The Effect of Fracking on Agriculture, Forestry, Fishing, and Hunting in Pennsylvania

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Abstract

This paper uses graphical analysis and a regression using a random effect panel data to study whether fracking has a discernible effect on employment, measured through wages, in Pennsylvania. The regression used focuses on the dependent variable of the log of wages. The results of this regression have significant results for non-gas producing Pennsylvania, meaning it has notably higher wages than gas producing Pennsylvania in the time period of 2001-2011; however, using graphical analysis, I judge that these results could have been skewed by a few non-gas Pennsylvania counties with very high wages. Simultaneously, the regression finds no significant results for the New York border counties, but given the graphical trends of these counties it is likely that there were simply too few New York counties utilized to find significance.

JEL codes: Q1, Q02, Q23, Q26, Q32

Keywords: fracking, hydraulic fracturing, resource industries,

Introduction:

The Marcellus Shale, a geological formation containing natural gas reserves, lies under large portions of New York, Pennsylvania, and West Virginia, as well as under smaller portions of Ohio and Virginia (Rumbach, 2011). The Marcellus Shale is estimated to have over 489 trillion cubic feet of recoverable natural gas (Hefley et al., 2011). Driven by high investment after the Great Recession, combined with high oil prices, relatively recent innovations have made fracking considerably less expensive as well as more efficient (CNN Money, 2016). As such, resource extraction from the Marcellus Shale has been rapidly expanding, including in Pennsylvania. By 2011, the records of Pennsylvania Department of Environmental Protection records showed that 2,773 wells had been drilled into the Marcellus Shale, with projections for as many as 60,000 to be drilled by 2030 (Hefley et al., 2011). This growth is not restricted to Pennsylvania, of course; the Energy Information Administration asserts that, as of 2016, fracking accounted for over half of United States oil output, while it only accounted for 2% in 2000 (CNN Money, 2016). This growth is staggeringly sharp, as illustrated in Figure 1. While there are certainly significant economic benefits associated with fracking, the United States must be wary of possible externalities.

Recently, researchers have placed an increased focus on negative externalities associate with fracking. From earthquakes affecting home prices to an increase in crime, the possible effects of fracking are vary widely. This paper focuses on the effect of fracking on the Agriculture, Forestry, Fishing, and Hunting industries in Pennsylvania. New York is included as a point of reference as, citing health risks, Governor Andrew Cuomo banned fracking (NYTimes, 2014).

To examine the difference between wages, as an indicator of employment, between gas-producing and nongas-producing counties, I utilize graphical analysis and a random effects model for my panel data. I utilize employment data across all counties as well as unemployment and population statistics. Graphical evidence supported my belief that there was obvious differences in wages between the two groups of Pennsylvania counties as well as the New York border counties, namely that the gas producing Pennsylvania counties seemed to have the lowest average wage as well as the most noticeable decrease in wages over the time period.

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However, after running my regression, only the non-gas Pennsylvania wages came out significant. It is likely, though, that this significance was affected by the few very obviously higher waged counties with relatively extreme slopes. Similarly, it is probable that there was simply too little data included on New York to find significance, as the graphical evidence suggested much higher slopes and intercepts than the gas Pennsylvania states, which was not ultimately found in the regression.

Literature Review:

Researchers have pursued a wide breadth of topics on the many possible effects of fracking. While the focuses of this research various widely, there are several popular topics of focus including health effects, environmental effects, and overall economic effects. As my research question of whether or not fracking affects employment in several resource industries has not widely addressed, I have modeled my approach after and retrieved motivation from several existing papers.

Rumbach (2011) examines the potential negative effects of fracking on tourism in the Southern Tier of New York. The paper places a strong emphasis on the valuation of natural assets and their value to tourism in the largely rural area. Using data from Tourism Economics, the paper concludes that the travel and tourism industry directly accounted for 3,335 jobs in the STC region, and therefore resulted in $66,789,000 in direct labor income (Rumbach, 2011). Further, the paper gathers that tourism contributed $30,781,145 in total tax income through state and local taxes (Rumbach, 2011). These values illustrate that there is much at stake when policy makers approve fracking without considering the other industries it could affect, driving my desire to explore another industry. Also of importance to my research question, the paper examines the effects of fracking on the overall labor supply of the region, surmising that it is possible that fracking would have a detrimental effect if it monopolized the already relatively small labor population of these relatively rural areas (Rumbach, 2011). Ultimately, Rumbach concludes that it is necessary to assess the cumulative impact of drilling on all industries in a region, providing me with the motivation to pursue my research question (Rumbach, 2011).

