

Economic Changes in Pennsylvania within the Context of Marcellus Shale Development

The Marcellus Shale Impacts Study Wave 2: Chronicling Social and Economic Change in Northern and Southwestern Pennsylvania

March 2017

Executive Summary

The significance of Marcellus Shale gas development to local, regional, state, and national economies has been of public policy importance since the mid-2000s. In the last 10 years, many researchers have estimated economic impacts of shale development in Pennsylvania and forecasted expected outcomes into the coming decades.

This research analyzed recently published peer-reviewed studies of economic impacts from Marcellus Shale development. Generally, these studies found modest positive economic changes associated with development. However, what those impacts are, where they are, and their magnitude vary widely, although areas with the most wells often experienced the most positive benefit. These studies found that employment and compensation are generally found to be less significant than income generated from leases and royalties. These findings indicate that the distribution of the economic benefits are not necessarily community-wide, but rather accrue to a smaller subset of the population (or even non-residents), and are determined by factors such as mineral rights ownership, age, gender, and employment status. The studies did not account for costs to social and environmental systems and the review indicated the need to investigate industry impacts at scales beyond the county level given the spatial and temporal patterns of the industry.

The implications of this review were two-fold. First, economic impacts will likely be short-run due to the temporal dynamics of the industry. Drilling a well produces more jobs than later stages of development, meaning employment and compensation impacts will likely occur early in development. Royalties and leasing payments benefits are also temporal. These payments, and subsequent benefits, will be subject to changes in commodity prices, flow rates from wells, and investment strategies of mineral rights owners. Distributed public funds collected through impact fee payments, or a proposed severance tax, could provide short-term economic benefits to communities but will also rely on the pace of well development and production.

Second, there is fairly strong consensus in the academic literature that impacts to employment and compensation are modest, indicating that employment should be considered neither a long-term economic benefit of development nor the most significant local economic benefit of development.

This project was sponsored by a grant from the Center for Rural Pennsylvania, a legislative agency of the Pennsylvania General Assembly.

The Center for Rural Pennsylvania is a bipartisan, bicameral legislative agency that serves as a resource for rural policy within the Pennsylvania General Assembly. It was created in 1987 under Act 16, the Rural Revitalization Act, to promote and sustain the vitality of Pennsylvania's rural and small communities.

Information contained in this report does not necessarily reflect the views of individual board members or the Center for Rural Pennsylvania. For more information, contact the Center for Rural Pennsylvania, 625 Forster St., Room 902, Harrisburg, PA 17120, telephone (717) 787-9555, email: info@rural.palegislature.us, www.rural.palegislature.us.

Table of Contents

About this Project	4
Marcellus Shale Activity	5
1. Economic Changes and Impacts.....	5
i. Scholarship on Economic Impacts.....	7
ii. Recent Analysis of Economic Changes Associated with Marcellus Shale Development in Pennsylvania	9
a. Economic changes in the PA economy	10
2. Economic impacts: Employment and Compensation, Leasing and Royalties.....	12
i. Employment and Compensation.....	13
ii. Leasing and Royalties	17
3. Variation in findings: Degree of Impacts, Spatial and Temporal Considerations	20
i. Data and methodological limitations in estimating employment and compensation	21
ii. Limitations in model parameters	24
iii. Limitations in Estimating Impacts from Leases and Royalties	26
iv. Continuing Questions due to the temporal dynamics of the industry.....	27
4. Continuing Questions due to Geographic Factors	27
i. Variation in County-level analysis	28
ii. Limits to county-level analysis and regional analysis.....	28
5. Summary	30
6. Policy Implications	31
i. Economic impacts will largely be short run	31
ii. Employment impacts are generally modest	32
Report Authors.....	33
Funding	33
References	33

About this Project

The Marcellus Shale Impacts Project chronicles the effects of shale-based energy development in Pennsylvania by focusing on the experiences of four counties with significant extraction and production activity – Bradford, Lycoming, Greene, and Washington counties. Wave 1 of the project was completed in 2013 and Wave 2 began in early 2014. Wave 1 was focused predominantly on data collection and the use of descriptive statistics to present changes in various outcomes over time. Wave 2 focused on developing statistical models to describe relationships between Marcellus Shale development and a set of social and economic indicators, identifying change in social and economic outcomes that are associated with Marcellus Shale development, and identifying the characteristics of people and places associated with the magnitude and types of impact experienced. A particular focus of Wave 2 was to explore the heterogeneity in Marcellus Shale development impact on different population groups. The purpose of this research was to use the growing number of economic studies of Marcellus to examine the economic implications of Marcellus Shale activity in Pennsylvania.

Study Counties

This study focused on the same four counties examined in Wave 1 of the Marcellus Shale Impacts Study: Bradford, Lycoming, Greene, and Washington. These counties experienced among the highest levels of Marcellus Shale development in Pennsylvania over the past 8 years, and they have diverse populations, histories, economic bases, and geographic locations. These differences allow comparisons that facilitate understanding the potential relationships between Marcellus Shale development and various social, economic, and health outcomes. Regional comparisons are also made based on adjacency to the study counties. The northern tier counties include Bradford, Lycoming, Clinton, Columbia, Montour, Northumberland, Potter, Sullivan, Susquehanna, Tioga, Union, and Wyoming. The southwestern counties include Greene, Washington, Allegheny, Beaver, Fayette, and Westmoreland.

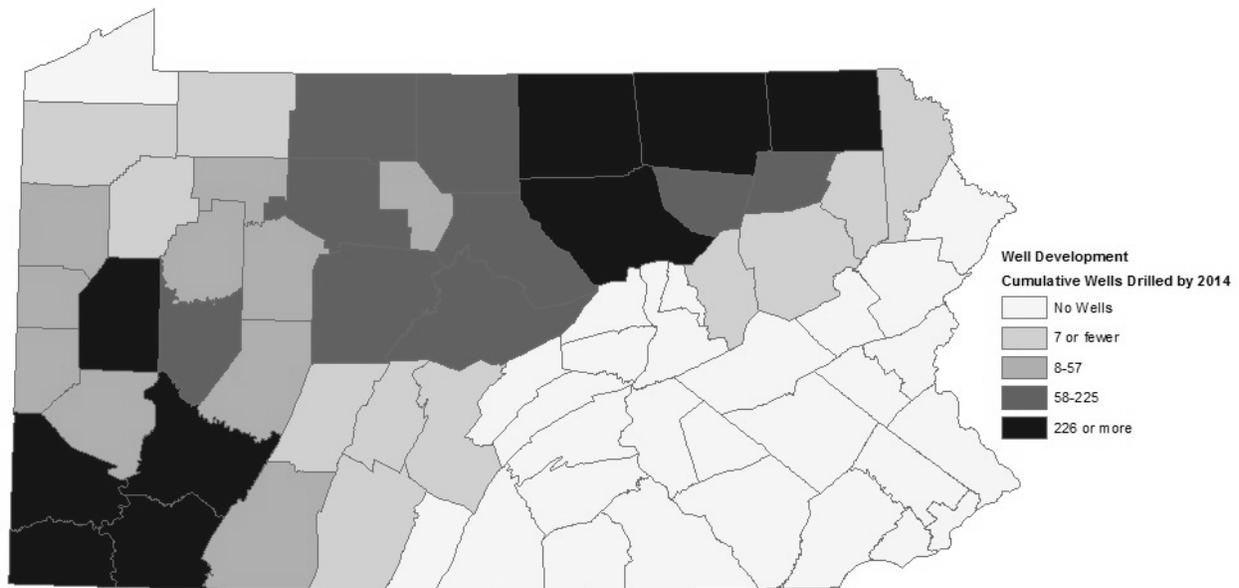
All four study counties are classified as rural by the Center for Rural Pennsylvania with population densities of less than 284 people per square mile. However, the U.S. Department of Agriculture's (USDA) Economic Research Service (ERS) classifies Lycoming and Washington counties as being located inside metropolitan areas. Lycoming County encompasses much of the Williamsport metropolitan area, and Washington County is part of the Pittsburgh metropolitan area. Bradford and Greene counties are classified by the USDA ERS as being located outside of metropolitan areas. Bradford

and Greene counties have small urban populations of less than 20,000 people. However, both are adjacent to metropolitan areas.

Marcellus Shale Activity

Figure 1 presents the distribution of the cumulative number of wells drilled in each county in Pennsylvania through August of 2014. The cut points represent quintiles (intervals of 20 percent). Well development is concentrated in the northeast, northcentral, and southwestern portions of the state. In the Northern Tier, Bradford, Lycoming, Tioga, and Susquehanna have all experienced similar high levels of development. This suggests that comparisons of outcomes among these counties will be particularly useful. Similarly, the most useful comparisons will be between the neighboring Southwest counties with the most natural gas well development. These include Greene, Washington, Fayette, and Westmoreland, although Greene and Washington Counties have had substantially more wells drilled than Fayette and Westmoreland Counties.

Figure 1. Cumulative Number of Unconventional Gas Wells Drilled, 2005-2014



Source: PA Dept. of Environmental Protection, Office of Oil and Gas Management

Economic Changes and Impacts

The significance of Marcellus Shale gas development to local, regional, state, and national economies has been of public policy importance since the mid-2000s. In the last 10 years, many researchers have estimated economic impacts of shale development in Pennsylvania and forecasted expected outcomes into the coming decades. These studies have tried to anticipate and measure the extent to which shale gas generates new employment, income from leases and royalties, local business activity and revenue in the commonwealth. As the shale gas industry is still relatively new in Pennsylvania, early analyses relied on data collected in the industry's infancy. Many were not peer-reviewed, which means the studies were not independently and anonymously reviewed by other researchers to ensure the methods and analysis were accurate. Such "blind" peer review is an important standard for scientific studies. In addition, many early studies lacked longitudinal data and required significant assumptions about the pace and location of development (Kelsey et al., 2011; Kinnamon, 2011). These studies did, however, identify many challenges of studying Marcellus Shale impacts, including data availability and the complexity of modeling the spatial and temporal patterning of the industry, among other issues (Kay, 2011; Kinnamon, 2011; Barth, 2013).

Now that the shale gas industry has been active in the commonwealth for nearly a decade, sufficient longitudinal data have become available to better estimate the economic changes associated with Marcellus Shale development. The peer-reviewed literature on economic impacts significantly expanded in 2015, and several additional studies are forthcoming. Addressing limitations of early studies, these newer analyses now incorporate data and models that can better reflect the varied paces and intensities of development over the last decade.

Many studies have found some positive impacts from shale gas development in Pennsylvania, yet these findings have not been uniform. Differences may be attributable to modeling choices and data selection, thus policy makers increasingly need to be aware of the limitations of the data and models

used to evaluate this emerging literature and use it to make policy decisions. Additionally, significant spatial variation in the experienced economic changes has been found; some studies have shown different magnitudes of impacts across study areas, while others have found that impacts vary between local and non-local resident status. Additionally, although employment and compensation are frequently discussed as potentially important economic benefits of shale gas development, some studies have found that leasing and royalties may have significantly more economic impact than employment and compensation. These present potentially significant equity issues of which policy makers should be aware.

This research provides an updated review of this rapidly growing body of peer-reviewed scholarship on economic changes and impacts associated with Marcellus Shale development in Pennsylvania. This new peer-reviewed scholarship employed the most recently available data, and is diverse in its aims to address many of the limitations of early economic analyses. This research did not try to replicate previous research efforts but instead highlights significant findings and trends, and discusses the complexities, limitations, and continuing questions the new research raises to help policy makers interpret future findings more successfully.

i. Scholarship on Economic Impacts

The complexity of the shale gas industry – its variable spatial and temporal patterning and its overlap with multiple sectors of the economy and society – has made accurate economic assessments of Marcellus Shale development a considerable challenge. Early analyses of the economic changes related to Marcellus Shale development focused on a variety of factors, including employment, compensation, and leasing bonuses and royalties for owners of mineral rights. Many were speculative, using models to project expected impacts that relied on evidence from other shale plays, projections of the pace and longevity of the industry, and limited available data from the early years of Marcellus Shale development. Reviews of these early analyses raised questions about the models and assumptions used

(Kay, 2011; Kinnamon, 2011; Barth, 2013), issues more recent analyses have tried to address. Table 1 provides a summary of these literature review studies.

Table 1: Reviews of Economic Impact Studies

Authors	Peer-reviewed	Date	Scope	Significant Findings
Kay	No	2011	Review of literature on economic impact	<p>Many studies have limitations in projecting pace and location of development overtime</p> <p>Many studies suffer from limitations of data and models in analysis</p>
Kinnaman	Yes	2011	Review of literature on economic impact	<p>Identified major limitations of data and models in analysis to date</p> <p>Estimations using industry data may be overestimations</p> <p>Existing economic conditions can create further limitations in modeling</p>
Barth	Yes	2013	Review of literature on economic impacts, models, and resource economy theories	<p>Noted major variations across different analyses</p> <p>Need short and long term assessments, local and statewide case studies</p> <p>Data needed to better model inter-industry relationships and other uncertainties</p>
Wang, Chen, Jha, and Rogers	Yes	2014	History of shale gas and review of literature	<p>Reviews several studies of economic impacts, shows variability across shale basins</p> <p>Indicates needs to manage environmental and sustainability issues to help ensure economic benefits can be obtained</p>
Rousu, Ramsaran, and Furlano	Yes	2015	Review of literature on economic impacts, prescriptions for future research	<p>Finds bias in some established literature</p> <p>Reviews literature on direct economic activity, and literature attempting to capture externalities</p> <p>Questions assumptions in IMPLAN, and selection of multipliers</p> <p>Suggests studies should explicitly discuss price of natural gas and how it is accounted for in studies</p>

Economic impact studies of Marcellus Shale development have primarily relied on county level data, although the scale of analysis (state, county, local, resource basin) has varied. Similarly, reports use a variety of economic indicators to estimate impacts including employment, wages, tax revenue,

royalties, etc. These studies have generally found positive economic impacts associated with development, although the magnitude and location of impact varies significantly.

Historical and contemporary economic factors may help account for this variation; however, the unevenness of impacts within and across communities requires the attention of policy makers as individuals unevenly experience benefits and costs of the industry. Recent studies have found that differences in results may be attributable to differences in data and modeling choices; these choices of whether to measure industry activity by production rates or wells drilled, for example, can have significant impacts on results. Therefore, no one indicator can be sufficient to plan and anticipate economic impacts across the commonwealth. However, as this research indicates, multiple indicators and findings can provide a useful overview of impacts from which to develop policy.

The studies reviewed were selected from key term searches in Web of Knowledge. These key terms included combinations of “Marcellus Shale,” “Pennsylvania,” “Economic Impacts,” “Horizontal Hydraulic Fracturing,” “Economic Analysis,” “Employment,” “Wages,” “Compensation,” and “Taxes.” Studies were chosen from the search results based on the inclusion of and emphasis placed upon findings regarding Pennsylvania’s economic impacts from Marcellus Shale development. However, as so much of the literature to date has not been peer reviewed, additional works were then selected from those referenced in the Web of Knowledge search results and from the authors’ expertise. This report summarizes the findings of these studies after providing some context of the recent changes to Pennsylvania’s economy, the circumstances under which Marcellus Shale development has occurred.

ii. Recent Analysis of Economic Changes Associated with Marcellus Shale Development in Pennsylvania

Only recently have the data allowed for longitudinal study of the impacts associated with Marcellus Shale development. As this data have become available more studies have been published

within the peer-reviewed literature. This report provides some background information on the broader context of changes within the Pennsylvania economy over the last decade.

a. Economic changes in the PA economy

If and to what extent Pennsylvania economies will be positively impacted by Marcellus Shale development has been of significant public policy interest. Many of the counties home to the development activity had experienced population losses or very slow population growth in the decades prior to activity occurring, which likely affected how residents there viewed the economic development potential of Marcellus Shale.

As Marcellus Shale development is a new economic activity, the industry has been framed as potentially a way to generate positive employment and income changes in rural areas whose economies have historically been struggling. Measuring this impact, however, is not straightforward; broader changes to the state and national economies, the spatial and temporal complexity of the industry, and major data limitations make analysis more challenging.

Since 2007, Pennsylvania has experienced several significant changes to its economy. Like most parts of the country, the economic recession beginning in late 2007 negatively impacted Pennsylvania. Unemployment rates suffered (CWIA, 2009) peaking in 2010 at 8.4 percent (BLS, 2015a; 2015b; 2015c; 2015d; 2015e; 2015g) (seasonally adjusted). These rates have begun to return closer to pre-recession levels; as of June 2015, Pennsylvania's unemployment rate was 5.4 percent (BLS, 2015f), in comparison to Pennsylvania's unemployment rate in 2007 of 4.5 percent (BLS, 2015g). Similarly, Pennsylvania experienced a decline in overall employment until 2011, when employment began to rise (Table 2).

Table 2: Statewide Changes in Employment, 2007- 2014

Year	Wells Drilled	Full-time and Part-time Jobs	Rate of Change
2007	116	7,258,378	
2008	332	7,276,472	0.25%
2009	818	7,106,916	-2.33%
2010	1,599	7,104,396	-0.04%
2011	1,957	7,201,592	1.37%
2012	1,351	7,262,251	0.84%
2013	1,207	7,325,659	0.87%
2014	1,371	7,399,728	1.01%

Source: U.S. Bureau of Economic Analysis, Pennsylvania Department of Environmental Protection

Statewide trends, however, are not always indicative of local and county-level economic patterns. It is within this context that researchers have tried to evaluate the economic changes associated with Marcellus Shale development. The economic recession coincided with the beginning of significant increases in the pace and intensity of development in certain areas of the state. Though studies show that the most positive economic changes are in the counties with the highest levels of drilling (O’Coonahern, Hardy and Kelsey, 2014; Hardy and Kelsey, 2015), the spatial variation of the benefits within these counties are questions researchers are still working to understand.

These questions are particularly salient as development of new wells has not been spatially uniform over the last decade of development across the Marcellus Shale region of Pennsylvania. Of Pennsylvania’s 67 counties, 39 have had at least one well drilled as of January 1, 2015, but just six counties (Bradford, Washington, Susquehanna, Lycoming, Greene, and Tioga) account for more than 71 percent of total, unconventional wells drilled. The pace of development across heavily drilled counties has similarly not been even, as some initially rapid and densely drilled counties have experienced a decline in the recent establishment of wells, in part, due to the major drop in natural gas prices (see, for example, EIA, 2015). Conversely, some counties continue to experience an increase in the number of wells drilled.

In the available literature, key questions driving research include how many jobs are being created by Marcellus Shale development, the compensation associated with Marcellus Shale related-

jobs, how Marcellus Shale development impacts local tax bases, and how Marcellus Shale development impacts local communities through leasing and royalty payments, among others. These questions have both spatial dimensions (are benefits going to local communities or elsewhere? And who within communities benefits?), and temporal dimensions (when are benefits occurring and how long will they last?) that need to be considered. These recent studies provide relevant information to policy makers, the results of which are reviewed below.

2. Economic impacts: Employment and Compensation, Leasing and Royalties

Two key areas in which academic research has tried to estimate impacts are employment and compensation, and leasing and royalties. The most recently produced, peer-reviewed economic studies show employment impacts are smaller than early industry-funded studies suggested. Additionally, some of these studies indicated that benefits from leasing and royalties may be greater than those experienced by employment. The details of these studies are discussed in more depth below.

This literature also revealed two significant factors necessary for interpreting these studies. First, impacts vary geographically, even within counties of similar development activity. Second, benefits are uneven, which significantly impacts whether or not local rural economies positively benefit. These differences include: who owns mineral rights and where they are from, and who, and from where, individuals are being employed. Tables 3 and 4 summarize this literature, the details of which are described in the next sections.

i. Employment and Compensation

Table 3: Economic Impacts Studies: Employment, Wages, Total impacts

Authors	Peer-reviewed	Date	Scope	Significant Findings
Considine et al.	No	2009	Economic impacts, employment, PA Study was funded by the Gas Industry	~ 29,000 Marcellus jobs in PA in 2008
Considine et al.	No	2010	Economic impacts, employment, PA Study was funded by the Gas Industry	~44,000 Marcellus jobs in PA in 2009 Uses expected production data
Kelsey et al.	No	2011	Economic development, employment, landownership, PA Study was funded by state government	Positive economic impacts in localities with well-drilling 9,372 direct and indirect jobs, 23,385-23,884 total employment in 2009 associated with drilling \$3.1-\$3.2 billion increase in labor income and value-added in 2009 Difference with Considine et al. 2010 partially attributable to more accurate data on land ownership, and taking into account spending of leasing, royalty and wage dollars
Brundage et al.	No	2011	Employment, workforce assessment, PA Study was funded by state government	Most jobs created during the drilling and completion stages of the well 8,735 full-time jobs created in 2009
Costanzo and Kelsey	No	2012	State income and sales tax collections, by county, PA	Positive economic impacts, especially in counties with significant activity (90+wells) Variation among counties with similar level of drilling Positive impacts to local retail, rents, royalties and leasing
Weber	Yes	2012	Employment and income; CO, TX, WY w/ PA comparison	Empirical estimates and input-output models are necessary for context-specific decision making by policy makers Results significantly lower than Considine et al. 2010 IMPLAN approach Captures economic impacts over several years to capture more stages of production, difference-in-difference approach
Kelsey, Hardy, Glenna, and Biddle	No	2013	Economic benefits, focus on four highly drilled PA counties	Includes Washington, Greene, Lycoming, and Bradford counties

				Impacts vary by drilling intensity
				Increases to employment in mining sectors, but slight increases to wages, variation among study counties in other economic benefits
O'Coonahern, Hardy, and Kelsey	No	2014	State income and sales tax collections, by county,	<p>Impacts are most seen in counties with the most well development (90+ wells)</p> <p>2007 - 2011, counties with 90+ wells only experienced 1.4% positive average change in gross compensation</p> <p>Indications that development has larger effect on total wages received by county residents than number of employed county residents</p>
PA Center for Workforce Information and Analysis (CWIA)	No	2011-2014	Employment estimates, PA	<p>Data from Quarterly Census of Employment and Wages from Bureau of Labor Statistics</p> <p>Assumes all employment in core and ancillary sectors is related to Marcellus Shale activity.</p> <p>~218,000 to 234,000 total employment, 2011 through 2014</p>
PA Center for Workforce Information and Analysis (CWIA)	No	2015	Employment estimates, PA	<p>Used IMPLAN to estimate employment in ancillary sectors (rather than assuming all ancillary sector employment is Marcellus-related)</p> <p>Ancillary industries not included in estimate</p> <p>~89,000 direct, indirect, and induced employment</p>
Hardy and Kelsey	Yes	2015	Local income, rents, royalties, county level, PA	<p>Impacts more significant in rents and royalties than compensation and employment</p> <p>Variation in counties of similar drilling intensity</p>
Munasib and Rickman	Yes	2015	AK, PA, ND net economic impacts	<p>Questions input-output models</p> <p>Finds no statically significant employment impacts from Marcellus Shale</p>
Paredes, Komerek, and Loveridge	Yes	2015	Income and employment, PA	<p>Little evidence of impacts to income</p> <p>Employment impacts found are likely temporary, as they are associated with the drilling of a well</p>
Wrenn, Kelsey, and Jaenicke	Yes	2015	Employment, income to country residents, PA	<p>Modest positive effects to employment.</p> <p>Employment impacts on county residents are much smaller, suggesting many of the new jobs go to non-county residents</p> <p>Indicates the importance of measuring for migratory labor</p>

The development of the shale gas industry has been associated with anticipated gains to employment and compensation in parts of the commonwealth. The shale gas industry requires a

workforce to engage in activities such as leasing and land acquisition, well pad and pipeline construction, and well drilling and completion. Additionally, it has been anticipated that gas workers, either hired from the area, or coming into the area from elsewhere, would increase demands for services generating indirect and induced employment in construction, hospitality, and retail. Industry demand for workers can affect local economies by increasing the number of local people working and by increasing the number of hours worked by local employees. This could potentially increase local wages if the labor market tightens and businesses have to compete to gain and retain their employees.

Since 2010, the Pennsylvania Department of Labor's Center for Workforce Information and Analysis (CWIA) has published monthly reports to chart changes to employment and wages from Marcellus Shale development across several related economic sectors (these monthly reports were officially entitled, Marcellus Shale Fast Facts, starting in 2011). These numbers were consistently very high, around 229,000 jobs, in part because they included total employment in these related sectors, even though not all establishments within the sectors were involved in shale gas industry development. In June 2015, CWIA released a new calculative approach that found that more than 33,000 people were directly employed in oil and gas (CWIA 2015b), and around 56,000 indirect and induced jobs were associated with Marcellus Shale Development. Therefore, more than 89,000 jobs, in total, were attributable to shale gas development (CWIA, 2015a; 2015b). These new estimates are starkly different from early industry funded studies, but more consistent with academic economic research over the last 6 years (Considine et al., 2009, 2010; Kelsey et al., 2011).

Several reports have recently been published within the peer-reviewed literature examining how employment and compensation associated with development has impacted Pennsylvania. Paredes, Komarek, and Loveridge (2015) used a statistical method of analysis called "propensity score matching," and panel data techniques to estimate the income and employment attributable to Marcellus Shale development within Pennsylvania counties. These methods attempt to control for other factors that

would affect changes in employment. While the researchers found no significant impacts to income, they did find modest impacts to employment, effects they expect to be temporary. Their analysis also found no spillover effects with respect to income. However Paredes, Komarek and Loveridge (2015) largely did not account for the significant differences in the scale of drilling across Pennsylvania counties and analyzed a period in which most drilling was concentrated in just a few counties. By contrast, Wrenn, Kelsey, and Jaenicke (2015) used a different statistical method of controlling for other factors, called the “triple difference model,” to account for the number of wells drilled in their analysis of BEA and state income tax data. They found that drilling a well had a slightly positive impact on county resident income, but also found indications that county resident income was significantly lower than non-resident income. Additionally, their analysis found job growth to be positive, but modest.

These studies suggest that any impacts to employment and compensation from shale gas development are modest. Key issues that need to be closely considered when interpreting employment numbers include how much of employment activity involves local workers, how much involves non-local workers coming temporarily into the community, and how employment may change through the life cycle of shale gas development.

ii. Leasing and Royalties

Table 4: Economic Impacts Studies: Leases and Royalties

Authors	Peer-reviewed	Date	Scope	Significant Findings
Considine et al.	No	2010	Economic impacts, employment, PA	Surveys industry, estimates leases and royalties (in thousands) in 2008 \$22,183; 2009 \$54,683; planned 2010 \$252,463; planned 2011 \$633,135 Expects "royalties will dominate payments to land owners, eventually exceeding lease and bonus payments." Industry funded study
Kelsey et al.	No	2011	Economic development, employment, landownership, PA	~ 51% of land in Marcellus counties owned by county residents; 25% owned by persons living elsewhere in PA; 7.7% owned by persons living outside PA; 17% owned publicly; suggests large portion of the benefits immediately leaves counties Where leasing and royalty dollars go has a significant effect on estimates of impacts
Costanzo and Kelsey	No	2012	State income and sales tax collections, by county, PA	Positive economic impacts, especially in counties with significant activity (90+wells) Variation among counties with similar level of drilling Positive impacts to local retail, rents, royalties and leasing
Kelsey, Metcalf and Salcedo	No	2012	Leasing and royalty dollars, 'voice' in decisions about development	Small number of residents benefit from leasing and royalty dollars; 90% of local landowners will receive just over 11% of income from leasing and royalty dollars Just under 50% of local benefit will go to 10% of landowners; Nearly 40% of benefit will go to non-resident landowners and public sector
Kelsey, Hardy, Glenna, and Biddle	No	2013	Economic benefits, focus on four highly drilled PA counties	Includes Washington, Greene, Lycoming, and Bradford counties; majority of the income increases were in Lease and Royalty income, 2007-2010
O'Coonahern, Hardy, and Kelsey	No	2014	State income and sales tax collections, by county	Impacts are most seen in counties with the most well development (90+ wells); some economic benefits go to local residents, significant increases to rents and royalties, varied among counties Greater increases in lease and royalty income in northeast than in southwest Benefits may have peaked for many counties
Hardy and Kelsey	Yes	2015	Local income, rents, royalties, county level, PA	Increases in lease and royalty income exceed impacts to local employment and compensation in high drilling counties Large increase in highest drilled counties (460.8%); smaller in counties without wells (15%); Summed income on tax returns as rents, royalties, patents, and copyrights in 90+ well counties exceeded \$2 billion (2007 dollars), 2007-2010 Small percentage of residents in drilled counties receive lease and royalty income

Other studies of economic impacts have estimated how Marcellus Shale development activities, such as land acquisition through leasing agreements, and royalties from producing wells have economically impacted communities. Leasing and royalties have the potential to be significant because they can increase the dollars flowing through communities by increasing the income of local residents, and enabling local residents to spend more within their localities. The results of these studies generally show positive impacts from leasing and royalties that are unevenly felt. Further, these studies show that leasing and royalties impacts at the county level can be significantly greater than those from employment and compensation (Hardy and Kelsey, 2015).

Leasing and royalty benefits can impact the income of mineral rights owners. However, Kelsey et al. (2009) estimated that approximately 51 percent of the land within counties is owned by county residents, 25 percent of land is owned by people living in other counties within Pennsylvania, and nearly 8 percent of land is owned by people living outside of the commonwealth. This means that many benefits would go to persons not living locally in the counties with Marcellus Shale activity.

Not all landowners own their mineral rights. Mineral rights were commonly severed from surface rights during several previous coal and natural gas booms in Pennsylvania, particularly in the southwest part of the commonwealth. The difference in positive impacts from leasing and royalties felt in the northeast region and the southwest region could be attributable to these historical factors that make landowners in the southwestern region less likely to own their mineral rights (O'Coonahern, Hardy, and Kelsey, 2014). Additionally, income from leasing and royalties is often highly concentrated among a relatively small number of landowners. Kelsey, Metcalf and Salcedo (2012) found that nearly 50 percent of the land in high drilling counties is owned by the top 10 percent of local landowners, with a significant remainder being owned by people living outside the counties. This would suggest that lease and royalty dollars are similarly highly concentrated among a small share of local residents.

Where benefits are felt also depends on the level of activity that an area is experiencing. O’Coonahern, Hardy, and Kelsey (2014) found positive changes to personal incomes in counties with Marcellus Shale development, particularly in counties with the highest level of drilling (90 or more wells). From 2007 to 2010, Hardy and Kelsey found a 460.8 percent increase in rents, royalties, patents, and copyrights income in the most drilled counties during a period when counties without wells experienced far smaller increases of around 15 percent. Additionally, increased income reported on tax returns as rents, royalties, patents, and copyrights in counties with 90 or more wells surpassed \$2 billion (in 2007 dollars) during that period. However, there is variation in the degree of impact felt, even among highly drilled counties (Hardy and Kelsey, 2015). Thus, impacts from leasing and royalties vary both between counties and within counties. These studies also found that benefits from leases and royalties may have peaked in many counties (O’Coonahern, Hardy, and Kelsey, 2014) due to the recent decline in drilling activity in some areas.

Benefits from leasing and royalty dollars are also related to if, how, where and when the additional income is spent. Kelsey et al. (2009) used survey data from two highly drilled counties to examine how much landowners were receiving by way of leasing and royalty dollars, and how and when leasing and royalty dollars were being spent. Their results indicated that more than 50 percent of both leasing and royalty dollars were saved or invested for later use, rather than being immediately spent.

Impacts from leasing and royalty dollars have spatial and temporal patterns that impact where the benefits are being felt. There is still very little research that has examined the impacts of this kind of income on individual spending and saving, local tax bases, etc., but this kind of income has the potential to have very significant local impacts over time as the saved dollars are eventually spent (Hardy and Kelsey, 2015). Despite this spatial variation, policy makers should be aware of the more pronounced positive impacts of leasing and royalties than employment and compensation, when considering policy.

3. Variation in findings: Degree of Impacts, Spatial and Temporal

Considerations

Variation has been a consistent finding across many studies that focused on employment and compensation, and leases and royalties. In their 2013 report, Kelsey et al. found positive economic benefits to employment across the four highly drilled counties studied, but that the degree of economic benefits varied greatly across the counties. Although more intensive drilling was associated with more economic benefits, these benefits varied among the counties. For example, net income increased in the northeast region, but fell in the southwest region. Population size and proximity to urban centers can also influence the experienced impacts. Additional positive benefits to businesses associated with Marcellus Shale development have been found, although there are indications that while revenues in these businesses have increased, the number of businesses has decreased (Hardy and Kelsey, 2015). This raises questions about which firms are surviving in the counties, whether consolidation is occurring, or if and why firms may be relocating.

These studies of economic changes have used a variety of techniques to examine impacts. In their study of economic impacts across several shale basins that include the Marcellus Shale, Munasib and Rickman (2015) controlled for expected economic growth absent shale fuel development. They suggest that this estimation enabled the researchers to understand the regional economic context and impact because it accounted for both potential negative and positive economic impacts, contrasting with other models that model only positive change (2015). Unlike other shale basins, they found no statistically significant impacts to economic growth in the Marcellus Shale.

While most studies examine county level changes, recent studies have also considered other spatial boundaries. For example, Cascio and Narayan (2015) examined the impacts to local labor forces in the commuting areas around shale development in plays across the United States, including the

Marcellus in Pennsylvania, finding that local activity increased high school dropout rates, as primarily young men may seek opportunities in the shale economy.

Overall, many studies found some positive impacts of Marcellus Shale development, although the magnitude of the positive benefit and the kind of economic impacts vary, from modest impacts from employment and compensation, to significant impacts from royalties and leases; however, not all academic studies find economic benefits. Furthermore, studies indicate that impacts will vary over time. For example, it appears that benefits from leasing may have peaked in several areas as the industry as moved in some areas from development to production stages, but also from royalties due to the noted decline in production rates after several years, and the influence of commodity markets, such as low prices for natural gas. This variation, however, needs to be considered in the context of the data used and modeling selections when interpreting the results of these studies.

i. Data and Methodological Limitations in Estimating Employment and Compensation

The availability of data to measure the economic changes associated with Marcellus Shale development has, until recently, limited longitudinal assessments. The additional data do not, however, overcome several critical limitations to capturing the economic changes directly associated with the industry. These limitations need to be considered when using these studies to make policy decisions, and indicate the need to use multiple measures of economic impact.

Most studies of economic changes from Marcellus Shale development rely on a variety of government data sources, including figures from the Bureau of Labor Statistics (BLS), the U.S. Census, and the Bureau of Economic Analysis (BEA). Used widely, the BLS uses employer reported figures to produce state and local quarterly reports of employment and wages. The U.S. Census's County Business Patterns (CBP) surveys business establishments using federal Employer Identification Numbers (EIN) and is a standard reference for county economic data. The U.S. Census's American Community Survey also

provides 1-, 3-, and 5-year employment estimates on a county-level basis. Although these agencies provide unique data sets, some of their data sets are mutually dependent. For example, BEA uses BLS data to derive its findings in its Quarterly Census of Employment and Wages (QCEW). CWIA uses QCEW data in its analyses. These government data are limited due to how the information is collected, estimated, and disseminated; for example, some county-level information about private establishments is not made available due to federal data disclosure rules. Additionally, QCEW uses the North American Industry Classification System (NAICS) that uses broad categories that capture the activities of the oil and gas industry more broadly, and not shale gas specific.

More broadly, a major limitation of these datasets for understanding Marcellus shale activity is that the data are collated by broad industry groupings (e.g. agriculture, mining, construction, transportation) without regard to what the workers within the sectors actually do; therefore there is no way to determine how many workers in the transportation sector, for example, are hauling water or other supplies for Marcellus shale development, and how many are hauling other products unrelated to the gas activity. Therefore, the data cannot be used directly to identify how many jobs are related to Marcellus shale activity.

The Pennsylvania Department of Labor's CWIA struggled with this identification problem in its reporting about shale gas development. For several years in its monthly Marcellus Shale report, CWIA simply reported the sum of total employment in the economic sectors with some relationship to Marcellus shale development, including construction, transportation, engineering services, testing laboratories, iron and steel mills, water supply and irrigation systems, sewage treatment facilities, and highway, and street and bridge construction, with an easily missed footnoted caveat that not all establishments in these sectors are involved in Marcellus shale. The result was public confusion about the employment impacts of the industry (see, for example, StateImpact, 2015).

Due, in part, to such inaccuracy and confusion, in June 2015, CWIA significantly changed its approach to counting workers, including restricting the count of employment to the six Marcellus shale “core” sectors (these include cured petroleum and natural gas extraction; natural gas liquid extraction; drilling oil and gas wells; support activities for oil and gas operations; oil and gas pipeline and related structures construction; and pipeline transportation of natural gas). In addition, it now explicitly compares the changes in employment in these sectors from the years prior to and after the onset of the activity, recognizing that there already were jobs in these sectors prior to Marcellus, and it uses the input-output model IMPLAN to estimate employment effects in the ancillary sectors.

In CWIA’s latest analysis, it found that direct employment in oil and gas is over 33,000, a three-fold increase since 2007 (CWIA, 2015b). When including indirect and induced employment in sectors that provide goods and services to the industry, and taking into account employment in the core sectors prior to Marcellus shale, CWIA reports an estimated more than 56,000 indirect and induced jobs associated with Marcellus Shale Development (CWIA, 2015a; 2015b). The new estimates are more consistent with academic studies, and are likely to present a more accurate picture of the number of jobs that the industry is responsible for creating in the commonwealth.

The federal data sources have difficulties addressing the spatial and temporal patterns characteristic of many direct jobs related to Marcellus shale activity. Data from BLS and BEA, which many studies use, rely on employer reporting about where their employees work, not where they live, and consider full-time and part-time employment together. These figures might not fully capture the extent of non-county resident workers present in the workplace or be representative of employment due to increases in only part-time work (Wrenn, Kelsey, and Jaenicke, 2015). Additionally, direct employment in shale gas development has been associated with flexible scheduling over days, weeks and months, where workers may work for several weeks or months, but then be off work for similarly long stretches of time. Thus, the available data may be less representative of economic impacts, may overestimate economic

impacts, or may present misleading representations of how shale gas development will impact the area over time due to the spatial and temporal characteristics of the industry (Wrenn, Kelsey, and Jaenicke, 2015).

ii. Limitations in Model Parameters

The indicator used to measure the industry's activity can create confusion, inconsistencies, and limitations in the estimation of employment and compensation. Several studies suggest that wells drilled, rather than production rates, is a better measure of drilling activity (e.g. Kelsey, Hardy, and Glenna, 2013) yet both measures have been used widely. Studies that have used wells drilled to establish drilling areas often attribute this choice to the higher number of employees that are required in the construction, drilling, and completions stages of development. Brundage et al. (2011) analyzed workforce needs, for example, showing that labor needs were concentrated during predrilling, drilling and construction periods, accounting for 98 percent of jobs, while only 2 percent of labor was needed for post-drilling activities. This means that an individual well will generate more employment during the time when it is being drilled than when it is producing. Other studies have used production data (e.g. Weber, 2012) to determine the intensity of activity within a given area, and may be a useful measure when considering the effects of royalty payments to mineral owners. The definition of intensity of activity in an area has an impact on many studies' findings that examine differences in economic changes.

Studies have worked with available data to try to best capture the spatial patterning of the industry. Several different attempts have been made to determine drilling boundaries and intensities. For intensities, these may include, as mentioned, resource basin estimates, wells drilled, or production rates. For boundaries of these areas, studies have used counties, regions, resource basins, or commuting areas, as the data allow. Some researchers have tried to understand how areas defined by research studies are influenced by the dynamics of adjacent areas. Some have indicated that studies should

evaluate and account for spillover effects (Wrenn, Kelsey, and Jaenicke, 2015), while others find no spillover effects or do not assess the impacts at all (Weber, 2012; Paredes et al., 2015).

Many studies that have been used to estimate employment figures have used input-output models, (Kay 2011; Kinnamon 2011), such as IMPLAN. Input-output models like IMPLAN enable researchers to estimate multiplier effects from economic activity, such as additional jobs created by industry purchasing from local suppliers, and from spending by employees. This allows researchers to examine Marcellus Shale development as embedded within multiple industries across various scales. Still, some of the IMPLAN-based studies and nearly every published review paper point to the limitations of this model; Kinnamon (2011) suggests that input-output models may overestimate the benefits of development. These studies also indicate that other models, such as a difference-in-difference approach, may present their own limitations.

As Rousu et al. (2015) caution, some studies suffer from bias and many insufficiently explain and justify the parameters they select. Rousu et al. (2015) have critiqued input-output models for the particular assumptions regarding multiplier effects (Rousu et al., 2015). Weber (2012) suggests that input-output models should be paired with empirical observations to account for the influence of long-term economic trends. To contrast his results with the IMPLAN models, Weber (2012) compared his empirical estimates for Marcellus Shale to Considine et al.'s (2010) industry-funded study. Weber found that 2,183 jobs in 2009 in Pennsylvania were attributable to Marcellus Shale development, in contrast to Considine et al.'s estimated 44,098 jobs during the same time period. Overall, while some studies still continue to use input-output models, they have tried to account for many of their limitations. Although most input-output studies have found some economic benefits associated with drilling activity, the kind of economic impacts and the magnitude of the economic impacts vary greatly among the studies largely due to differing assumptions used to build the models.

iii. Limitations in Estimating Impacts from Leases and Royalties

There are also limitations in the information available regarding impacts from leases and royalties. Kelsey et al. (2011) examined landownership to evaluate the proportion of county-resident and non-county resident surface ownership; there are few data resources to help estimate the number of landowners who own the mineral rights under the surface. Due to Pennsylvania's long history of resource extraction across several regions of the state, many landowners in some counties no longer own their mineral rights. However, as the data are limited to public records of individual property transactions, many of which may have occurred decades if not over a century ago, and are not available in an aggregated format, estimating who owns mineral rights and where those owners reside is very difficult (O'Coonahern, Hardy, and Kelsey, 2014).

Many studies rely on reported tax data at the state and federal level. However, these data sources are not always comparable and have limitations. State tax returns can include individual and joint returns; reported figures are also linked to the county residence of the filer, rather than the county in which the money was earned (Kelsey et al., 2013). Furthermore, state tax data do not provide information at a fine enough scale to reflect some of the temporal economic impacts of the industry associated with mineral rights ownership. State income tax data for leasing and royalties are reported under the category "rents, royalties, patents, and copyrights." Therefore, leases and royalties are not discrete reporting categories. However, the impacts of leases are likely to occur in a more contained time period than royalty dollars, which are connected to the production of wells (O'Coonahern, Hardy, and Kelsey, 2014).

Reviews of these studies have also identified limitations in the assumptions made within models that examine the magnitude of economic impacts. Studies may assume individuals receiving lease and royalty income spend it within the same year within Pennsylvania (such as Considine et al., 2009; 2010) although evidence from Kelsey et al. (2011) suggests that many who receive this kind of income save or

invest it within the first year. How to capture if and how these dollars are spent over time may also be connected to the continued development and productivity of extractive activity.

iv. Continuing Questions due to the Temporal Dynamics of the Industry

The industry is highly mobile and adaptive to changes in markets and availability of infrastructure, so these geographic patterns change over time. Notably, development peaked several years after the industry began in Pennsylvania, although some regions over time have continued to see intense development, while others have not. New wells, however, are not the only way that economic impacts are felt; rather royalties from producing wells also accrue economic benefits. Thus, key questions have not only been where development has been occurring and where it has been productive, but also how long development of new wells will continue and how long wells will be productive. Furthermore, as Brundage et al. (2011) indicated, drilling and completing wells create far more opportunities for employment and compensation growth than later stages of production. In contrast, the production stage, when the well is actively producing gas, has the ability to create greater impacts through payments of royalties. Consequently, understanding the productivity of wells over time is a significant factor estimating the economic impacts of development over time.

4. Continuing Questions due to Geographic Factors

The patterns of Marcellus Shale development present challenges to current methods of measurement. This report provides several descriptions of these geographic factors to indicate the complexity of identifying, analyzing, and interpreting economic impacts. These factors do not make analysis of economic impacts impossible, but rather create complex dynamics that researchers must attempt to estimate.

The report presents these challenges to indicate that policy makers need to assess data at multiple scales and sites of analysis. Measures of local economic impacts from Marcellus Shale

development should not be treated as representative of statewide trends. Differences between state and county level impacts and among counties suggest significant variability that needs to be examined further. Much policy is established within political boundaries, like townships and counties, but economic impacts often occur across these boundaries due to the spatial nature of the activity.

i. Variation in county-level analysis

Impacts can vary from county to county, even across counties with similar drilling intensity. For example, Kelsey et al.'s 2013 report found that counties with high levels of drilling experienced positive economic changes but that these changes are not uniform. Focusing on four highly drilled counties, the 2013 report found that counties experienced different positive and negative changes to total taxable income even as all counties experienced benefits from increases to employment and wages, particularly in the mining sector. Several other studies have found that counties with similar drilling intensities experience different kinds of positive impacts, and that the magnitudes of these impacts vary even within counties of similar development (Costanzo and Kelsey, 2012; O'Coonahern, Hardy, and Kelsey, 2014). Understanding the factors that contribute to these spatial differences is an area of research that is still emerging and includes: differing levels of local mineral rights ownership, participation in and characteristics of the local labor markets, and demographic factors such as age and economic status.

ii. Limits to County-level Analysis and Regional Analysis

Additionally, county-only analysis may not be the best measure of change given the spatial patterning of this extractive activity. A statewide analysis that aggregates total activity across counties can account for these shifting patterns of development, but misses the local nuance and variation within counties. While most studies have relied on county and state-level data to measure impacts, other new studies have used commuting zones to measure the impact of the labor market pulls on educational outcomes (Cascio and Narayan, 2015). Economic impacts are not necessarily limited to the county in which a well is located. Workers, equipment, and supplies move in between counties without the need

for duplication. Infrastructure, including storage yards and worker housing may be located in one county, but used to service several counties. Although some studies have accounted for the regional dynamics of shale gas employment (e.g. Wrenn, Kelsey, and Jaenicke, 2015), the scope of these geographic dynamics needs to be investigated further.

Evidence indicates that shale extraction has been concentrated in counties with high levels of recoverable gas, yet changes in the price of natural gas and other petroleum liquids, and the availability of pipelines, storage facilities, and processing locations, can also cause the intensity and nature of extractive activities to vary within and across counties. Some counties have consistently had high levels of drilling activity, while others have experienced slowing paces of development over time. More than half of the counties in Pennsylvania have at least experienced some Marcellus Shale development, yet their experiences (and the economic impacts) are very different than in counties with high levels of drilling activity. Policy makers should use caution when using evidence from a few highly drilled counties, as they are likely not representative of all counties.

Once the initial investment in establishing infrastructure in a region has been made, firms can more easily relocate to adjust to changing economic circumstances. Further, the regional nature of production means that economic impacts may accrue in areas with few or no wells but where worker housing, warehouses, and equipment service/storage services are located, including some New York counties bordering Pennsylvania (see, for example, Philadelphia Inquirer, 2010; and Crook, 2011).

Although most Marcellus Shale development has occurred in rural areas, a significant amount is located in the Pittsburgh metropolitan area. Few studies of economic impact have directly accounted for urban-rural factors, as they represent very different kinds and scales of economies. Proximity to urban locations may also be a contributing factor to county-level differences that need to be explored further. Rural economies and labor markets across the commonwealth are themselves not uniform, and may be differentially impacted by Marcellus Shale activity.

One county-level measure is thus insufficient to estimate impacts to other counties and may not capture measurable impacts when regional scale dynamics have not been sufficiently considered. Additionally, one county-level indicator cannot be used to estimate impacts at the state level. Thus, it is possible that analyses of both regions and counties will be needed to best make policy determinations that can capture these geographic factors of the industry.

5. Summary

New peer-reviewed scholarship is emerging that uses longitudinal analysis to evaluate the economic changes associated with Marcellus Shale development. Generally, the literature finds positive but modest economic changes associated with Marcellus Shale development. However, what those impacts are, where they are, and their magnitude varies widely, although areas that have the largest number of wells drilled often experience the most positive benefits. Limitations to data and models can shape the results, especially as currently available data might not be collected in a way that best reflect the spatial and temporal patterning of the industry. Similarly, these analyses suggest important spatial variation of impacts across different scales of analysis that need to be considered further.

More research is needed to understand the dynamics of industry impacts at various scales beyond the county level, as well as at the sub-county level. This research highlighted equity issues concerning who is receiving the most economic benefits, with some studies finding that the most economic benefits may not be going to local residents and economies, and may be determined by other factors such as mineral rights ownership, educational attainment, employment status, and age and gender, considering many more direct jobs in the oil and gas industry are filled by younger, men. Finally, these studies are not able to account for costs of the industry in their analyses. Additional research will be needed to account for costs to social and environmental systems, in addition to costs to economies.

6. Policy Implications

New peer-reviewed literature on Marcellus Shale development's economic impact indicates that positive impacts are associated with the areas of highest drilling intensity, but that the impacts and their magnitude vary. Policy makers should be aware of the limitations of the data and modeling used in public policy decisions and consider using more than one study and indicator of economic impact that are specific to their policy needs. This review of the literature highlights two additional themes that policy makers should consider: Economic impacts will largely be short run, and employment impacts are generally modest.

i. Economic Impacts Will Largely Be Short Run

Economic impacts from Marcellus Shale development will be heavily influenced by the temporal dynamics of the industry. As the activities associated with drilling a well produces more jobs than later stages of development (Brundage et al., 2011) many economic impacts associated with employment and compensation are likely to occur only during the earliest stages of development. Thus, the modest gains in employment and compensation are likely to be only felt in the short term.

Far fewer jobs are required during the period when the well is producing, and economic benefits are more likely to be associated with royalty payments in those later stages. These payments, and subsequent benefits, will be subject to changes in commodity prices, flow rates from wells, and investment strategies of mineral rights owners, many of whom do not live in the county where activity is occurring. Additionally, distributed public funds collected through impact fee payments or a proposed severance tax, could provide short-term economic benefits to communities. However, these funds are also subject to the industry's temporal dynamics, as they rely on the pace of well development and production.

Decision makers should consider how to use these funds in ways that strengthen communities over time while acknowledging that economic impacts will likely only be short term. Increased revenues

from taxes, and impact fees/severance taxes should be used for public goods that do not require long-term availability of funds, and could be reserved for capital investments, used to cover the cost of development impacts or invested in one-time expenses. Caution should be used in applying funds towards long-term public services unrelated to the development, such as public education, for which costs will not decline in parallel with revenues as the drilling activity slows.

ii. Employment Impacts Are Generally Modest

Although many studies have found positive economic impacts from Marcellus Shale development, there is fairly strong consensus within academic studies that impacts to employment and compensation are modest. Further, employment and compensation may have less impact than income generated from leases and royalties; wells require many more jobs during the earliest stages of production, and far fewer in later stages of production, meaning the generated employment is not consistent over time.

The dynamics of the rural economies, which are the context of these modest gains in employment, matter to policy development. Given that well development is primarily occurring in small rural economies, the scope and scale of the industry may appear to be more significant than its actual impact on the local community. Policy makers should not consider employment as a long-term economic benefit of Marcellus Shale development, nor the most significant local economic benefit of development. Policy makers should consider who is most likely to be employed by the industry, considering that much direct employment goes to men, and how employment in the industry might impact educational attainment.

Finally, these studies are not currently able to account for social and environmental costs of Marcellus Shale development that may differentially impact certain populations. Thus decision makers should consider who benefits from development, both within counties, and between counties. The same consideration should be given to the costs of development. In developing policy, decision makers should

consider those who are adversely impacted by development, while also choosing appropriate measures that reflect the short-term nature of many economic benefits to support their communities fairly and into the future.

Report Authors

Arielle Hesse, PhD Student in Geography and Women's Studies
Timothy Kelsey, PhD, Professor of Agricultural Economics
Max Pohlman, Undergraduate Student

Other Research Team Members

Kathryn Brasier, PhD – Associate Professor of Rural Sociology
Leland Glenna, PhD – Associate Professor of Rural Sociology
Kai Schafft, PhD – Associate Professor of Educational Leadership & Director of Center on Rural Education and Communities
Shannon M. Monnat, PhD – Assistant Professor of Rural Sociology, Demography, and Sociology
Mark Suchyta – MS Student in Rural Sociology
Joshua Perchinski – MS Student in Rural Sociology
Raeven Faye Chandler – PhD Student in Rural Sociology and Demography
Max Pohlman – Undergraduate Student

Funding

This research was sponsored by a grant from the Center for Rural Pennsylvania, a legislative agency of the Pennsylvania General Assembly. The Center for Rural Pennsylvania is a bipartisan, bicameral legislative agency that serves as a resource for rural policy within the Pennsylvania General Assembly. It was created in 1987 under Act 16, the Rural Revitalization Act, to promote and sustain the vitality of Pennsylvania's rural and small communities. Information contained in this report does not necessarily reflect the views of individual board members of the Center for Rural Pennsylvania. For more information, contact the Center for Rural Pennsylvania, 625 Forster St., Room 902. Harrisburg, PA 17120, telephone (717) 787-9555; email: info@rural.palegislature.us, www.rural.palegislature.us.

References

- Alter, T.R., T.E. Fuller, and S.M. Smith. 2009. *Pennsylvania Road to Growth*. Pennsylvania Department of Labor and Industry. <http://extension.psu.edu/publications/ua455> Accessed 5 August 2015.
- Barth, J. 2013. The Economic Impact of Shale Gas Development on State and Local Economies: Benefits, Costs, and Uncertainties. *New Solutions* 23 (1) 85-101.
- Brundage, T. L., J. Jacquet, T.W. Kelsey, J.R. Ladlee, J. Lobdell, J.F. Lorson, L.L. Michael, and T.B. Murphy. 2011. *Pennsylvania Statewide Marcellus Shale Workforce Needs*. Williamsport, PA: Marcellus Shale Education and Training Center.
- Bureau of Labor Statistics (BLS). 2015a. Local Area Unemployment Statistics: Over-the-Year Change in Unemployment Rates for States: 2009-2010. <http://www.bls.gov/lau/lastch10.htm> Accessed 4 August 2015.

Bureau of Labor Statistics (BLS). 2015b. Local Area Unemployment Statistics: Over-the-Year Change in Unemployment Rates for States: 2010-2011. <http://www.bls.gov/lau/lastch11.htm> Accessed 4 August 2015.

Bureau of Labor Statistics (BLS). 2015c. Local Area Unemployment Statistics: Over-the-Year Change in Unemployment Rates for States: 2011-2012. <http://www.bls.gov/lau/lastch12.htm> Accessed 4 August 2015.

Bureau of Labor Statistics (BLS). 2015d. Local Area Unemployment Statistics: Over-the-Year Change in Unemployment Rates for States: 2012-2013. <http://www.bls.gov/lau/lastch13.htm> Accessed 4 August 2015.

Bureau of Labor Statistics (BLS). 2015e. Local Area Unemployment Statistics: Over-the-Year Change in Unemployment Rates for States: 2013-2014. <http://www.bls.gov/lau/lastch14.htm> Accessed 4 August 2015.

Bureau of Labor Statistics (BLS). 2015f. Local Area Unemployment Statistics: Over-the-Year Change in Unemployment Rates for States: 2014-2015. <http://www.bls.gov/web/laus/laumstch.htm> Accessed 4 August 2015.

Bureau of Labor Statistics (BLS). 2015g. Local Area Unemployment Seasonally Adjusted Statistics: Pennsylvania, 2005-2015. <http://data.bls.gov/pdq/SurveyOutputServlet>. Accessed 28 October 2015.

Cascio, E. and A. Narayan. 2015. Who Needs a Fracking Education? The Educational Response to Low-Skill Biased Technological Change. *NBER Working Paper* 21359. <http://www.nber.org/papers/w21359> Accessed 5 August 2015

Considine, T., R. Watson, R. Entler, and J. Sparks. 2009. The Emerging Giant: Prospects and Economic Impacts of Developing the Marcellus Shale Natural Gas Play.

Considine, T., R. Watson, and S. Blumsack. 2010. The Economic Impacts of the Pennsylvania Marcellus Shale Gas Play: An Update. <http://marcelluscoalition.org/wp-content/uploads/2010/05/PA-Marcellus-Updated-Economic-Impacts-5.24.10.3.pdf> Accessed 5 August 2015

Costanzo, C. and T.W. Kelsey. 2012. Marcellus Shale and Local Collection of State Taxes: What the 2011 Pennsylvania Tax Data Say. *CECD Research Paper Series: Strengthening Pennsylvania's Communities*.

Center for Workforce Information and Analysis (CWIA). 2009. Economic Review of Pennsylvania 2008. http://www.doleta.gov/Programs/2008ReportsAndPlans/Economic_Analysis_Reports/PA.pdf Accessed 4 August 2015.

Center for Workforce Information and Analysis (CWIA). 2012. Marcellus Shale Fast Facts: November 2012 Edition.

Center for Workforce Information and Analysis (CWIA). 2015a. IMPLAN Analysis of Core Shale Industries.

Center for Workforce Information and Analysis (CWIA). 2015b. Marcellus Shale Update.

Crook, Ann B. 2011. Natural Resources and Revenue Generation: Natural Gas. Elmira, New York: Elmira Corning Regional Airport. Available on-line at: http://www.aci-na.org/static/conferences/enviro%202011/Monday/Ann%20Crook_27%20JUN%2011%20ACI%20Environmental%20Affairs.pdf Accessed September 8, 2015.

Hardy, K. and T.W. Kelsey. 2015. The Shale Gas Economy in the Northeast Pennsylvania Counties. *Natural Resource Management and Policy* 45: 71-91.

Kay, D. 2011. The Economic Impacts of Marcellus Shale Gas Drilling. What Have We Learned? What are the Limitations? *Working Paper Series: A Comprehensive Economic Impact Analysis of Natural Gas Extraction in the Marcellus Shale*.

Kelsey, T.W., M. Shields, J.R.Ladlee, M.Ward, T.L. Brundage, J.F. Lorson, L. Michael, and T.B. Murphy. 2011. Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009. Williamsport, PA: The Marcellus Shale Education & Training Center.

Kelsey, T.W., K. Hardy, L. Glenna, and C. Biddle. 2013. Local Economic Benefits Related to Marcellus Shale Development. *The Marcellus Impacts Projects Report #8*.

Kelsey, Timothy W., Alex Metcalf, and Rodrigo Salcedo. "Marcellus Shale: Land Ownership, Local Voice, and the Distribution of Lease and Royalty Dollars." Center for Economic and Community Development White Paper Series. University Park, PA: Penn State University, 2012. 15 pages.

Kinnamon, T.C. 2011. The economic impact of shale gas extraction: A review of existing studies. *Ecological Economics* 70: 1243-1249.

Munasib, A. and D.S. Rickman. 2015. Regional economic impacts of the shale gas and tight oil boom: A synthetic control analysis. *Regional Science and Urban Economics* 50: 1-17.

O'Coonahern, K. Hardy, and T.W. Kelsey. 2014. Marcellus Shale and Local Economic Activity: What the 2013 Pennsylvania State Tax Data Say. *CECD Research Paper Series: Strengthening Pennsylvania's Communities*.

Paredes, D., T. Komarek, and S. Loveridge. 2015. Income and employment effects of shale gas extraction windfalls: Evidence from Marcellus region. *Energy Economics* 47: 112-120.

Philadelphia Inquirer. 2010. Marcellus Shale sends short-line railroad booming. Available on-line at: http://www.philly.com/philly/news/special_packages/inquirer/marcellus-shale/20100321_Marcellus_Shale_sends_short-line_railroad_booming.html Accessed September 8, 2015.

Rousu, M., D. Ramsaran, D. Furlano. 2015. Guidelines for Conducting Economic Impact Studies on Fracking. *International Advances in Economic Resources* 21: 213-225.

StateImpact. 2015. Under Wolf, Pennsylvania continues publishing disputed Marcellus job figures. April 7, 2015. Available on-line at: <https://stateimpact.npr.org/pennsylvania/2015/04/07/under-wolf-pennsylvania-continues-publishing-disputed-marcellus-job-figures/> Accessed September 8, 2015.

U.S. Energy Information Administration. 2015. U.S. Crude Oil and Natural Gas Proved Reserves, 2014. Washington, D.C.: U.S. Energy Information Administration.

Wang, Q., X. Chen, A.N. Jha, and H. Rogers. 2014. Natural gas from shale formation – The Evolution, evidences and challenges of shale gas revolution in United States. *Renewable and Sustainable Energy Reviews* 30: 1-28.

Weber, J. 2012. The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming. *Energy Economics* 34: 1580-1588.

Wrenn, D.H., T.W. Kelsey, and E.C. Jaenicke. 2015. Resident versus Non-Resident Employment Impacts Associated with Marcellus Shale Development. *Agriculture and Resource Economics Review*.

**The Center for Rural Pennsylvania
Board of Directors**

Chairman
Senator Gene Yaw

Vice Chairman
Representative Garth D. Everett

Treasurer
Representative Sid Michaels Kavulich

Secretary
Dr. Nancy Falvo
Clarion University

Dr. Livingston Alexander
University of Pittsburgh

Stephen M. Brame
Governor's Representative

Dr. Michael A. Driscoll
Indiana University

Dr. Stephan J. Goetz
Northeast Regional Center for Rural Development

Dr. Timothy Kelsey
Pennsylvania State University



The Center for Rural Pennsylvania
625 Forster St., Room 902
Harrisburg, PA 17120
Phone: (717) 787-9555
www.rural.palegislature.us
1P0317