B: D5 - Five years difference						
	1936-2015		**1936-1969**		**1970-2015**	
ΔOilEmp(Decline=1)	-0.028	0.028	-0.015	0.008	-0.04	0.034
ΔOilEmp(Decline=0)	0.057	0.038	0.042	0.029	0.071	0.039
ΔCoalEmp(Decline=1)	-0.053	0.029	-0.055	0.039	-0.052	0.014
ΔCoalEmp(Decline=0)	0.033	0.024	0.026	0.016	0.04	0.028
ΔAgEmp(Decline=1)	-0.026	0.017	-0.027	0.02	-0.024	0.015
ΔAgEmp(Decline=0)	0.01	0.008	0.008	0.008	0.011	0.008
ΔOilInc	0.026	0.072	0.049	0.039	0.007	0.086
ΔCoalInc	-0.31	1.196	0.009	0.055	-0.574	1.569
ΔAgInc	0.011	0.045	0.032	0.048	-0.006	0.033
Obs	3,840		1,632		1,968	

Notes: Summary statistics for the variables used in the analysis for the whole sample 1936-2015 and two subsamples: 1936-1969 and 1970-2015.

Table A2– Effects of Natural Resources on Population Growth

VARIABLES	(1) 1936-1974 End 1935 Knowledge 1935	(2) 1936-1974 End 1935 Knowledge 2015	(3) 1975-2015 End 1935 Knowledge 1935	(4) 1975-2015 End 1935 Knowledge 2015	(5) 1975-2015 End 1969 Knowledge 2015
(OilEmpDecline=0)XOilEndXΔOilEmp	0.070	0.100	0.087***	0.136***	0.136***
	(0.144)	(0.137)	(0.027)	(0.048)	(0.046)
(OilEmpDecline=1)XOilEndXΔOilEmp	0.438*	0.263	0.001	0.024	0.025
	(0.221)	(0.299)	(0.051)	(0.044)	(0.043)
(CoalEmpDecline=0)XCoalEndXΔCoalEmp	0.246**	0.227***	-0.029	0.018	0.018
	(0.112)	(0.082)	(0.034)	(0.031)	(0.034)
(CoalEmpDecline=1)XCoalEndXΔCoalEmp	0.015	0.054	0.151***	0.108**	0.113**
	(0.059)	(0.055)	(0.044)	(0.046)	(0.052)
(AgEmpDecline=0)XAgEndXΔAgEmp	-0.791**	-1.129***	-0.217**	-0.124*	-0.036
	(0.301)	(0.329)	(0.085)	(0.072)	(0.098)
(AgEmpDecline=1)XAgEndXΔAgEmp	-0.244**	-0.280***	0.126*	0.029	-0.002
	(0.098)	(0.076)	(0.069)	(0.062)	(0.082)
Observations	1,872	1,872	1,968	1,968	1,968
R-squared	0.751	0.758	0.852	0.859	0.859

Notes: This table presents estimates of equation (2) using endowment measures based on 1935 and 2015 knowledge. In columns 1 and 3 OilEnd and CoalEnd are oil and coal endowments in 1935 based on 1935 knowledge of reserves, in columns 2 and 4 OilEnd and CoalEnd are oil and coal endowments in 1935 based on 2015 knowledge of reserves, and in column 5 OilEnd and CoalEnd are oil and coal endowments in 1969 based on 2015 knowledge of reserves. AgEnd is the agriculture endowment based on the value of land in 1935 in columns 1 through 4 and based on the value of land in 1969 in column 5. The construction of the variables is described in the resources section. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. ΔPop is difference in log of population. D5 represent one and five year differences. Decline is a dummy variable indicating a decline in respective sectoral employment. Estimated effects in columns 3-5 are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for census division by year and state fixed effects. Columns 1and 2 also include controls for year interacted with natural log of the average population in 1929-1934, columns 3-5 includes controls for year interacted with natural log of the average population in 1969. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table A3 - Effects of Natural Resources on Income PC Growth