The examination of the effects of fracking on crime rates in the counties it occurs in has been a particularly popular research topic within the last several years. "There Will Be Blood: Crime Rates in Shale-Rich U.S. Counties" uses a difference-in-differences strategy for counties throughout the United States (James and Smith, 2014). The authors define the treatment group as having geographic centers that lie above major shale formations, while all other U.S. counties, minus those they drop, are controls (James and Smith, 2014). They drop any county that reports zero crimes of any kind, as well as all Illinois counties as they have implausible year-to-year changes, as well as several other counties for various limitations (James and Smith, 2014). I, rather than dropping many of these counties, averaged the two year values prior and for counties with missing years. Others I dropped if there were several consecutive years with missing data. To measure the increase in production associate with the resource boom, this paper utilizes the national level of employment in the oil and gas industry (James and Smith, 2014). Similarly, I use the combined employment data for the agriculture, forestry, fishing, and hunting industries for my analysis to measure the overall industry health in response to fracking.

In order to study the possible overall economic impact, "The Economic Impact of Marcellus Shale Gas Drilling: What Have We Learned? What are the Limitations?" examines several existing papers that tout positive economic impacts for possible flaws – namely their failure to note the relationship with short run positive impacts and long term development when dealing with exhaustible resources (Kay, 2011). He cites evidence that illustrates that resource dependent communities cannot translate short-term gains into long-term economic development, and can even end up worse than they were before exploiting the resource (Kay, 2011). As almost all of the existing studies that show economic improvement for these communities use an input-output analysis, the paper examines the shortcomings of this model, including the inability for it to capture rapid and large change, the assumption of independence, the privileging of exports in relation to economic growth, the over simplification of the economy, and the lack of available data at the community level (Kay, 2011). Ultimately, the paper concludes that well-governed communities that understand the temporary nature of this influx and are capable of negotiating with gas companies are more likely to be able to capitalize on short-term benefits and recognize that they cannot rely on the fleeting resource to secure their future (Kay, 2011). As many of these rural communities are not as well positioned, and therefore may fall into the ill prepared group that the paper describes, my resolve to

pursue the question of whether fracking can injure other less impermanent industries within these communities is strengthened as it will assist these communities in assessing whether or not fracking will be beneficial.

Data:

The data I utilize covers all counties in Pennsylvania from 2001 to 2011 as well as several border counties from New York. I initially chose to study Pennsylvania because I knew fracking was permitted and that the Marcellus Shale divided the state in half, hopefully providing me with a number of control and test counties. Upon realizing that there were not a high number of comparable counties in each group, I chose to add in New York, which has banned fracking, as a control state. The United States Department of Agriculture's Economic Research Service (USDA ERS) provided the oil and gas county level data from 2000 to 2011. I had to remove the data from 2000 because I did not have the corresponding employment data for that year. I retrieved the employment data from he United States Department of Labor's Bureau of Labor Statistics (BLS). It is clear that there are many gaps in the data, as some counties will have a non-zero number for establishment count and still have zeros for annual wages and annual employment level. For several Pennsylvania counties, I had to average the values for annual employment level and total annual wages in order to fill an obvious missing gap. I felt sure that the zeros in these cases were not accurate and instead represented missing data as the years around them still had high non-zero values and the average establishment count for those years remained fairly constant. I did this for Potter in 2003 and 2009, York in 2004, Armstrong in 2006, Cameron in 2006, Mifflin in 2006 and 2007, Allegany in 2008, Greene in 2009, Clinton in 2010, and Pike in 2010. For counties with several consecutive years evidently missing data, I did not feel confident that an average would be an accurate depiction and therefore dropped them.

