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Is There a Resource Curse in the US and Canada? Evidence from the Shale Revolution

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Abstract

This paper uses the shale revolution as a natural experiment to test the resource curse in American states and Canadian provinces. We use a comprehensive set of unproved reserves of unconventional gas and oil plays for North America in 2010 to identify the impact of resource dependence on state-level economic growth. We estimate a growth regression with mining production (resource dependence), corruption and other long-run determinants. Using least squares, we find no significant link between resource dependence and state-level economic growth. However, by instrumenting resource dependence, we find evidence of a resource curse in that greater mining production (and employment) leads to lower state-level growth. Our resource curse finding is robust to fracking bans and moratoriums, alternative GDP measures and resource abundance (proved reserves). In tests for indirect transmission mechanisms, we find that greater mining activity reduces educational attainment, non-resource tax revenue, and trade openness in North America and increases the price of nontradeables relative to tradeables in the US.

JEL Classification: C21, O13, O51, Q33, R11

Keywords: natural resource curse, shale revolution, economic growth, US states, Canada

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1 Introduction

What role do natural resources play in economic growth? Classical economists such as Adam Smith, John Stuart Mills and David Ricardo viewed land as a factor of production distinct from capital and labor. By being fixed and scarce, natural resources were seen as a primary source of national wealth. During the so-called first golden age of economic growth from 1870 to 1913, resource abundant countries like the US experienced more rapid growth than resource poor (Lewis, 1978; Maddison, 1995). This resource blessing hypothesis played a prominent role in the "take-off" development theory of Rostow (1960) which held sway into the 1970s.

An alternative "resource curse" hypothesis began to emerge in the 1990s. Coined by Auty (1993), the resource curse predicts that natural resource wealth can impede growth by a host of channels - the Dutch disease, macroeconomic volatility, rent seeking, corruption, lower rule of law, and reduced educational attainment (Van der Ploeg, 2011). Early empirical work estimated a negative relationship between resource dependence (mining exports) and long-run economic growth across a broad sample of countries (Sachs and Warner, 1995, 2001). Subsequent analysis found that the resource curse operates through lower educational attainment (Gylfason, 2001), reduced capital investment (Gylfason and Zoega, 2006), increased corruption (Mehlum et al., 2006), and an appreciation of the real exchange rate (Corden and Neary, 1982; Egert, 2012). However, other authors find no evidence of a resource curse (Brunnschweiler and Bulte, 2008; Brunnschweiler, 2008) and even a growth-enhancing "resource boom" (Alexeev and Conrad, 2009). Sometimes observed effects are only restricted to developing countries, while no impact for developed countries is observed (Smith, 2015). Likewise, US state-level analysis finds evidence for (Papyrakis and Gerlagh, 2007; Goldberg et al., 2008) and against (Mitchener and McLean, 2003; James and James, 2011) the resource curse.

One methodological issue behind these conflicting results is the identification of the resource variable. Early studies of Sachs and Warner (1995, 2001) and Papyrakis and Gerlagh (2007) regress economic growth on the share of mining in exports and GDP. However, these resource dependence measures are likely endogenous due to the direct impact of growth on the denominator and indirect effects on the numerator. Later papers by Brunnschweiler and Bulte (2008) and Norman (2009) use natural wealth and subsoil assets to instrument for resource dependence. However, with resource rents and thus subsoil wealth depending upon growth, these resource dependence measures are also likely endogenous

(Van der Ploeg and Poelhekke, 2010).

This paper uses the shale revolution as a natural experiment to test the resource curse in North America. Technological innovations in horizontal drilling and hydraulic fracturing or "fracking" allowed access heretofore commercially unavailable oil and natural gas deposits trapped in shale and tight rock formations. Using a comprehensive set of unproved technically recoverable resources by play, we create state-level instruments of unconventional tight oil, shale gas, tight gas, and coalbed methane.[1] These instruments are strongly correlated with resource dependence and likely independent of growth outcomes due to their limited *current* economic viability.

Our paper contributes to two strands of the US resource curse literature reviewed in Table 1. The first strand estimates the impact of natural resources directly on long-run state-level growth. These authors use cross-sectional least squares or panel fixed effects and find mixed results for the resource curse. In a critical review, Van der Ploeg and Poelhekke (2017) attribute confounding factors and the endogeneity of the resource variable as the sources of these conflicting results. In this paper, we use largely-exogenous unproved reserves of unconventional oil and gas to identify the causal impact of resource dependence on growth. We further extend the initial U.S. state level analysis to Canadian provinces to test whether the U.S. evidence generalizes to a institutionally-similar North American setting.

The second strand estimates the effects of resource booms and fracking on short-run local economic outcomes. These authors mostly use a difference-in-difference approach to estimate the impact of shale oil and gas endowments on county income and earnings. Fetzer (2014) and Feyrer et al. (2017) use the presence and percent of land covered by unconventional shale to instrument for the revenue from oil and gas wells. Alternatively, Allcott and Keniston (2018) and Bartik et al. (2019) use undiscovered oil and gas reserves post-2011 and high fracking exposure as their treatment. Our state-level identification extends this previous work by using both the presence and magnitude of unconventional resources to identify resource dependence.

The identification scheme closest to ours is that of James (2015). He uses undiscovered, technically recoverable stocks of oil and natural gas multiplied by energy prices to identify the effects of resource

[1]Figure 3 shows technically recoverable resources in the context of resource classifications. Using the EIA definitions, *tight oil* is light crude oil found in impermeable rock (tight sand, limestone or shale). *Shale oil* is a subset of tight oil found exclusively in shale formations. *Tight gas* is natural gas located in low-permeability sandstone and carbonate rock, while *shale gas* is natural gas trapped and sourced from even lower-permeability shale. *Coalbed methane* is methane gas trapped in coal seams, produced during the coalification process.

revenue on state fiscal policy. In particular, James (2015) apportions energy resources by geological "province" to the states using ARCGIS. Our identification has several advantages. First, we use unconventional oil and gas resources rather than total undiscovered resources. Our unconventional resources are a direct consequence of the shale revolution and thus more likely to be exogenous than conventional resources. Second, most of the USGS geological provinces encompass multiple states, while the majority of our plays already fall in a single state or are disaggregated by state (Yamarik, 2026). Third, our empirical variation relies on cross-state differences in unconventional resource potential rather than limited within-state information from reserve updates. The one drawback of our identification strategy is that the shale revolution occurs essentially once and thus provides only a single cross-section of instruments.

We test the resource curse across US states and Canadian provinces for 2010-2019. We posit a growth regression with resource dependence (mining production or employment), corruption and other growth determinants. Using least squares, we estimate no significant effect of resource dependence on economic growth. We next instrument resource dependence with unconventional resources. Using LIML, we find evidence of a resource curse in that a 1% increase in mining activity leads to about 0.05%-0.15% decrease in average annual state-level growth in the US and North America. Further analysis finds that the resource curse occurs across different measures of GDP and the use of resource abundance (proved reserves).

We also test for indirect transmission mechanisms behind the resource curse. We find that greater resource activity reduces educational attainment, non-resource tax revenue, and trade openness in the US and in North America. In contrast, we find no significant effect on capital investment and crime rates. For the US, we find support for the Dutch disease (Corden and Neary, 1982) in that greater resource dependence increases the prices of non-tradeables relative to tradeables. Taken together, our results show that resource dependence can negatively impact regional growth even in advanced economies of North America.

The rest of the paper proceeds as follows. Section 2 provides a background of the shale revolution and a literature review of the resource curse. Section 3 lays out the identification strategy and a description of the data. Section 4 presents the econometric results, while section 5 concludes with policy implications.

2 Background

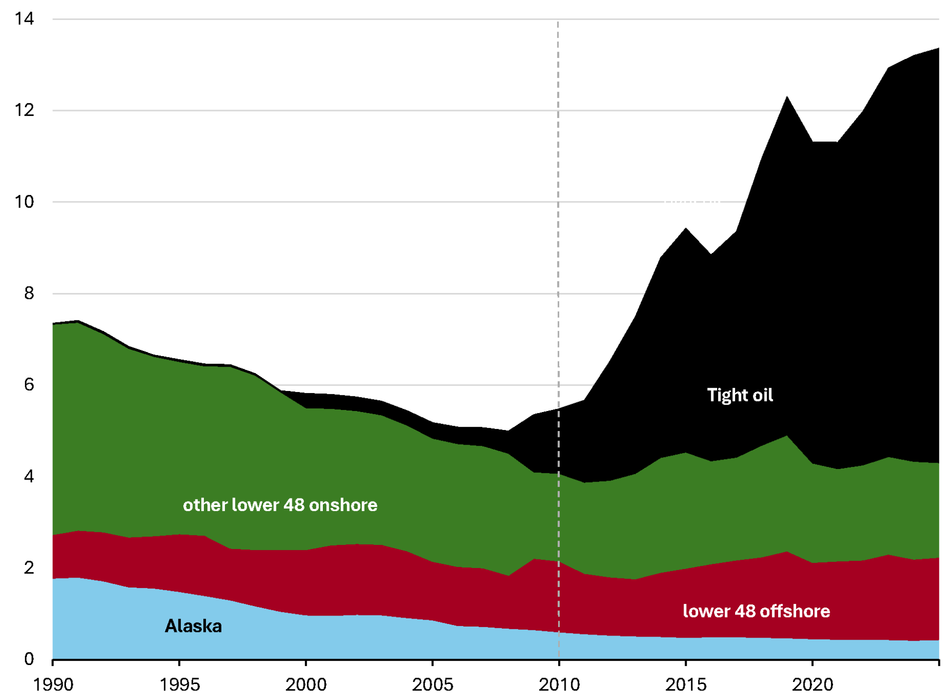
2.1 The shale revolution in North America

The shale revolution transformed oil and gas extraction by making hydrocarbons in low-permeability formations commercially viable. Conventional oil and gas resources are deposits that accumulate in discrete pools or reservoirs and thus are relatively easy to extract with standard vertical drilling. By contrast, unconventional resources are trapped in rock with very low permeability. As a result, it is extremely difficult for oil or natural gas to flow through the pores. Thus, extraction requires the use of hydraulic fracturing to create cracks for the oil or gas to flow and possibly horizontal drilling to access the resources.