VARIABLES	(1) 1936-1974 End 1935 Knowledge 1935	(2) 1936-1974 End 1935 Knowledge 2015	(3) 1975-2015 End 1935 Knowledge 1935	(4) 1975-2015 End 1935 Knowledge 2015	(5) 1975-2015 End 1969 Knowledge 2015
(OilEmpDecline=0)XOilEndXΔOilEmp	-0.027	-0.048	0.107***	0.098***	0.097***
	(0.077)	(0.072)	(0.032)	(0.033)	(0.032)
(OilEmpDecline=1)XOilEndXΔOilEmp	0.461***	0.667***	0.198***	0.346***	0.346***
	(0.166)	(0.237)	(0.070)	(0.104)	(0.102)
(CoalEmpDecline=0)XCoalEndXΔCoalEmp	0.351***	0.299***	-0.169	0.024	0.013
	(0.085)	(0.100)	(0.125)	(0.055)	(0.060)
(CoalEmpDecline=1)XCoalEndXΔCoalEmp	0.035	-0.033	0.315***	0.142	0.156*
	(0.096)	(0.054)	(0.095)	(0.085)	(0.092)
(AgEmpDecline=0)XAgEndXΔAgEmp	0.279	0.270	-0.120	-0.073	0.187
	(0.350)	(0.250)	(0.186)	(0.133)	(0.165)
(AgEmpDecline=1)XAgEndXΔAgEmp	0.084	0.063	-0.003	-0.063	-0.038
	(0.097)	(0.086)	(0.081)	(0.079)	(0.094)
Observations	1,872	1,872	1,968	1,968	1,968
R-squared	0.921	0.921	0.756	0.764	0.765

Notes: This table presents estimates of equation (2) using endowment measures based on 1935 and 2015 knowledge. In columns 1 and 3 OilEnd and CoalEnd are oil and coal endowments in 1935 based on 1935 knowledge of reserves, in columns 2 and 4 OilEnd and CoalEnd are oil and coal endowments in 1935 based on 2015 knowledge of reserves, and in column 5 OilEnd and CoalEnd are oil and coal endowments in 1969 based on 2015 knowledge of reserves. AgEnd is the agriculture endowment based on the value of land in 1935 in columns 1 through 4 and based on the value of land in 1969 in column 5. The construction of the variables is described in the resources section. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. ΔInc PC is difference in log of income per capita. D5 represent one and five year differences. Decline is a dummy variable indicating a decline in respective sectoral employment. Estimated effects in columns 3-5 are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for census division by year and state fixed effects. Columns 1and 2 also include controls for year interacted with natural log of the average income per capita in 1929-1934, columns 3-5 includes controls for year interacted with natural log of the average income per capita in 1969. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table A4.1 - Effects of Natural Resources on Population: Employment vs Income

	(1) 1936-2015	(2) 1936-2015	(3) 1936-1974	(4) 1936-1974	(5) 1975-2015	(6) 1975-2015
	ΔPop	ΔPop	ΔPop	ΔPop	ΔPop	ΔPop
	D5	D5	D5	D5	D5	D5
VARIABLES	Emp	Inc	Emp	Inc	Emp	Inc
Panal A. Population						
(OilEmpDecline=0) X	0.027	0.055	0.070	0.044	0.087***	0.042**
OilEnd X ΔOilX	(0.067)	(0.050)	(0.144)	(0.129)	(0.027)	(0.019)
(OilEmpDecline=1) X	0.112**	0.036*	0.438*	-0.614*	0.001	0.020
OilEnd X ΔOilX	(0.053)	(0.021)	(0.221)	(0.308)	(0.051)	(0.024)
(CoalEmpDecline=0) X	0.103**	0.013	0.246**	-0.031**	-0.029	0.019
CoalEnd X ΔCoalX	(0.043)	(0.015)	(0.112)	(0.013)	(0.034)	(0.017)
(CoalEmpDecline=1) X	0.064	0.012	0.015	0.010	0.151***	0.070***
CoalEnd X ΔCoalX	(0.055)	(0.021)	(0.059)	(0.036)	(0.044)	(0.022)
(AgEmpDecline=0) X	-0.375***	-0.058*	-0.791**	-0.128***	-0.217**	0.030
AgEnd X ΔAgX	(0.111)	(0.029)	(0.301)	(0.047)	(0.085)	(0.032)
(AgEmpDecline=1) X	-0.165**	0.144**	-0.244**	0.083	0.126*	0.131***
AgEnd X ΔAgX	(0.072)	(0.054)	(0.098)	(0.071)	(0.069)	(0.043)
Observations	3,840	3,840	1,872	1,872	1,968	1,968
R-squared	0.741	0.739	0.751	0.747	0.852	0.849