As in "There Will Be Blood: Crime Rates in Shale-Rich U.S. Counties", I use various employment statistics as a measure of industry heath as gathered from the BLS. They provide thirty variables that measure county level employment and wages. As many of these variables list mostly zero values, I opted to focus specifically on annual wages (sum_total_annual_wages), employment level (sum_annual_avg_emplvl), and establishment count (sum_annual_avg_estabs_count) for my graphical analysis as these variables had the most complete data. Ultimately, I focused largely on the wage data as the trends were most obvious.

The oil and gas production data I retrieved from the USDA ERS. The gas variable is measured in annual withdrawals of 1,000 cubic feet, while there oil variable is annual withdrawals in barrels of crude oil. I focused predominately on the gas variable.

As for my control variables, I used unemployment data from the Bureau of Labor Statistics and population data from National Bureau of Economic Research U.S. Census Intercensal County Population Data base. I limited both data sets to the years provided me by the BLS employment data set.

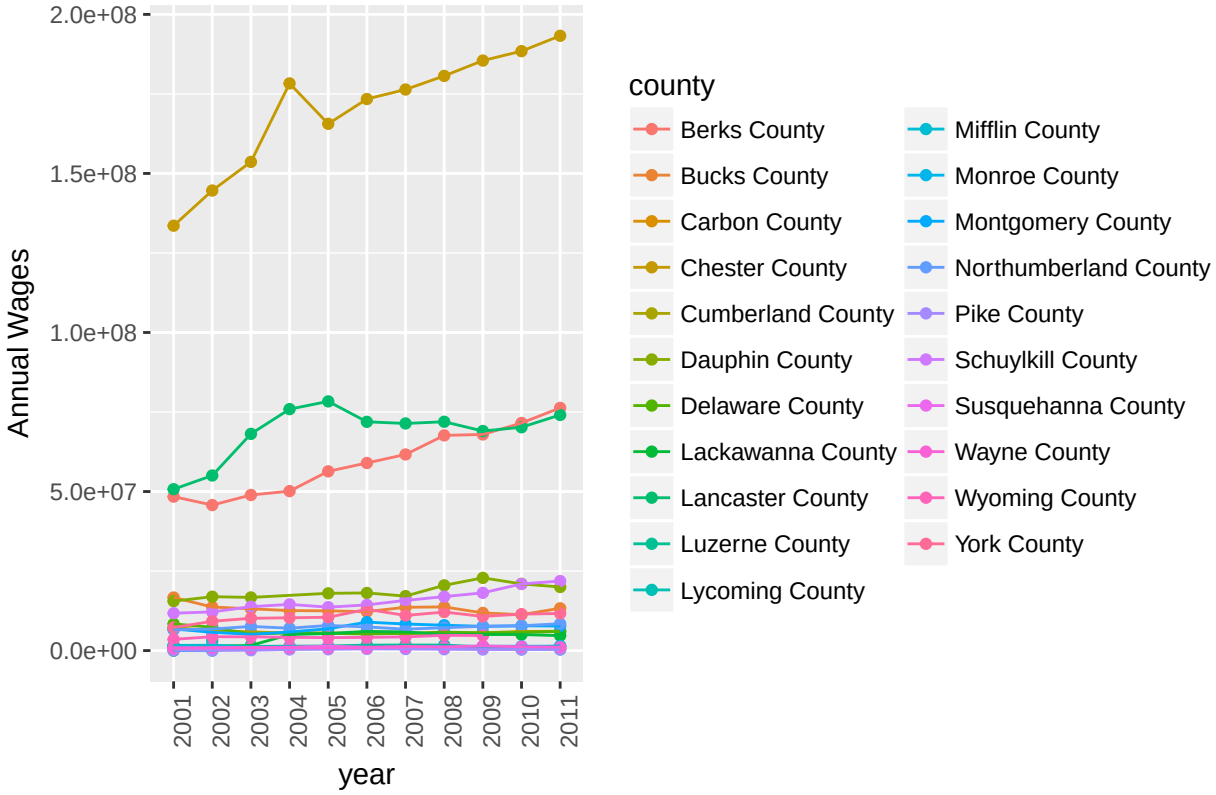
Methodology:

I utilize both graphical and regression analysis. My main graphs include wages for the New York and Pennsylvania border counties measured across the time period as well as annual wages over the time period for non-gas PA, gas PA and New York each measured separately.

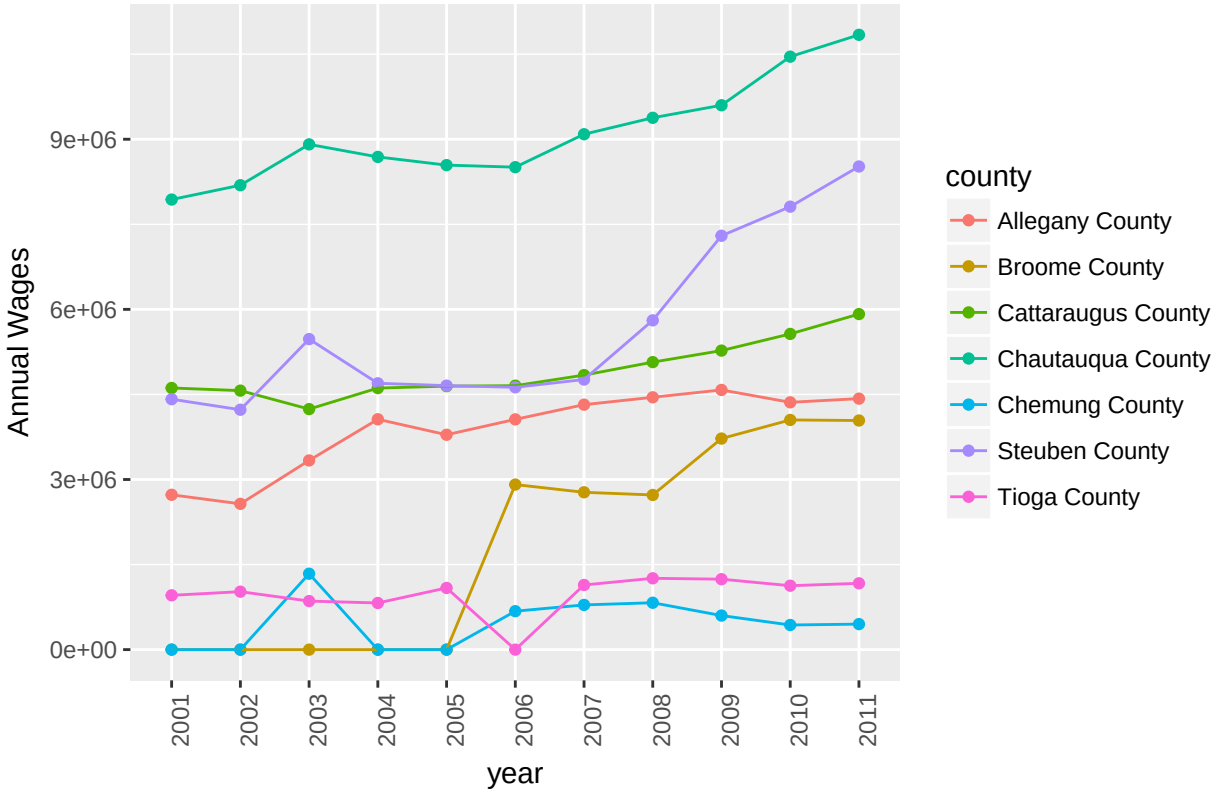
Graphical Analysis

Several trends are clear from the graphs. In the graph of annual wages from 2001-2011 in gas-producing Pennsylvania for agriculture, forestry, fishing and hunting, several counties clearly have consistently negative slopes as seen in Graph 3. While many counties in non-gas producing Pennsylvania have significantly lower overall wages, several counties have comparably high wages with positive slopes over the time period as shown in Graph 1. Although fewer counties are utilized, the New York graph illustrates higher wages on average with every included county having an upward slope for the time period, evident in Graph 2.

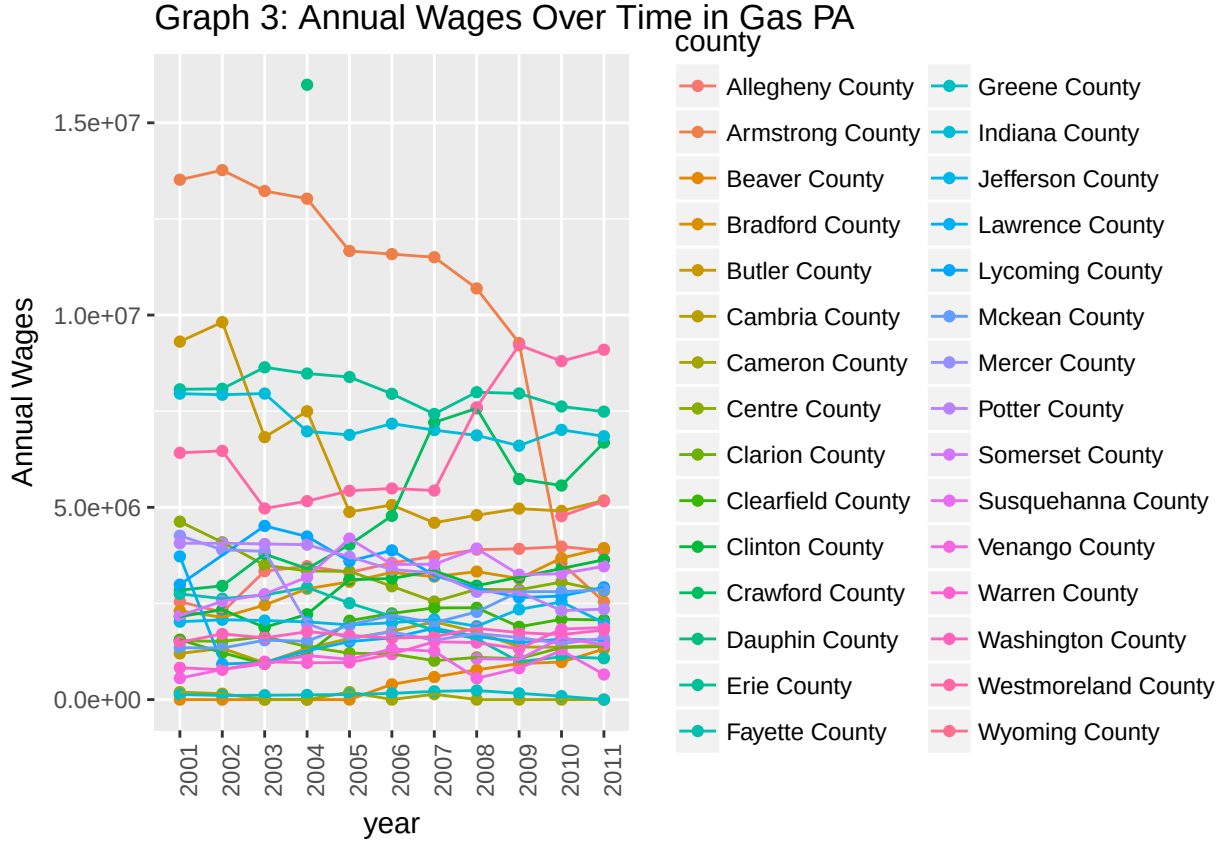
Graph 1: Annual Wages Over Time in Non−Gas PA



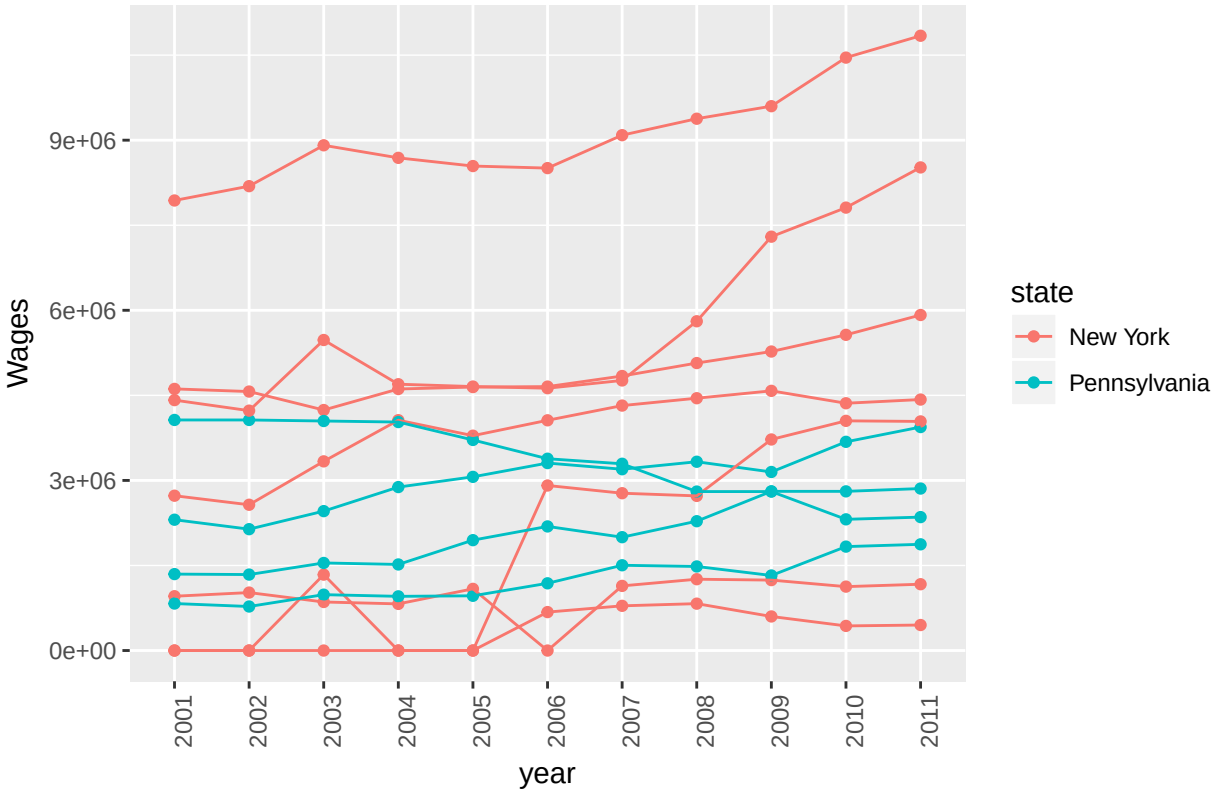
Graph 2: Annual Wages Over Time in NY



Graph 3: Annual Wages Over Time in Gas PA



Graph 4: Annual Wages Over Time



The various trends become even more pronounced when viewing the wage trends of bordering gas-producing Pennsylvania counties alongside those of the New York border counties. One would probably assume that these two groups would have relatively similar trends, considering that they are alongside each other and therefore likely have similar amounts of the natural resources being analyzed in this study. However, the upward trends of many of the New York counties become even more pronounced when view alongside the Pennsylvania gas counties in Graph 4.

Regression Methodology and Analysis

I utilized a regression in an attempt to support the apparent graphical trends while controlling for possible confounding variables. As my graphs focus on time trends of wages in gas producing and non-gas producing counties, I use a regression to focus in on any differences between the two. My dependent variable is a log of wages for the two sections of Pennsylvania counties as well as the New York border counties. In deciding what model to use, I utilized a Hausman test. It did not reject the null hypothesis of no correlation between the fixed effects and other regressors, enabling me to use both the fixed and random effects models and compare their results. The most significant difference between the two models is that the random effects model allows me to include dummy-variables for non-gas Pennsylvania and New York counties trended over time, whereas these dummies are absorbed into the fixed effects of the fixed effects model. Ultimately, this difference allows for each county type to have different intercepts and slopes within the random effects model. I include controls for population and unemployment rate in both models to account for large differences the two may cause in wages within each county. I also include a variable for a set of dummmies for the years in the data set.

$$logwages_{it} = \alpha_i + \beta_1 NYyear + \beta_2 ngPAyear + \beta_3 pop + \beta_4 unemployment.rate + \Gamma year + u_{it} \quad (1)$$

As the random effects model allows for these difference slopes and intercepts, it is easier to examine the differences between wages within fracking and non-fracking counties in the resource industries I focus on. As I have mentioned, the fixed effects model absorbs the dummy-variables for the various county groups, thereby obscuring variation. In contrast, as seen on Table 1, the random effects model gives several statistically significant results. Notably, this model illustrates a difference between the trend of non-gas producing PA counties and the gas counties. As seen by their intercepts, non-gas counties have a lower starting wage, but a higher upward slope in wages over time. Conversely, the model produces no significant trend for the NY border counties.

These trends, or lack thereof, can be explained and disputed through graphical analysis. As stated, several non-gas Pennsylvania counties have a noticeably higher intercept and slope, as illustrated in Graph 1. It is likely, then, that the level of significance found by my regression is driven at least partially by these outlier counties. Similarly, there are attributes of the graph of wages in New York that dispute its insignificance. As apparent in Graph 2, almost every border county in New York has a markedly higher level of wages compared to their Pennsylvania neighbor as well as noticeably higher slopes. Therefore, it is possible that there is a significant difference between New York and Pennsylvania but that there was not enough data to make this trend significant within the model.

Discussion

While my regression produced some significant results, I am hesitant to rely heavily on them as my graphical evidence offers an alternative narrative. Although my regression found that non-gas producing Pennsylvania had a higher wage trend compared to gas-producing Pennsylvania, it is evident that several counties could be responsible for skewing this result. Likewise, New York was not significant but graphical evidence illustrates that it may have been had more New York county data been included. As discussed by Rumbach (2011) and Kay (2011), it is of the utmost importance to quantify the possible negative economic externalities associate with fracking so that these rural counties will not fall victim to long run negative economic impacts. If these counties become wholly reliant on income from this exhaustible resource and let other industries fall by the wayside, they will be much more susceptible to the fluctuation of natural gas prices on the international level. Like Venezuela

when the price for oil plummeted, they will risk having no other industry to fall back on if fracking is truly negatively affecting the other major industries of their area.

It would be prudent for future researchers to examine other states where fracking occurs to examine if there is a noticeable negative impact on important industries in the respective states, although data is certainly a significant barrier to finding meaningful results. If it is determined conclusively that fracking will have a long run negative impact, these counties can better prepare themselves for the long run while simultaneously retrieving the short run economic gains.

References

Census U.S. Intercensal County Population Data, 1970-2014. (2017). Retrieved April 30, 2017, from http://www.nber.org/data/census-intercensal-county-population.html

County-level Oil and Gas Production in the U.S. – USDA ERS (2016). Retrieved April 30, 2017, from http://www.ers.usda.gov/data-products/county-level-oil-and-gas-production-in-the- us.aspx

Fracking now fuels half of U.S. oil output. (2016, March 24). Retrieved May 02, 2017, from http://money.cnn.com/2016/03/24/inve shale-oil-boom/

Hefley, B., & Seydor, S. (2011). The Economic Impact of the Value Chain of a Marcellus Shale Well. SSRN Electronic Journal. doi:10.2139/ssrn.2181675

James, A., & Smith, B. (2017). There Will be Blood: Crime Rates in Shale-Rich U.S. Counties. Journal of Environmental Economics and Management, 84, 125-152. doi:10.1016/j.jeem.2016.12.004

Kaplan, T. (2014, December 17). Citing Health Risks, Cuomo Bans Fracking in New York State. Retrieved May 02, 2017, from https://www.nytimes.com/2014/12/18/nyregion/cuomo-to-ban-fracking-in-new-york-state-citing-health-risks.html?_r=0

Kay, D. (2011). The Economic Impact of Marcellus Shale Gas Drilling: What Have We Learned? What are the Limitations? Retrieved April 1, 2017, from http://www2.cce.cornell.edu/naturalgasdev/documents/pdfs/kayformattedmarcellus%20wo 4-2011.pdf

Local Area Unemployment Statistics. (2016). Retrieved April 30, 2017, from https://www.bls.gov/lau/#cntyaa

Quarterly Census of Employment and Wages – Data Files. (2016). Retrieved April 30, 2017, from https://www.bls.gov/cew/datatoc.htm

Rumbach, R. (2011). Natural Gas Drilling in the Marcellus Shale: Potential Impacts on the Tourism Economy of the Southern Tier. Retrieved April 1, 2017, from https://www.fe.doe.gov/programs/gasregulation/authorizations/Orders_Issued_201

U.S. Energy Information Administration - EIA - Independent Statistics and Analysis. (2016, May 5). Retrieved May 02, 2017, from https://www.eia.gov/todayinenergy/detail.php?id=26112

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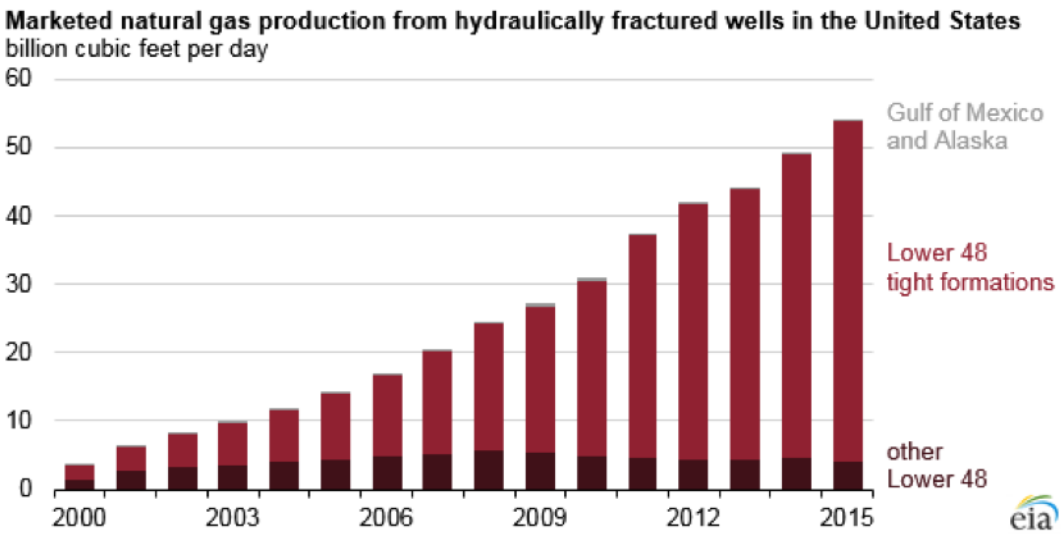

Figure 1: Source: Energy Tomorrow

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Table 1:

	Dependent variable:	
	lwages	
	(1)	(2)
NY		−16.220
		(26.265)
NYyear	0.018	0.008
	(0.012)	(0.013)
nongasPA		−37.430**
		(17.315)
ngPAyear	−0.00003	0.019**
	(0.0001)	(0.009)
pop	0.002	0.002***
	(0.002)	(0.001)
unemployment.rate	0.011	−0.019
	(0.029)	(0.030)
year2002	−0.058	−0.044
	(0.059)	(0.060)
year2003	−0.031	−0.020
	(0.060)	(0.061)
year2004	0.033	0.030
	(0.058)	(0.060)
year2005	0.062	0.033
	(0.055)	(0.058)
year2006	0.090	0.041
	(0.056)	(0.061)
year2007	0.114**	0.050
	(0.057)	(0.063)
year2008	0.111*	0.069
	(0.057)	(0.062)
year2009	0.046	0.083
	(0.109)	(0.110)
year2010	0.018	0.059
	(0.117)	(0.118)
year2011	0.040	0.053
	(0.101)	(0.104)
Constant		14.556***
		(0.261)
Observations	568	568
R^2	0.054	0.110
Adjusted R^2	−0.073	0.084
F Statistic	2.036** (df = 14; 500)	3.687*** (df = 16; 551)
Note:		*p<0.1; **p<0.05; ***p<0.01