The Effect of the Energy Boom on Schooling Decisions in the U.S.

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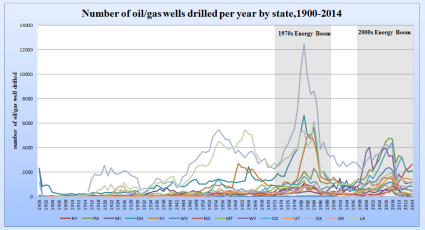
Motivation

- Shale gas and oil extraction has surged in the U.S. since late 1990s



Source: Various state agencies, collected by author.

- Recent studies have documented the energy boom as a clear local economic shock
  - Increase in local employment and income (Weber 2012 and 2013)
  - Local labor market restructuring (Weinstein 2014)
  - No local Dutch Disease effects (Allcott and Keniston 2014; Fetzer 2014)
- The shale gas boom increases demand for and earnings of low-skilled labor, which could draw teenagers out of school
  - Significant counter-cycle correlations between energy boom/bust and schooling decisions during the oil shocks in 1970s to 1980s (Black, McKinnish, and Sanders 2005; Emery 2012)
- Human capital has long been recognized as an important factor for economic growth, and crowding out human capital development (e.g., education) may be major cause of the resource curse
  - E.g., Gylfason (1999), Stijns (2006), and Papyrakis and Gerlagh (2007)

Objective

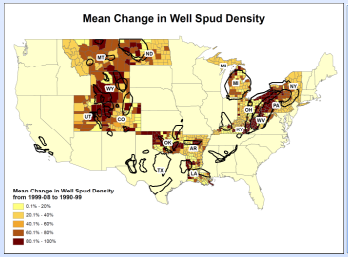
- Quantify the impact of the energy boom on aggregate (county level) schooling decisions

Data and Descriptive Analysis

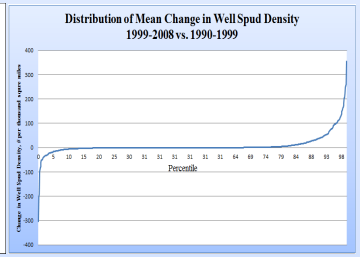
- 1995-2010 annual data of 916 counties from 14 states
- Measures of aggregated schooling decisions at high school level
  - $G9\text{–}12\ Enrollment\ Rate_{ct} = \frac{G9\text{–}12\ enrolled\ students\ \#_{ct}}{Population\ of\ age\ 15\text{–}19_{ct}}$
  - The Average Freshman Graduation Rate (AFGR)

$$AFGR_{ct} = \frac{Regular\ High\ School\ Diplomas\ Awarded_{ct}}{Enrollment\ in\ (Grade\ 8_{c,t-4} + Grade\ 9_{c,t-3} + Grade\ 10_{c,t-2})/3}$$

  - Source: Author's calculations based on data from the Common Core of Data (CCD), the National Center for Education Statistics (NCES)
- Measures of the shale energy boom: well spud density
  - The number of oil/gas wells drilled per thousand square miles, county-by-year
  - Source: Comprehensive well records requested from state agencies, such as Dept. of Natural Resources – Oil and Gas Resources, Dept. of Environmental Conservation or Protection, State Oil and Gas Conservation Commission and so on.



Source: Well records from various state agencies.



Source: Well records from various state agencies. .

- Control the confounding factors
  - Variables on schooling conditions (the NCES)
  - Variables on county characteristics, including county economic and demographic conditions (source: U.S. Census Bureau).

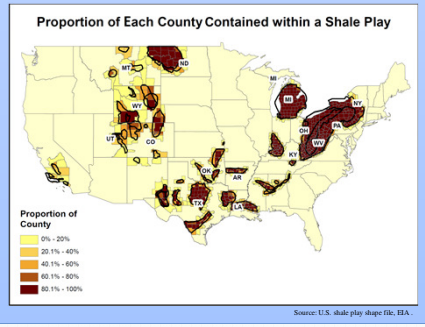
Method and Identification

- Well spud density is better for identifying the boom, compared to oil/gas production
  - Labor requirements are highest during the active drilling years and largely are driven by the number of wells drilled per year (Brundage et al., 2010; Kelsey et al., 2011)
  - Production lags the construction periods
- Further instrument well spud density with the interaction of exogenous geological characteristics, e.g., the proportion of county covering a shale play, and the world energy price index.
- Model specification

(1) $Y_{ct} = \beta_0 + \beta_1 \widehat{well}_{ct} + \beta_3 (\widehat{well} * MHHInc)_{ct} + \boldsymbol{\gamma'} \boldsymbol{X}_{ct} + s_c + \lambda_t + \varepsilon_{ct}$

(2) $well_{ct} = \alpha_0 + \alpha_1 shale_{ct} + \boldsymbol{\delta'} \boldsymbol{X}_{ct} + s_c + \lambda_t + u_{ct}$

- Y is two measures of schooling decisions: G9-12 enrollment rate and the AFGR
- $well$ is well spud density, measuring the number of wells drilled per thousand square miles
- $shale$ is the proportion of county covering a shale play multiplied by annual world energy price index.
- $MHHInc$ is median household income in thousand dollars; $\boldsymbol{X}$ is a matrix of control variables
- c and t refer to county and year; s_c and λ_t are state and year fixed effects



Source: U.S. shale play shape file, EIA .