Notes: This table presents estimates of equation (2) using resource endowment interacted with national changes in resource employment in odd columns and using resource endowment interacted with national changes in resource income in even columns. The construction of the variables is described in the resources section. ΔPop is difference in log of income per capita. D5 represent one and five year differences. Decline is a dummy variable indicating a decline in respective sectoral employment. Estimated effects are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for census division by year and state fixed effects. Columns 1and 2 also include controls for year interacted with natural log of the average income per capita in 1929-1934, columns 3-5 includes controls for year interacted with natural log of the average income per capita in 1969. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table A4.2 - Effects of Natural Resources on Per Capita Income Growth: Employment vs Income

	(1) 1936-2015 ΔIncPC D5	(2) 1936-2015 ΔIncPC D5	(3) 1936-1974 ΔIncPC D5	(4) 1936-1974 ΔIncPC D5	(5) 1975-2015 ΔIncPC D5	(6) 1975-2015 ΔIncPC D5
VARIABLES	Emp	Inc	Emp	Inc	Emp	Inc
(OilEmpDecline=0) X	0.101***	0.059**	-0.027	0.065	0.107***	0.048
OilEnd X ΔOilX	(0.027)	(0.025)	(0.077)	(0.071)	(0.032)	(0.030)
(OilEmpDecline=1) X	0.195***	0.077***	0.461***	0.004	0.198***	0.107***
OilEnd X ΔOilX	(0.069)	(0.027)	(0.166)	(0.230)	(0.070)	(0.034)
(CoalEmpDecline=0) X	0.046	0.082**	0.351***	0.107	-0.169	0.074**
CoalEnd X ΔCoalX	(0.130)	(0.034)	(0.085)	(0.098)	(0.125)	(0.028)
(CoalEmpDecline=1) X	0.129	0.138***	0.035	0.237***	0.315***	0.003
CoalEnd X ΔCoalX	(0.099)	(0.043)	(0.096)	(0.067)	(0.095)	(0.032)
(AgEmpDecline=0) X	-0.082	0.016	0.279	0.036	-0.120	0.083
AgEnd X ΔAgX	(0.227)	(0.078)	(0.350)	(0.106)	(0.186)	(0.074)
(AgEmpDecline=1) X	0.028	-0.050	0.084	-0.085	-0.003	0.217**
AgEnd X ΔAgX	(0.076)	(0.102)	(0.097)	(0.128)	(0.081)	(0.086)
Observations	3,840	3,840	1,872	1,872	1,968	1,968
R-squared	0.914	0.914	0.921	0.923	0.756	0.749

Notes: This table presents estimates of equation (2) using resource endowment interacted with national changes in resource employment in odd columns and using resource endowment interacted with national changes in resource income in even columns. The construction of the variables is described in the resources section. ΔIncPC is difference in log of income per capita. D5 represent one and five year differences. Decline is a dummy variable indicating a decline in respective sectoral employment. Estimated effects are relative to zero. Decline = 0 means no decline, Decline=1 means decline in employment between t to t-5. All regressions include controls for census division by year and state fixed effects. Columns 1and 2 also include controls for year interacted with natural log of the average income per capita in 1929-1934, columns 3-5 includes controls for year interacted with natural log of the average income per capita in 1969. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table A5.1 – Effects of Natural Resources: Agricultural Land as Endowment
Effects of Natural Resources on Population Growth:
Land vs Land Value, 1936-2015