Figures 1 and 2 show the evolution of US oil and natural gas production by source from 1990 to the present. For both energy types, conventional sources dominated until the mid-2000s. Rapid development and diffusion of new drilling technologies led to large, regionally concentrated production increases. US tight oil and shale gas expanded from marginal contributors in 2005 to dominant players within a decade. By 2022, unconventional resources represents 67% of oil and 87% of natural gas production. Appendix A shows that Canada experienced the same trends in unconventional oil and gas production. In terms of the macroeconomy, the shale revolution switched the US from a net importer to a net exporter of energy in 2019 (EIA, 2020) and created around three-quarters of a million jobs during the Great Recession (Feyrer et al., 2017).

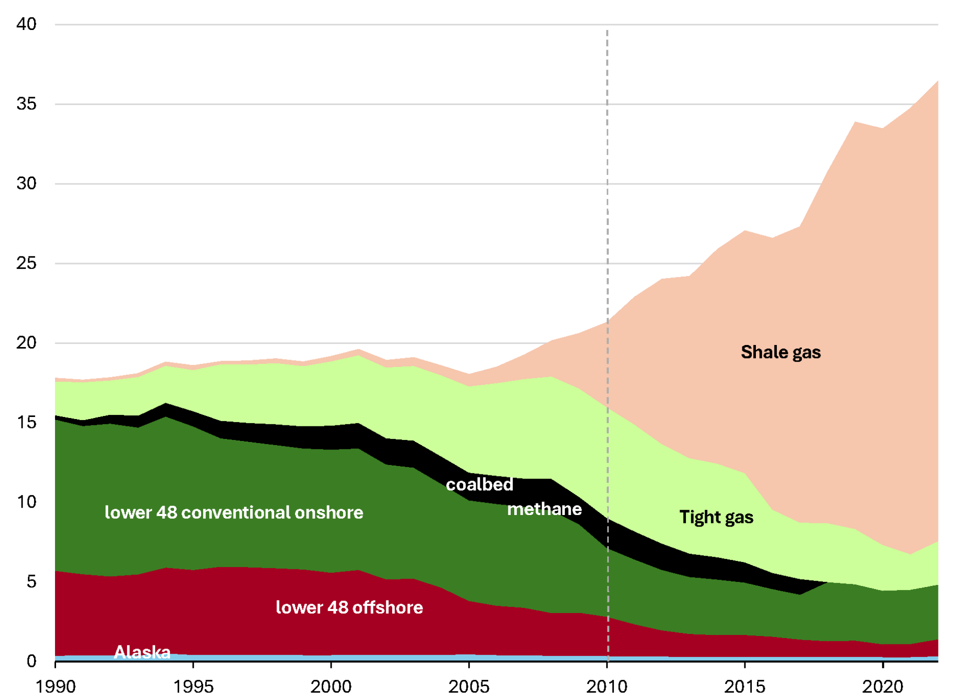
Figure 3 illustrates the hierarchical classifications of energy resources as defined by the US Energy Information Administration (EIA). The dotted line surrounding the whole oval is the original resource in-place. If one removes the cumulative production to date (red), then we are left with the remaining resource in-place (blue) running from less certain on left to more certain on right. The technically recoverable resources or TRR we use is the share that can be recovered using current technology and geological knowledge, while the remainder is non-recoverable. Within TRR, the economically recoverable resources is the fraction that is profitable under prevailing market conditions and current costs with exploratory proved reserves being the most certain. While economically recoverable and proved reserves are inherently endogenous to economic conditions and policy, TRR estimates can in principle be considered exogenous given their lack of economic viability.

Figure 1: US oil production by source (million barrels per day)



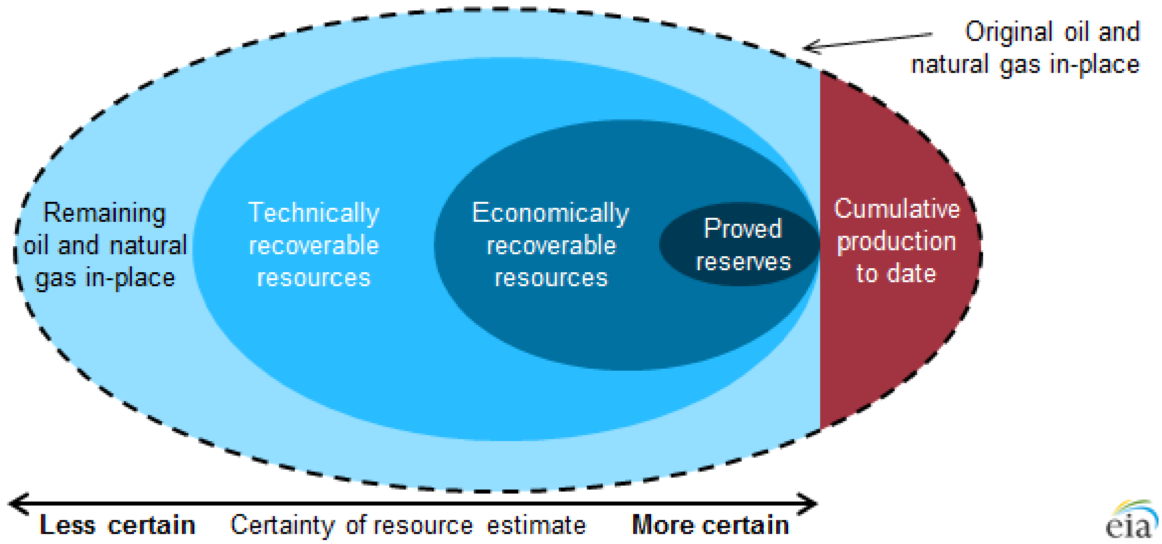
Sources: EIA (2012b) for 1990-2010 and EIA (2025) for 2010-2024.

Figure 2: US natural gas production by source (trillion cubic feet)



Sources: EIA (2012a) for 1990-2010 and EIA (2023) for 2010-2022.

Figure 3: Stylized representation of oil and natural gas resource categorizations



Notes: The figure shows the resource classification hierarchy from original oil and gas in place to technically and economically recoverable resources and proved reserves. Certainty increases from left to right. Source: EIA (2024).

2.2 Literature review of the resource curse

Several studies have surveyed and assessed the cross-country resource curse literature (Van der Ploeg, 2011; Havranek et al., 2016; Dauvin and Guerreiro, 2017; Van der Ploeg and Poelhekke, 2017; Alssadek and Benhin, 2023). Most empirical studies estimate the direct impact of natural resource dependence and abundance on growth (Alssadek and Benhin, 2023). These studies use different samples, time periods, natural resource measures, and empirical methods; and find different answers to this question.[2] Two questions frame this literature. First, what are the impacts of natural resources on economic growth? Second, what are the indirect transmission mechanisms or explanations behind the curse?

Table 1 provides a summary of the empirical tests of the resource curse in the US. The literature can be broadly divided into three groups – cross-sectional state growth, panel state growth and county-level treatment effects. Early analyses by Papyrakis and Gerlagh (2007) and Boyce and Emery (2011) use least squares to test the impact of mining activity on GDP per capita growth. Both studies find that resource-dependent states grow more slowly even after accounting for initial GDP and other

[2]In their meta-analyses, Havranek et al. (2016) and Dauvin and Guerreiro (2017) document that 40% estimate a negative effect, 40% find no effect and 20% estimate a positive effect. They find that the different results are a consequence of control of institutional quality and investment, natural resources types, use of resource dependence vs abundance, development levels, and time period. Our estimation strategy and data presented later addresses each of these sources.

determinants. In contrast, James and James (2011) and Jaimes and Gerlagh (2020) estimate a positive effect of resource dependence when using non-mining income and including mining and agricultural production separately.

For panel regressions, Mitchener and McLean (2003) use decade-level data and find that natural resource activity is associated with higher labor productivity levels conditioned on historical and geographic factors. However, Freeman (2009) and Goldberg et al. (2008) estimate a negative impact for resource dependence when using fixed effects (FE). In contrast, Clay and Portnykh (2018) and Jaimes and Gerlagh (2020) use *shift-share* analysis where the state-level industry shares are interacted with their respective national industry-level growth rates (shift). They find that mining has a positive short-run (annual) and medium-run (5-year) effect on economic growth.

The third strand examines the local economic effects of resource booms and hydraulic fracking. This strand uses a variety of identification strategies. James and Aadland (2011) regress broad resource dependence on 15-year per capita income growth and find a negative relationship. A second set of papers construct instruments to identify resource dependence and fracking exposure. Fetzer (2014) uses the presence of shale and the percent of land area with shale to instrument for shale wells and resource dependence. Feyrer et al. (2017) use the presence of an unconventional play by year to instrument for oil and gas revenue from new wells. The last set of papers uses a difference-in-difference design to estimate the local effects of fracking. Allcott and Keniston (2018) uses a *shift-share* to measure the impact of fracking. In contrast, Weber (2012) and Bartik et al. (2019) use ex-post cut-offs in natural gas production and fracking exposure to determine treatment. Likewise, Marchand (2012) and James and Smith (2017) classify treated Canadian and US regions as those with high fracking earnings and exposure. Regardless of the identification, this strand of literature consistently finds that resource booms and fracking is associated with higher local income and earnings, but higher crime and lower non-resource tax collection. Recent studies focusing explicitly on shale gas development reach similar conclusions. Mei et al. (2022) use a synthetic control design for Fuling, China, and find that shale gas development increased regional GDP and employment, Similarly, Bilgili et al. (2016) show, using U.S. monthly time-series evidence, that shale gas production is positively related to industrial production. These findings are consistent with the local-boom literature showing that realized shale extraction can stimulate short-run demand. Our analysis asks a different question, testing whether general resource dependence weakens longer-run regional growth.

Table 1: Summary of empirical tests of the resource curse in the US

Paper	Dependent variable	Obs unit	Time	Method	Resource measure	Covariates	Estimate(%)
Papyrakis and Gerlagh (2007)	GDP per capita	49 states	1986-2000	OLS	ag+mining prod	investment, education, openness, R&D, corruption	-0.14
Boyce and Emery (2011)	GDP per capita	50 states	1970-2001	OLS	mining emp	initial GDP per capita only	-0.11***
James and James (2011)	non-mining income per capita	49 states	1980-2000	OLS	mining prod	education, poverty, pop density, demographics	+0.28**
Jaimes and Gerlagh (2020)	GDP per capita	50 states	1997-2014	OLS	mine, ag prod	investment, ed spend, openness, R&D, corruption, taxation	+0.13** +0.25***
Mitchener and McLean (2003)	labor productivity	47 states	1880-1980	P-OLS	mining emp	slave pop, geography	+0.1-1.1
Freeman (2009)	5-year GDP per capita	50 states	1977-2002	FE	ag+mining emp	investment, education, labor force, taxation	-0.46***
Goldberg et al. (2008)	annual income per capita	50 states	1950-2000	FE	oil+coal prod	capital stock, education, gov spend	-0.14***
Clay and Portnykh (2018)	5-year income per capita	48 states	1936-2015	FE	oil×Δnat emp coal×Δnat emp ag×Δnat emp	–	+0.13*** +0.10*** +0.01
Jaimes and Gerlagh (2020)	annual GDP per capita	50 states	1997-2014	DiD	mine×Δ nat GDP ag×Δnat GDP	state FE	+1.38*** +0.13
James and Aadland (2011)	income per capita	3,092 counties	1980-1995	FE	ag+mining earnings	education, demographics, poverty	-0.12***
Fetzer (2014)	income per capita	counties	1999-2012	P-IV	shale well	county, state-time FE	+8.0**
Feyrer et al. (2017)	wages per capita	3,079 counties	2005-2012	P-IV	oil+gas revenue from new wells	geography	+80,000***
Black et al. (2005)	earnings per capita	3,420 counties	1970-1989	DiD	coal county	state FE	+3.0***
Weber (2012)	earnings per capita	counties	2000-2010	DiD	boom county	state FE, initial earning	+2.6**
Allcott and Keniston (2018)	earnings per capita	3,075 counties	1969-2014	DiD	oil×Δnat emp gas×Δnat emp	region FE	+1.8***
Bartik et al. (2019)	income per capita	405 counties	2000-2010	DiD	top-quartile	county, play FE	+4-7***

Notes: The dependent variable is an annual growth rate unless otherwise states. The statistical methods are cross-section ordinary least squares (OLS), pooled OLS (P-OLS), fixed effects (FE), instrumental variables (IV), pooled instrumental variables (P-IV), and difference-in-difference (DiD).

The resource curse literature has attempted to identify the potential channels of transmission from resource dependence to growth. First, natural resources makes a country more susceptible to "Dutch Disease" or de-industrialization. In their seminal paper, Corden and Neary (1982) show that a resource boom can inadvertently harm tradable sectors like agriculture and manufacturing. In particular, the booming resource sector increases demand for all goods and thus raises the price of nontradable goods and services. This leads to a real exchange rate appreciation which increases the costs for the tradable sector. In addition, the booming resource sector can "bid away" labor and capital and thus drive up factor prices for the tradable sector. Second, large natural resource rents create opportunities for harmful rent-seeking and corruption (Mehlum et al., 2006). Third, resource dependence can decrease the accumulation of human and physical capital. Higher wages in the resource sector and lower perceived returns to education can weaken incentives for skill acquisition and educational attainment (Gylfason, 2001; James, 2017). Likewise, greater resource abundance can decrease the incentive to save and invest in physical capital (Gylfason and Zoega, 2006). Fourth, the surge in resource revenue can create a "rentier state" which decreases the government's reliance on traditional taxation and thus thwart economic development (Mahdavy, 1970). For US states, an increase in resource revenue is associated with a decrease in non-resource tax income (James, 2015). Fifth, recent research highlights the link between resource booms and crime. A booming resource sector attracts migrants especially lower-attached, young men and reduces the social cohesion of the community.(James and Smith, 2017) In the US, historical analysis links mining activity to greater interpersonal violence (Couttenier et al., 2017), while recent evidence finds that shale booms are associated with increases in various property and violent crime (James and Smith, 2017).

Our analysis builds directly upon the US resource curse literature. First, we use a cross-section of 50 states augmented with the 10 Canadian provinces to maximize our sample. Second, we use growth in GDP per capita as our dependent variable although we do test the robustness to private and non-mining GDP (James and James, 2011). Third, as with Fetzer (2014) and Feyrer et al. (2017), we use the presence of unconventional resources to instrument for resource dependence. Finally, we test an extensive set of indirect mechanisms through which the resource curse might affect the economy.

Our analysis however extends the past literature in two important ways. First, our state-level identification uses the presence and magnitude of unconventional TRR for identification. Although close to that of James (2015), our identification scheme benefits from endowments by play, no relationship to national energy prices, and a reliance on cross-sectional information. Second, we expand our geographic scope to include Canada. This expansion increases our sample size and allows for a comparative assessment of the shale revolution within two advanced, institutionally-similar economies.

3 Identification Strategy and Data

We estimate the following growth model:

$$growth_i = \beta_0 + \beta_1 \ln(y_i) + \beta_2 RD_i + \beta_3 corruption_i + \boldsymbol{X_i'\beta_X} + \epsilon_i \tag{1}$$

where i indexes the state or province. The dependent variable *growth* is the average annual growth rate of real GDP per capita for 2010 to 2019. The independent variable y is the initial level of real GDP per capita, RD is resource dependence, *corruption* is corruption convictions per capita, $\boldsymbol{X}$ is a vector of control variables, and ϵ is an i.i.d. error term. The predictions are that $\beta_1 < 0$ (conditional convergence), $\beta_2 < 0$ (resource curse), and $\beta_3 < 0$ (corruption is bad for growth).

The two endogenous variables RD and *corruption* are determined by two reduced-form equations:

$$RD_i = \pi_0 + \pi_1 \ln(y_i) + \boldsymbol{TRR_i'\pi_T} + \boldsymbol{INST_i'\pi_I} + \boldsymbol{X_i'\pi_X} + v_i \tag{2}$$

$$corruption_i = \gamma_0 + \gamma_1 \ln(y_i) + \boldsymbol{TRR_i'\gamma_T} + \boldsymbol{INST_i'\gamma_I} + \boldsymbol{X_i'\gamma_X} + \eta_i \tag{3}$$

where $\boldsymbol{TRR_i}$ is our set of unconventional technically recoverable reserves per capita, and $\boldsymbol{INST_i}$ are institutional determinants of corruption.

Our identification strategy is to use $\boldsymbol{TRR_i}$ and $\boldsymbol{INST_i}$ to identify RD and *corruption.* Estimates of TRR reflect geological and technological potential rather than contemporaneous economic activity – making them a strong and plausibly exogenous predictor of future extraction. They are notoriously uncertain, particularly in basins with limited drilling history. To avoid this problem, we use a comprehensive set of TTR estimates of unconventional tight oil, shale gas, tight gas and coalbed methane in 2010 (EIA, 2012c). These estimates represent a major revision in geological assessments following technological breakthroughs in fracking during the shale revolution of 2005-2010. We create state-level unconventional TTR instruments to identify resource dependence.[3] Due to their similar

[3] See Yamarik (2026) for details.

geological origin, conventional and unconventional resources generally occur in the same basins. As a result, resource dependence resulting from conventional resource extraction is likely to be correlated with unconventional resources.

Corruption may also be endogenous to economic performance as weaker growth can itself foster rent-seeking or increase incentives for misappropriation. To address this potential reverse causality, we instrument corruption using state institutional characteristics that shape long-run variation in political accountability but are plausibly exogenous to contemporary economic outcomes. Following Johnson et al. (2011), we use two state-level institutional instruments. The first is the number of days an individual had to be in residence in a state to be eligible to vote in 1964. Longer waiting periods indicate a historical tendency toward disenfranchisement and lower political participation. The second instrument is the age of the current state constitution as of 1970. States can modify political rules by amending the constitution (typically via the legislature) or by adopting an entirely new constitution. The latter is a more sweeping reform, often associated with institutional upheaval and potentially greater scope for rent extraction.

We use cross-sectional data for the 50 US states and 10 Canadian provinces for 2010 to 2019. Table 2 presents the descriptive statistics.[4] The dependent variable is the annual growth rate of real GDP per capita. We measure *RD* as the percent of mining (NAICS 21) in production and in employment.[5] [6] We include the unconventional resources individually with each measured in *common* one million Btu per 1,000 persons units. Corruption is the number of corruption convictions per 100,000 persons. We include a parsimonious set of control variables – initial real GDP per capita, capital investment, college share of labor force, population density and tax share. This parsimonious specification follows standard empirical-growth models applied in the resource curse literature, in which initial income, investment and education account for conditional convergence, physical-capital accumulation and human capital (Barro, 1991; Mankiw et al., 1992; Sachs and Warner, 1995, 2001; Papyrakis and Gerlagh, 2007). Since our analysis is conducted at the state/province level, we additionally control for population density

[4]The data sources can be found in Yamarik (2026).

[5]The NAICS sector 21 is comprised of subsectors Oil and Gas Extraction (NAICS 211), Mining (except Oil and Gas) (NAICS 212) and Support Activities for Mining and Oil/Gas (NAICS). The lack of US state-level employment data prevent us from using NAICS subsector measures.

[6]Prominent cross-country studies such as Sachs and Warner (1995, 2001) use the percent of natural resource exports to measure resource dependence. US and Canadian state-level data report international exports by industry, but do not report intra-state exports. Given these significant omissions, we do not use natural resource exports in our state-level analysis.

and tax share to absorb differences in settlement structure and fiscal-policy environments (for example: Reed (2009)). To ensure exogeneity, each explanatory variable is measured in 2010 except taxes in 2008 and corruption for 2010-2019. Lastly, the transmission mechanisms at the bottom are averaged from 2010 to 2019 to capture the growth process.

Table 2: Descriptive Statistics

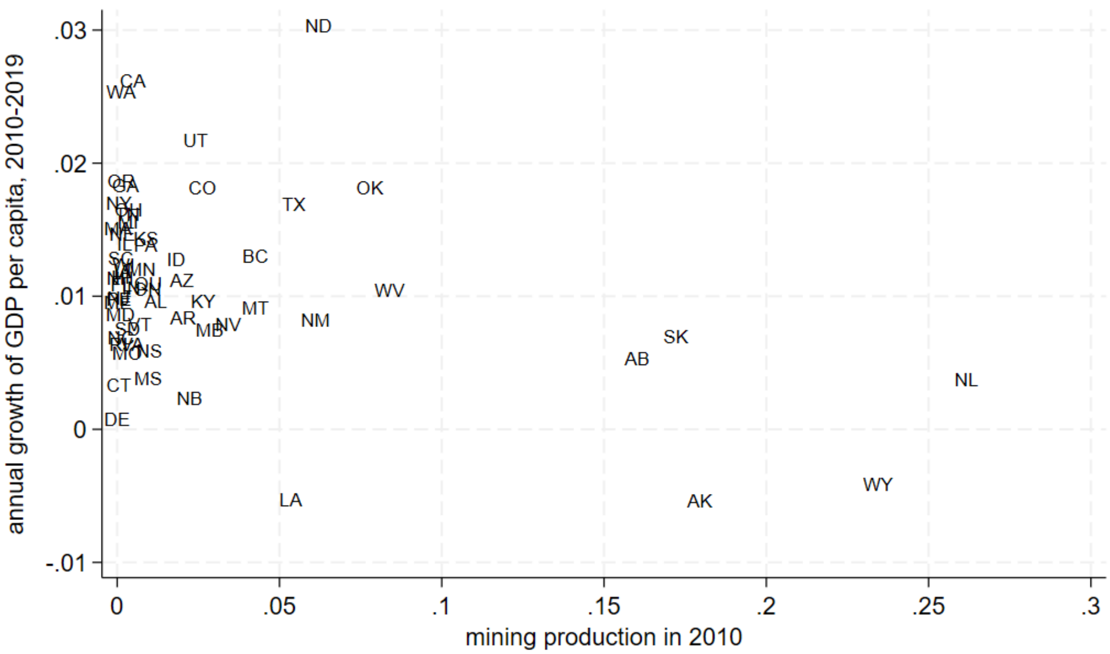
Variable	Obs	Mean	Std. Dev.	Min	Max
dependent variable					
annual growth rate	60	0.0109	0.0068	-0.0054	0.0304
resource dependence and unconventional resources					
mining production	60	0.0307	0.0569	0.0000	0.2617
mining employment	60	0.0103	0.0163	0	0.0886
tight oil	60	0.0017	0.0051	0	0.0333
tight gas	50	0.0058	0.0290	0	0.2039
shale gas	50	0.0029	0.0090	0	0.0605
shale+tight gas	60	0.0096	0.0315	0	0.2212
coalbed methane	60	0.0038	0.0090	0	0.0605
unproved coal	60	0.0468	0.1558	0	0.8883
corruption and institutional determinants					
corruption	50	0.2968	0.2126	0.0299	1.2356
voter residency (days)	50	110	86.98	0	365
age of constitution (years)	50	119	0.2126	32	239
control variables					
GDP per capita	60	52,293	10,087	35,963	76,054
investment	60	0.1395	0.0681	0.0385	0.4437
college	60	0.2741	0.0558	0.1500	0.4240
pop density	60	165.3	244.9	1.25	1185.1
tax share	60	0.1005	0.0303	0.0672	0.2073
transmission mechanisms					
investment	60	0.1430	0.0538	0.0927	0.3615
college	60	0.2956	0.0563	0.1830	0.4475
total tax	60	0.0992	0.0330	0.0670	0.2231
non-resource tax	60	0.0928	0.0359	-0.0093	0.2198
openness	60	0.2122	0.1403	0.0504	0.7982
crime rate	60	0.5860	0.1492	0.3896	1.1648
nontradable inflation	33	0.0190	0.0159	-0.0067	0.0612

Notes: There are 60 potential observations – 50 US states and 10 Canadian provinces. The annual growth rate is the average growth rate of real GDP per capita from 2010 to 2019. The units are one million BTU per 1,000 persons for **unconventional resources** and corruption convictions per 100,000 persons for *corruption*. The voter residency requirement in days is recorded in 1964, while the age of constitution in years is measured in 1970. The **control variables** are recorded in 2010 to ensure exogeneity, while the **transmission mechanisms** are averaged from 2010 to 2019 to capture the growth process.

Figure 4 plots mining production against the annual growth rate of real GDP per capita. The top-10 states ordered by mining production are Newfoundland and Labrador (NL), Wyoming (WY), Alaska

(AK), Saskatchewan (SK), Alberta (AB), West Virginia (WV), Oklahoma (OK), North Dakota (ND), New Mexico (NM) and Texas (TX). On the other end, there are 28 states with mining production below 0.5%. The line of best fit indicates a weak negative correlation (β=-0.045) between resource dependence and growth. Our North American evidence mirrors the classic resource curse findings of Sachs and Warner (2001). While this negative relationship is purely descriptive, it provides suggestive evidence that extractive activities may have coincided with slower overall economic growth.

Figure 4: mining production and growth



Source: Constructed.

4 Empirical Results

4.1 First-stage estimates

Table 3 presents the reduced-form estimates for resource dependence. Mining production is shown on the left and mining employment on the right. We include the unconventional TRR instruments in columns (1) and (4); add the control variables in (2) and (5); and then the full first-stage regression in (3) and (6). The F-statistic at the bottom is a test of the joint significance of all instruments including the institutional determinants.

Table 3: Resource determinants for the US

	mining production			mining employment		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
tight oil	0.9690***	1.3262**	1.5441***	0.4149***	0.5094**	0.5997**
	(0.2323)	(0.4952)	(0.5563)	(0.1275)	(0.1967)	(0.2313)
tight gas	1.5413***	1.4314***	1.4612***	0.8278***	0.7262***	0.7392***
	(0.3538)	(0.2771)	(0.2603)	(0.1873)	(0.1719)	(0.1708)
shale gas	3.9857***	3.9232***	4.1748***	1.5101***	1.4268***	1.5361***
	(0.6745)	(0.7332)	(0.7594)	(0.3497)	(0.3195)	(0.3473)
coalbed methane	-2.8668**	-2.3756**	-2.5502**	-1.8974**	-1.5121**	-1.5929**
	(1.3278)	(1.0283)	(0.9605)	(0.7076)	(0.6065)	(0.6085)
unproved coal	0.0316***	0.0192**	0.0262**	0.0135**	0.0094*	0.0127**
	(0.0077)	(0.0083)	(0.0089)	(0.0052)	(0.0049)	(0.0056)
ln(GDP/POP)		-0.0174	-0.0198		-0.0087	-0.0095
		(0.0195)	(0.0205)		(0.0063)	(0.0068)
investment		-0.0322	-0.0451		-0.0019	-0.0078
		(0.0322)	(0.0380)		(0.0161)	(0.0192)
college		-0.0200	-0.0203		-0.0165	-0.0162
		(0.0520)	(0.0525)		(0.0218)	(0.0217)
ln(pop density)		-0.0017	-0.0002		-0.0003	0.0003
		(0.0024)	(0.0029)		(0.0009)	(0.0012)
tax share		-0.1603	-0.1864		-0.0570	-0.0668
		(0.1846)	(0.1837)		(0.0672)	(0.0621)
ln(voter residency)			-0.0002			0.0000
			(0.0005)			(0.0002)
ln(age of constitution)			0.0056			0.0026
			(0.0036)			(0.0017)
Observations	50	50	50	50	50	50
R-squared	0.9213	0.9385	0.9420	0.8904	0.9160	0.9217
F-statistic	2591	138.9	98.92	1962	152.8	109.50

Notes: Each column presents the results of the reduced-form equation (2). The estimates in columns (3) and (6) are the first-stage results for columns (3) and (4) of Table 5. The robust standard errors are in parentheses where ***p<0.01, **p<0.05, *p<0.10.

Our unconventional resource reserves are strong and robust predictors of realized mining activity. The high F-statistics indicate that our instruments are relevant. For resource types, tight oil, tight gas and shale gas are positive and significant determinants of resource dependence. Unproved coal is a positive predictor although its magnitude is much lower. Surprisingly, coalbed methane has a negative impact on mining which may be due to its high concentration in only a few states.[7]

Table 4 shows the reduced-form estimates for corruption. We include the institutional determinants in column (1); add the control variables in (2); and then the full first-stage regression in (3). The institutional measures enter with their predicted signs and are each significant in each column. For

[7]30 of the 50 states have no coalbed methane, while five states – Washington, Iowa, Colorado, Alaska and Wyoming – contain 70% of the national estimate.

unconventional resources, shale gas and unproved coal are linked to greater corruption, while tight oil and coalbed methane are associated with lower corruption. In the full first-stage result of (3), the F-statistic of 62 indicates that our instruments are relevant.

In columns (4) and (5), we include resource dependence in the first-stage to test for its endogeneity. In both instances, the coefficient is insignificant and thus we fail to reject the null of endogeneity. This suggests that our instruments are exogenous.

Table 4: Determinants of corruption for the US

VARIABLES	(1)	(2)	(3)	(4)	(5)
ln(voter residency)	0.0150*	0.0148*	0.0187**	0.0148*	0.0143*
	(0.0075)	(0.0078)	(0.0077)	(0.0081)	(0.0080)
ln(age of constitution)	-0.1282*	-0.1526*	-0.0747*	-0.1527*	-0.1513*
	(0.0715)	(0.0800)	(0.0437)	(0.0834)	(0.0815)
ln(GDP/POP)		-0.1713	0.0725	-0.1692	-0.1970
		(0.1881)	(0.2076)	(0.2163)	(0.2109)
investment		0.4392	1.5393***	0.4410	0.3935
		(0.4779)	(0.5628)	(0.4860)	(0.4815)
college		-0.1756	-0.0236	-0.1824	-0.0733
		(0.7778)	(0.5715)	(0.8151)	(0.8114)
ln(pop density)		-0.0325	-0.0343	-0.0328	-0.0284
		(0.0382)	(0.0402)	(0.0490)	(0.0450)
tax share		-0.0585	-0.9675	-0.0494	-0.1258
		(1.4976)	(1.2935)	(1.3373)	(1.4639)
tight oil			-20.4424**		
			(8.2997)		
tight gas			1.0960		
			(2.7427)		
shale gas			13.3890**		
			(5.3031)		
coalbed methane			-24.6099**		
			(9.6491)		
unproved coal			1.1772***		
			(0.1036)		
mining production				-0.0201	
				(1.0865)	
mining employment					0.8149
					(2.9164)
Observations	50	50	50	50	50
R-squared	0.1370	0.2543	0.6688	0.2543	0.2558
F-statistic	8.119	5.154	62.44	4.279	4.475

Notes: Each column presents the results of the reduced-form equation (3). The estimates in column (3) are the first-stage results for columns (3) and (4) of Table 5. The robust standard errors are in parentheses where ***$p<0.01$, **$p<0.05$, *$p<0.10$.

4.2 Baseline US results

Table 5 shows the baseline growth regressions for US states. In columns (1) and (2), we estimate the growth regression with least squares (OLS). To account for potential heteroskedasticity, small sample, and the undue influence of high-leverage outliers in our small sample, we report HC3 heteroskedasticity-consistent standard errors in parentheses (MacKinnon, 2012). In columns (3)-(6), we estimate the growth regression with limited information maximum likelihood (LIML). LIML is a maximum-likelihood estimation of an instrumental variable equation that performs better in small samples and weak instruments (Flores-Lagunes, 2007). We report the Kleibergen-Paap rk Wald F-statistic and the p-value of the Hansen test of overidentifying restrictions.[8] The rk F-statistics exceed the strictest weak ID critical values and thus indicate strong instruments. In addition, we fail to reject the null of valid instruments at any conventional level which suggests exogeneity.

The control variables enter with their predicted signs. In particular, the negative sign for initial GDP per capita indicates conditional convergence, while the positive signs for investment and college are consistent with the Solow estimates of Mankiw et al. (1992), Garofalo and Yamarik (2002) and others. In contrast, the coefficients for tax share and corruption are negative but insignificant.[9]

For resource dependence, we find evidence for the resource curse when we identify resource abundance using our unconventional reserve estimates. Under OLS, the coefficient for mining production and employment is negative but not statistically significant in columns (1) and (2). However, by instrumenting resource abundance and corruption, the coefficients for mining production and employment increase in economic and statistical significance in columns (3) and (4). The point estimates imply that a 1% point increase in mining production (employment) leads to a a 0.06% (0.15%) decrease in annual state-level growth. These estimated effects are similar in magnitude to those reported in Table 1. In contrast, corruption becomes even more insignificant under LIML, suggesting no link between corruption and growth across US states.

In columns (5) and (6), we modify our unconventional resource instruments to allow for state-level bans and moratoriums:

[8] The Kleibergen-Paap rk Wald F-statistic and Hansen overidentification test are robust versions of the more common Cragg-Donald F-statistic and the Sargan overidentification test.

[9] HC3 gives higher weights to residuals observations of higher leverage and thus the standard errors are typically higher than standard robust errors like HC0 and HC1. As such, the HC3 standard error introduces a deliberate upward bias to account for the undue influence of these observations (Imbens and Kolesar, 2016)

Table 5: Growth results for the US

	OLS		LIML w/o ban		LIML with ban	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
ln(GDP/POP)	-0.0154*	-0.0166**	-0.0132*	-0.0149**	-0.0129*	-0.0147**
	(0.0085)	(0.0082)	(0.0075)	(0.0070)	(0.0075)	(0.0071)
investment	0.0348	0.0370	0.0343	0.0370*	0.0347*	0.0376*
	(0.0409)	(0.0420)	(0.0206)	(0.0217)	(0.0203)	(0.0215)
college	0.0551**	0.0563**	0.0522**	0.0540***	0.0510**	0.0528**
	(0.0247)	(0.0235)	(0.0200)	(0.0196)	(0.0202)	(0.0198)
ln(pop density)	-0.0008	-0.0006	-0.0010	-0.0007	-0.0010	-0.0008
	(0.0010)	(0.0010)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
tax share	-0.0709	-0.0825	-0.0676	-0.0831	-0.0659	-0.0821
	(0.0727)	(0.0691)	(0.0526)	(0.0506)	(0.0527)	(0.0508)
corruption	-0.0097	-0.0096	-0.0053	-0.0050	-0.0055	-0.0052
	(0.0064)	(0.0065)	(0.0046)	(0.0045)	(0.0045)	(0.0045)
mining production	-0.0453		-0.0599**		-0.0628**	
	(0.0612)		(0.0285)		(0.0285)	
mining employment		-0.1137		-0.1492**		-0.1571**
		(0.1720)		(0.0735)		(0.0731)
Observations	50	50	50	50	50	50
R-squared	0.4015	0.3990	0.3829	0.3804	0.3836	0.3811
rk F-statistic			52.51	55.08	52.22	54.83
Hansen p-value			0.128	0.137	0.140	0.148

Notes: Each column presents the results of the growth regression (1). Columns (1)-(2) are ordinary least squares (OLS) with robust HC3 standard errors in parentheses. Columns (3)-(6) are limited information maximum likelihood (LIML) with robust standard errors in parenthesis. Significance levels are ***p<0.01, **p<0.05, *p<0.10.

$$TRR_i^{ban} = TRR_i \times non\text{-}ban_i \tag{4}$$

where *non-ban* is 1 if **no** ban (or moratorium) was imposed *or* the percentage of years without a ban if state i imposed a ban for the resource in question.[10] The point estimates remain largely unaffected using the ban-adjusted instrument set (4). A 1% increase in mining production (employment) leads to a a 0.06% (0.16%) decrease in annual growth. Using our LIML estimates, our results predict that a resource-rich state like Wyoming will experience a decrease of around 1.3% in annual growth relative to a state with no mining resources.

[10]Quebec (2011), Vermont (2012), Newfoundland and Labrador (2013), New York (2014), New Brunswick (2014), Nova Scotia (2014), Maryland (2017), Prince Edward Island (2018), Washington (2019) and Oregon (2019) imposed bans on fracking during the sample period. See Yamarik (2026) for details.

4.3 Extension to Canadian provinces

Like the US, the fracking revolution played an important part in the Canadian resource sector and economy. We therefore add the 10 Canadian provinces to our 50 US state sample. As such, we are able to increase our sample size and geographic coverage. Unfortunately, there are no good corruption or rule of law data for Canadian provinces so we exclude it from the North American analysis. As a result, there is one endogenous variable so the Kleibergen-Paap rk Wald F-statistic reduces to the F-statistic from the single first-stage regression for resource dependence.

Table 6: Growth results for North America

	OLS		LIML w/o bans		LIML with bans	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
ln(GDP/POP)	-0.0135*	-0.0146**	0.0070	-0.0139**	0.0070	-0.0137**
	(0.0077)	(0.0064)	(0.0182)	(0.0055)	(0.0182)	(0.0056)
investment	0.0284	0.0338	0.0397**	0.0351*	0.0397**	0.0354*
	(0.0301)	(0.0295)	(0.0170)	(0.0180)	(0.0170)	(0.0182)
college	0.0570**	0.0591***	-0.0029	0.0569***	-0.0030	0.0564***
	(0.0240)	(0.0207)	(0.0566)	(0.0181)	(0.0567)	(0.0183)
ln(pop density)	-0.0006	-0.0006	-0.0028	-0.0007	-0.0028	-0.0007
	(0.0008)	(0.0008)	(0.0019)	(0.0007)	(0.0019)	(0.0006)
total tax	-0.0699**	-0.0762**	-0.0884**	-0.0781***	-0.0884**	-0.0784***
	(0.0323)	(0.0317)	(0.0338)	(0.0252)	(0.0339)	(0.0253)
mining production	-0.0326		-0.1550**		-0.1551**	
	(0.0298)		(0.0771)		(0.0770)	
mining employment		-0.1350*		-0.1568***		-0.1613***
		(0.0784)		(0.0542)		(0.0541)
Observations	60	60	60	60	60	60
R-squared	0.3342	0.3584	0.0151	0.3572	0.0143	0.3566
rk F-statistic			3.149	24.11	3.095	24.12
Hansen p-value			0.401	0.303	0.433	0.344

Notes: Each column presents the results of the growth regression (1). Columns (1)-(2) are ordinary least squares (OLS) with robust HC3 standard errors in parentheses. Columns (3)-(6) are limited information maximum likelihood (LIML) with robust standard errors in parenthesis. Significance levels are ***p<0.01, **p<0.05, *p<0.10.

Table 6 shows the growth results for North America. Our North American results provide further support for the resource curse. First and foremost, the LIML coefficient for resource abundance in North America is larger in economic size and statistical significance. The point estimates suggest that a 1% point increase in mining production or employment leads to a 0.15% decrease in annual GDP per capita growth. The effects of the control variables are also similar except that the tax share has a significant negative impact in North America.[11] The increase in magnitude especially for mining production arises from adding the resource-intensive provinces of Alberta (AB), Saskatchewan (SK) and Newfoundland and Labrador (NL).

4.4 Robustness tests

We test the robustness of our resource finding in three ways. First, we use alternative GDP measure by removing the public sector (Al Yussef et al., 2024) and the "slower-growing" mining sector (James and James, 2011). Second, we use resource abundance measures rather than resource dependence. In the cross-country literature strand, Brunnschweiler (2008) and Brunnschweiler and Bulte (2008) show that subsoil wealth and other resource abundance measures positively impact growth, while resource dependence does not. In the local economic outcomes strand, resource booms in the form of resource abundance raises short-run economic activity. Third, we use the log of resource dependence to match the transitional predictions of the Solow growth model Mankiw et al. (1992) and Garofalo and Yamarik (2002).

Table 7 presents the LIML results using private, non-mine, and private non-mining real GDP. The US states results are shown in Panel A and those for North America in Panel B. The point estimates for mining remain the same regardless of the GDP measure. For the US, a 1% increase in mining production (employment) leads to a 0.05-0.07% (0.12-0.17%) decrease in state-level growth. Likewise, for North America, a 1% increase in mining production (employment) leads to a slightly larger 0.06-0.12% (0.11-0.18%) decrease in state- and province-level growth.

Table 8 presents the results using resource abundance in the form of proved energy and its components oil, natural gas and coal. The OLS results in columns (1) and (2) show that resource abundance has no significant effect on long-run growth for both US states and North American states and provinces. However, when instrumented under LIML, proved energy in column (3) has a negative impact on growth of similar magnitudes. For the components, proved natural gas has a large economic and statistical impact on growth, while proved oil and coal have no significant effect. Nevertheless, the confirmation of the negative link using resource abundance provides further support for our resource

[11] The F-statistic for mining production drops from 52 in the US to 3 in North America. See Table B.1 for the first-stage results for North America. One source of the drop is Newfoundland and Labrador (NL) who had the highest mining production of 26% of GDP from conventional gas and oil and minerals, but no estimated unconventional TRR resources as of 2010 (EIA, 2013).

Table 7: Robustness to GDP measures

	private GDP		non-mining GDP		private non-mining GDP	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: US						
mining production	-0.0750**		-0.0467***		-0.0560***	
	(0.0289)		(0.0148)		(0.0161)	
mining employment		-0.1912**		-0.1245***		-0.1501***
		(0.0755)		(0.0400)		(0.0457)
Observations	50	50	50	50	50	50
R-squared	0.3800	0.3760	0.3090	0.3102	0.2899	0.2897
F-statistic	54.04	56.88	50.62	53.16	52.91	56.29
Hansen p-value	0.183	0.191	0.631	0.612	0.765	0.708
Panel B: North America						
mining production	-0.1484**		-0.0606**		-0.0659***	
	(0.0663)		(0.238)		(0.0226)	
mining employment		-0.1890***		-0.1121***		-0.1302***
		(0.0571)		(0.0385)		(0.0435)
Observations	60	60	60	60	60	60
R-squared	0.1571	0.3748	0.2518	0.2915	0.2878	0.3036
F-statistic	2.859	27.90	4.098	26.64	4.306	31.31
Hansen p-value	0.317	0.358	0.908	0.805	0.847	0.721

Notes: The table reports the LIML estimates of the growth regression (1) using alternative GDP measures as the dependent variable. Panel A presents results for the US and Panel B for North America. Columns (1)–(2) use private GDP, columns (3)–(4) use non-mining GDP, and columns (5)–(6) use private, non-mining GDP. Robust standard errors are reported in parentheses with ***p<0.01, **p<0.05, *p<0.10.

curse finding.

Table B.3 shows the results of using the log of resource dependence. Although our instruments are weak, we continue to find evidence for a resource curse when resource dependence is identified with unconventional oil and gas TTR.[12]

4.5 Indirect transmission mechanisms

Starting with Sachs and Warner (1995), there is a tradition of testing for indirect transmission mechanisms behind the resource curse. Cross-country research by Gylfason (2001), Stijns (2005) and Gylfason and Zoega (2006); and state-level analysis by Papyrakis and Gerlagh (2007), James (2015) and James and Smith (2017) estimate the effects of resource dependence on capital investment (crowding out), educational attainment, taxation, trade openness, crime, and the relative price of

[12]We used the TTR in levels and not logs because of the small values and many zeroes.

Table 8: Robustness to resource abundance

	OLS		LIML	
VARIABLES	(1)	(2)	(3)	(4)
Panel A: US				
proved energy	-0.0049		-0.0046*	
	(0.0051)		(0.0025)	
proved gas		-0.1987		-0.2160**
		(0.8101)		(0.1000)
proved oil		-0.0099		0.0375
		(2.1749)		(0.4334)
proved coal		-0.0015		-0.0008
		(0.0378)		(0.0027)
Observations	50	50	50	50
R-squared	0.3183	0.3484	0.3182	0.3480
rk F-statistic	–	–	7762	84.30
Hansen p-value	–	–	0.246	0.111
Panel B: North America				
proved energy	-0.0048		-0.0046**	
	(0.0031)		(0.0019)	
proved gas		-0.1886		-0.1681*
		(0.1223)		(0.1090)
proved oil		-0.1022		0.6586
		(0.2464)		(0.5959)
proved coal		-0.0014		-0.0002
		(0.0039)		(0.0031)
Observations	60	60	60	60
R-squared	0.3414	0.3700	0.3413	0.2520
F-statistic	–	–	399	2.041
Hansen p-value	–	–	0.127	0.235

Notes: Each column presents the results of the growth regression (1) using resource abundance. *Panel A* presents results for the US and *Panel B* for North America. Columns (1)-(2) are ordinary least squares (OLS) with robust HC3 standard errors in parentheses. Columns (3)-(4) are limited information maximum likelihood (LIML) with robust standard errors in parenthesis. The significance levels are ***p<0.01, **p<0.05, *p<0.10.

nontradeables to tradeables. For each transmission mechanism k, we estimate the following equation

$$X_i^k = \alpha_0^k + \alpha_1^k \ln(y_i) + \alpha_2^k RD_i + \mu_i \tag{5}$$

using the reduced-form equation (2) to instrument for RD.

Table 9 presents the results of the indirect transmission mechanisms. The specification tests show that our common instrument set of unconventional TTR are strong and exogenous. The results reveal a consistent pattern across both samples in that resource dependence lowers educational attainment,

Table 9: Indirect transmission mechanisms of mining production

VARIABLES	investment	education	tax share	non-res tax	openness	crime rate	nontradable
Panel A: US							
mining production	0.0654	-0.5726***	0.0110	-0.3148***	-0.3487**	0.3899	0.0570***
	(0.1657)	(0.0810)	(0.0294)	(0.0996)	(0.1794)	(0.5117)	(0.0180)
Observations	50	50	50	50	50	50	33
R-squared	0.0210	0.5599	0.0132	0.4579	0.0670	0.0985	0.1647
F-statistic	1672	1672	1672	1672	1672	1672	315.6
Hansen p-value	0.0964	0.356	0.368	0.165	0.530	0.225	0.378
Panel B: North America							
mining production	-0.3146	-0.5103***	0.0851	-0.2095**	-0.4074	0.4041	
	(2.2939)	(0.0905)	(0.0896)	(0.0874)	(0.2545)	(0.6393)	
Observations	60	60	60	60	60	60	
R-squared	0.0220	0.6089	0.0687	0.2150	0.0236	0.08990	
F-statistic	19.85	19.85	19.85	19.85	19.85	19.85	
Hansen p-value	0.519	0.948	0.385	0.395	0.628	0.597	

Notes: The table reports LIML estimates of the indirect transmission mechanisms of mining production. All specifications use the partial-ban (1) to instrument for mining production. Robust standard errors are reported in parentheses where ***p<0.01, **p<0.05, *p<0.10.

non-resource tax revenues, and trade openness, but has no significant effect on capital investment and crime. The point estimates indicate that a 1% increase in mining production lowers the share of college educated workers by around 0.50%, non-resource tax revenue by about 0.25% and trade openness close to 0.40%.[13] In the last column, we use the inflation rate of tradeables minus nontradeables from Hazell et al. (2022) as the dependent variable.[14] We find strong evidence of the Dutch disease in that resource dependence is associated with price increases in non-tradeables.

The results indicate that resource dependence affects long-run growth through several mechanisms. As with Gylfason (2001), we find that natural wealth lowers educational attainment. Resource-intensive regions weaken incentives for skill accumulation and shift labor demand toward lower-skill activities. For state fiscal policy, resource dependence leads state governments to decrease non-resource taxation but leave overall taxation the same. This fiscal response is consistent with the detailed findings of James (2015). With regards to resource allocation, we find that resource dependence reduces trade openness which is consistent with the earlier results of Sachs and Warner (1995) and Papyrakis and

[13] Table B.2 shows that mining employment has the same impact on the transmission mechanisms albeit with a higher magnitude.

[14] Hazell et al. (2022) uses BLS micro-data to create separate price indexes for tradeables vs. non-tradeables for 33 of the 51 states. Unlike the regional price deflators of the BEA (2026), the inflation data of Hazell et al. (2022) is free of cross-state imputation which would impact our cross-sectional analysis. For Canadian provinces, we could not locate any comparable tradeable vs. nontradeable price data at the province level.

Gerlagh (2007). For US states, resource intensity raises the price of nontradable goods and services relative to tradables which supports the micro and aggregate evidence of Aragón and Rud (2013) and Harding et al. (2020).

5 Conclusion

In this paper we test the resource curse hypothesis across US states and Canadian provinces. We estimate a standard growth regression in which average annual real GDP per capita growth depends on initial GDP, resource dependence, corruption and a set of additional controls. To address endogeneity in resource dependence, we use the shale revolution to create unproved reserves of unconventional gas and oil by state as instruments. These unproved unconventional resources capture geological and technological potential rather than current economic conditions and thus are plausibly exogenous. Our identification scheme exploits the presence and magnitude of unconventional reserves and relies solely on cross-sectional variation in resource potential and not on energy prices.

We find evidence for the resource curse across US states and Canadian provinces. Least squares estimation find that resource dependence has no significant effect on growth. In contrast, LIML estimation show that resource dependence reduces growth in the US and North America once endogeneity is controlled for. A one percentage point increase in mining production reduces annual state-level per capita growth by 0.05%, while the same increase in mining employment lowers growth by 0.15%. The estimates imply that a resource-intensive state such as Wyoming experiences about 1.3% lower annual growth than a state without mining activity. The results are robust to alternative GDP measures and the use of resource abudance. In tests of indirect transmission mechanisms, we find that resource dependence reduces the share of college-educated workers, non-resource tax revenue, trade openness and raises the price of nontradeables; but has no impact on total tax revenue and crime.

Our transmission mechanism results have direct policy implications. Since mining intensity lowers educational attainment, policy should protect human-capital accumulation in regions exposed to shale extraction. A stable share of resource revenues can be earmarked for education under multi-year fiscal rules that smooth spending over commodity cycles. Stay-in-school incentives, such as completion bonuses, can reduce the opportunity cost of longer education despite high mining wages. The increase in nontradable prices is consistent with Dutch disease pressures. Saving a share of resource revenues in external assets has proven effective in limiting such pressures, as shown by rules-based frameworks in Norway and Chile. The decline in non-resource fiscal capacity indicates rising dependence on volatile extraction income. Fiscal rules that separate temporary resource revenues from permanent spending can reduce this dependence. These measures are complementary. Education policies are effective only if regions create jobs outside extraction, and diversification toward tradable sectors requires a skilled workforce.

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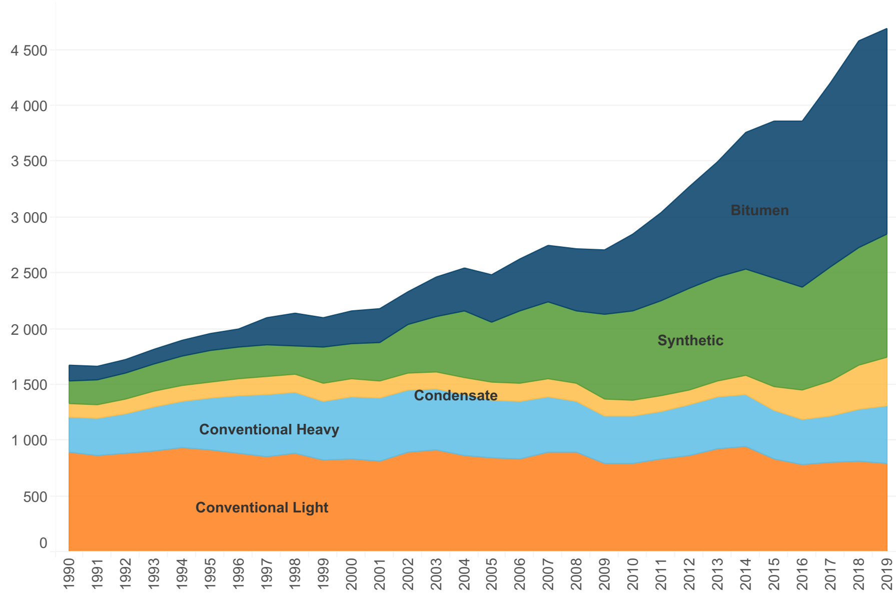
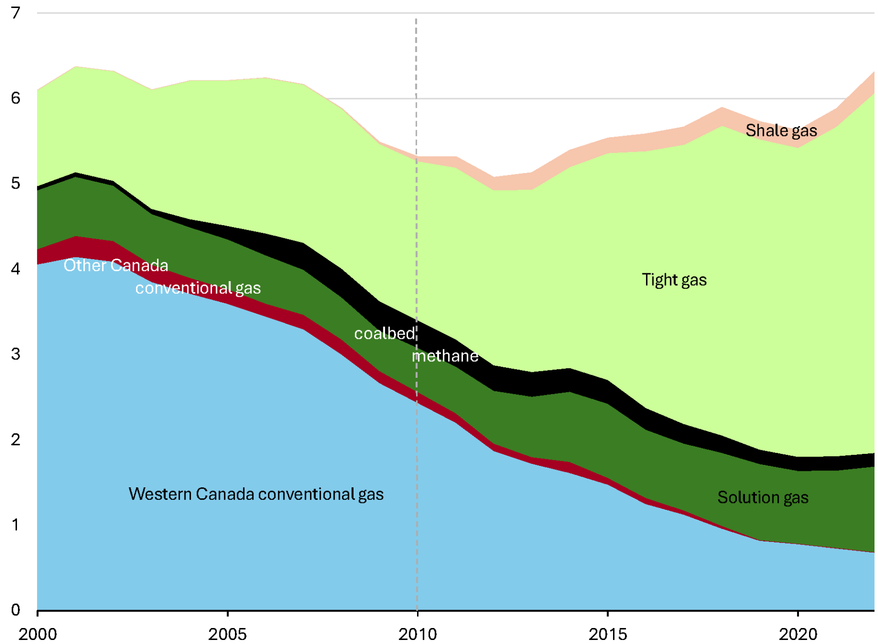
A Appendix A

Figure A.1: Canadian oil production by source (million barrels per day)



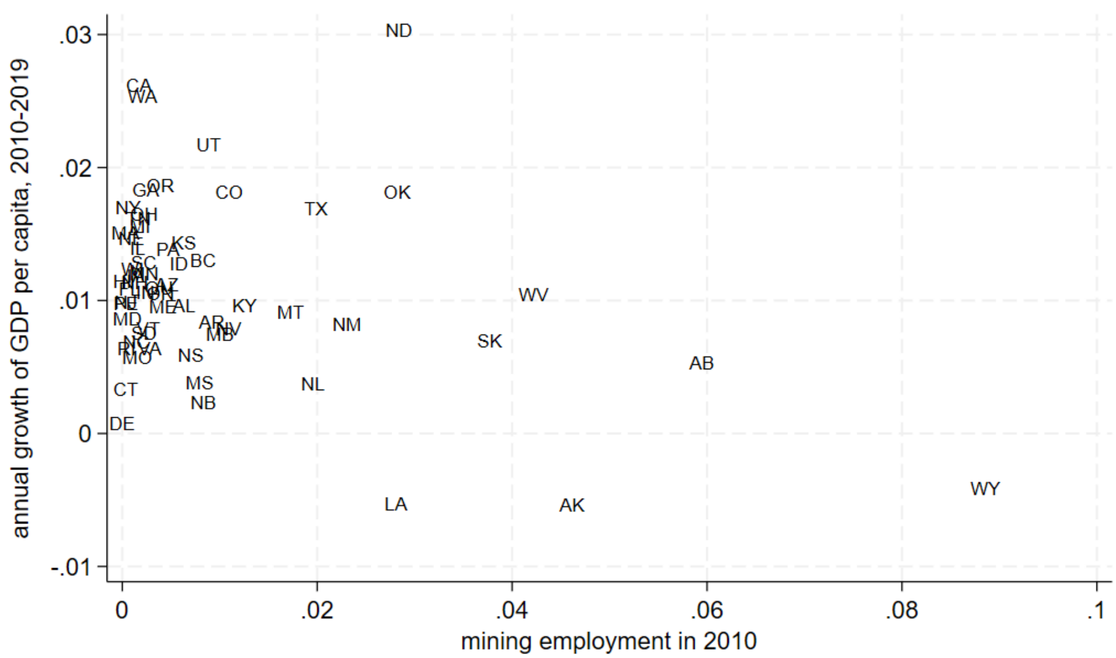
Source: Canadian Energy Regulator (2023)

Figure A.2: Canadian natural gas production by source (trillion cubic feet)



Source: Canadian Energy Regulator (2023)

Figure A.3: mining employment and growth



Source: Constructed.

B Appendix B

Table B.1: Resource determinants for North America

	Mining production		Mining employment	
VARIABLES	(1)	(2)	(3)	(4)
tight oil	2.9536*	0.0027	1.0055**	0.7971*
	(1.7565)	(1.7587)	(0.3857)	(0.4029)
shale+tight gas	0.8263***	0.3991*	0.2918***	0.2393***
	(0.2066)	(0.2009)	(0.0675)	(0.0662)
coalbed methane	0.2842	0.0659	0.1002	0.1012
	(0.5497)	(0.2433)	(0.1582)	(0.1317)
unproved coal	0.0160	0.0175	0.0104	0.0082
	(0.0312)	(0.0208)	(0.0100)	(0.0075)
ln(GDP/POP)		0.1409***		0.0146*
		(0.0505)		(0.0084)
investment		0.0637		0.0064
		(0.1069)		(0.0277)
college		-0.4492***		-0.0958***
		(0.1538)		(0.0350)
ln(pop density)		-0.0143**		-0.0011
		(0.0064)		(0.0011)
tax share		-0.1144		-0.0407
		(0.1677)		(0.0336)
Observations	60	60	60	60
R-squared	0.4428	0.7490	0.7171	0.8141
F-statistic	22.02	3.149	39.97	24.11

Notes: Each column presents the results of the reduced-form equation (2). The estimates in column (3) and (4) are the first-stage results for columns (3) and (4) of Table 6. The robust standard errors are in parentheses where ***p<0.01, **p<0.05, *p<0.10.

Table B.2: Indirect transmission mechanisms for mining employment

VARIABLES	investment	education	tax share	non-res tax	openness	crime rate	nontradable
Panel A: US							
mining employment	0.3002	-1.5827***	0.0319	-0.8166***	-0.9109	0.8621	0.2278***
	(0.6773)	(0.2499)	(0.0852)	(0.3037)	(0.6109)	(1.4285)	(0.0667)
Observations	50	50	50	50	50	50	33
R-squared	0.0418	0.5611	0.0145	0.3443	0.0557	0.0861	0.2311
rk F-statistic	1036	1036	1036	1036	1036	1036	165
Hansen p-value	0.125	0.328	0.378	0.204	0.608	0.244	0.515
Panel B: North America							
mining employment	1.0106	-1.3334***	0.2174	-0.5425***	-1.1010*	1.0539	
	(1.3692)	(0.2498)	(0.2122)	(0.2151)	(0.6266)	(1.6895)	
Observations	60	60	60	60	60	60	
R-squared	0.1453	0.5137	0.0444	0.2265	0.0472	0.0555	
rk F-statistic	39.19	39.19	39.19	39.19	39.19	39.19	
Hansen p-value	0.413	0.948	0.370	0.295	0.640	0.609	

Notes: The table reports LIML estimates of indirect transmission mechanisms of mining employment. All specifications use the partial ban instrument for mining production. Robust standard errors are reported in parentheses where ***p<0.01, **p<0.05, *p<0.10.

Table B.3: Robustness to log of resource dependence

	OLS		LIML	
VARIABLES	(1)	(2)	(3)	(4)
Panel A: US				
ln(mining production)	-0.0001		-0.0028	
	(0.0008)		(0.0017)	
ln(mining employment)		-0.0000		-0.0034*
		(0.0009)		(0.0018)
Observations	50	50	50	50
R-squared	0.3727	0.3726	0.0773	0.0194
rk F-statistic	–	–	6.66	5.79
Hansen p-value	–	–	0.332	0.375
Panel B: North America				
ln(mining production)	-0.0003		-0.0081*	
	(0.0007)		(0.0043)	
ln(mining employment)		-0.0003		-0.0073**
		(0.0007)		(0.0029)
Observations	60	60	60	60
R-squared	0.3139	0.3140	0.0773	0.0194
F-statistic	–	–	0.832	1.84
Hansen p-value	–	–	0.4220	0.3750

Notes: Each column presents the results of the growth regression (1) using the log of resource abundance. *Panel A* presents results for the US and *Panel B* for North America. Columns (1)-(2) are ordinary least squares (OLS) with robust HC3 standard errors in parentheses. Columns (3)-(4) are limited information maximum likelihood (LIML) with robust standard errors in parenthesis. The significance levels are ***p<0.01, **p<0.05, *p<0.10.