Primary Results

	AFGR (all sample)		AFGR (non-zero well spud)		G9-12 Enrollment Rate (all sample)		G9-12 Enrollment Rate (non-zero well spud)	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Well Spud Density	**0.0472**	**-0.957****	**-0.123**	**-1.083****	**0.423*****	**0.518**	**0.239***	**1.160**
Well Spud Density× Median HH Income	**-0.0168**	**0.350*****	**0.00702**	**0.340****	**-0.0712***	**-0.151**	**-0.0269**	**-0.248**
Median HH Income	0.0237***	0.0248***	0.0239***	0.0118	0.0732***	0.0681***	0.0851***	0.0997***
Pupil Teacher Ratio	-0.132***	-0.155***	-0.470***	-0.463***	0.0650	0.150	-0.0651	-0.0189
%School Revenue from Local	0.0638***	0.0466**	0.0609***	0.0380	-0.355***	-0.346***	-0.287***	-0.352***
%El-Sec Spending	0.000740	0.00200	-0.0118	-0.00750	-0.0423	-0.0434	0.0156	0.0217
Unemployment Rate	0.241**	0.284**	-0.172	-0.198	2.130***	2.229***	1.719***	1.682***
Poverty Rate	-0.555***	-0.501***	-0.492***	-0.484***	-0.512***	-0.625***	0.0425	-0.0381
Earn per Job	-0.00119	-0.00328	-0.00883**	-0.0120***	0.0378***	0.0346***	0.0585***	0.0599***
Population Density	-0.0372***	-0.0332***	-0.0283***	-0.0127	-0.0302***	-0.0178	-0.0206**	-0.0310**
%Black	-0.105***	-0.106***	-0.131***	-0.146***	-0.329***	-0.330***	-0.660***	-0.617***
%Hispanic	-0.113***	-0.107***	-0.283***	-0.318***	-0.105**	-0.0501	-0.203***	-0.0720
%Senior	0.670***	0.661***	0.554***	0.509***	2.283***	2.391***	2.453***	2.675***
Violent Crime Rate	-0.455***	-0.551***	-0.0401	-0.188	0.780***	1.150***	0.529***	0.611***
Property Crime Rate	-0.0209	-0.00557	-0.0475**	-0.0240	-0.121***	-0.156***	-0.116***	-0.134***
Constant	4.284***	4.265***	4.416***	4.468***	3.771***	3.659***	3.557***	3.320***
Number of Obs.	9441	8551	4445	4036	9723	8549	4564	4035
adj. R^2	0.292	0.262	0.390	0.355	0.254	0.250	0.285	0.279
F-stat at first stage		41.78		27.08		41.78		21.08

Note: "All sample" refers to all observations in the sample;" non-zero well spud" refers to observations with well spud density not equal to zero; OLS columns report the results of pooled OLS estimation of equation (1); IV columns report the 2SLS estimation of equation (1) and (2); state and year fixed effects are included in all estimations; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; robust standard errors are not reported.

Primary Conclusions and Further Work

- The recent shale energy boom negatively affects the high school graduation rate, measured as the Average Freshman Graduation Rate (AFGR), but shows no significant effect on grade 9 to 12 enrollment rate
- The impact of the shale energy boom on the AFGR is conditional on the income level of sample counties: higher drilling rates reduce the AFGR more in counties with lower median household incomes.
- The negative effect on the AFGR is bigger in drilling counties, which in turn requires a higher income level to overcome the negative effect.

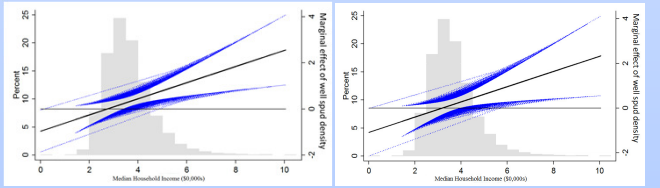


Figure: Conditional Marginal Effects of Well Spud Density on AFGR, IV models
All sample (left) vs. non-zero well spud subsample (right)

- Further work: include county fixed effects, gender heterogeneity, and spatial analysis to refine model specification; exclusion of private schools and migration effects could bias the results.

Acknowledgements and Contact

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