VARIABLES	(1) 1936-2015 ΔPop D5	(2) 1936-2015 Δ Pop D5	(3) 1936-2015 Δ Pop D5	(4) 1936-2015 Δ Pop D5
OilEnd X ΔOilEmp	0.053	0.057		
	(0.040)	(0.039)		
CoalEnd X ΔCoalEmp	0.078	0.074		
	(0.049)	(0.047)		
LandValueEnd X ΔAgEmp	-0.203***			
	(0.071)			
LandEnd X ΔAgEmp		0.165		
		(0.101)		
(OilEmpDecline=0) X OilEnd X ΔOilEmp			0.027	0.030
			(0.067)	(0.066)
(OilEmpDecline=1) X OilEnd X ΔOilEmp			0.112**	0.117**
			(0.053)	(0.056)
(CoalEmpDecline=0) X CoalEnd X ΔCoalEmp			0.103**	0.087**
			(0.043)	(0.040)
(CoalEmpDecline=1) X CoalEnd X ΔCoalEmp			0.064	0.067
			(0.055)	(0.056)
(AgEmpDecline=0) X LandValueEnd X ΔAgEmp			-0.375***	
			(0.111)	
(AgEmpDecline=1) X LandValueEnd X ΔAgEmp			-0.165**	
			(0.072)	
(AgEmpDecline=0) X LandEnd X ΔAgEmp				0.162
				(0.162)
(AgEmpDecline=1) X LandEnd X ΔAgEmp				0.164
				(0.102)
Observations	3,840	3,840	3,840	3,840
R-squared	0.740	0.739	0.741	0.739

Notes: Notes: OilEnd, CoalEnd are oil, coal endowments in 1935 constructed as described in the data section. AgEnd is constructed using land area in acres used in agricultural sector per square mile, rather than value of that land. AgEnd is rescaled so AgEnd=1 for the state with the largest land endowment. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. ΔPop is difference in log of population. D5 represents five year differences. All regressions include controls for year interacted with natural log of the average income per capita in 1929-1934, census division by year and state fixed effects. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.

Table A5.2 – Effects of Natural Resources: Agricultural Land as Endowment
Effects of Natural Resources on Per Capita Income Growth:
Land vs Land Value, 1936-2015

VARIABLES	(1) 1936-2015 ΔInc PC D5	(2) 1936-2015 ΔInc PC D5	(3) 1936-2015 ΔInc PC D5	(4) 1936-2015 ΔInc PC D5
OilEnd X ΔOilEmp	0.130***	0.130***		
	(0.035)	(0.030)		
CoalEnd X ΔCoalEmp	0.099***	0.094***		
	(0.027)	(0.028)		
LandValueEnd X ΔAgEmp	0.008			
	(0.075)			
LandEnd X ΔAgEmp		0.176***		
		(0.052)		
(OilEmpDecline=0) X OilEnd X ΔOilEmp			0.101***	0.102***
			(0.027)	(0.024)
(OilEmpDecline=1) X OilEnd X ΔOilEmp			0.195***	0.194***
			(0.069)	(0.062)
(CoalEmpDecline=0) X CoalEnd X ΔCoalEmp			0.046	0.022
			(0.130)	(0.127)
(CoalEmpDecline=1) X CoalEnd X ΔCoalEmp			0.129	0.134
			(0.099)	(0.098)
(AgEmpDecline=0) X LandValueEnd X ΔAgEmp			-0.082	
			(0.227)	
(AgEmpDecline=1) X LandValueEnd X ΔAgEmp			0.028	
			(0.076)	
(AgEmpDecline=0) X LandEnd X ΔAgEmp				0.266
				(0.236)
(AgEmpDecline=1) X LandEnd X ΔAgEmp				0.165***
				(0.058)
Observations	3,840	3,840	3,840	3,840
R-squared	0.914	0.914	0.914	0.914

Notes: Notes: OilEnd, CoalEnd are oil, coal endowments in 1935 constructed as described in the data section. AgEnd is constructed using land area in acres used in agricultural sector per square mile, rather than value of that land. AgEnd is rescaled so AgEnd=1 for the state with the largest land endowment. ΔOilEmp, ΔCoalEmp and ΔAgEmp are changes in the logged national employment in the oil and gas extraction, coal mining and agriculture sectors respectively. ΔInc PC is difference in log of income per capita. D5 represents one and five year differences. All regressions include controls for year interacted with natural log of the average income per capita in 1929-1934, census division by year and state fixed effects. Standard errors are clustered at the state level and are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels.