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An Economic Impact Report of Shale Gas Extraction in Pennsylvania with Stricter Assumptions

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ABSTRACT

During the onset of shale gas development, a variety of economic impact studies were released through the 'gray literature' without formal peer review. In a review of six such impact reports, Kinnaman (2011) speculates about several major issues worth scrutiny arising with analysis using input-output models. His central critique focuses on the assumptions of how industry spending is represented and how leasing and royalty dollars are spent. In this study, we use detailed county records and results from a survey to directly address these assumptions, and compare our results to the findings in an economic impact study of Marcellus Shale development in Pennsylvania which Kinnaman critiqued. Our results, which are only about 52% of the prior study, confirm his supposition that some ex ante studies use unrealistic assumptions which lead to gross overestimates of the impacts.

1. Introduction

Due to the massive potential of the Marcellus Shale Natural Gas play, several ex ante economic impact reports about Marcellus drilling appeared early in its development. Although these studies have been widely cited by the media and policymakers, none were peer reviewed. Instead, most ex ante shale gas impact analysis has been released through university "white papers" or consulting firms. One consequence is that estimates of the play's economic and fiscal impacts vary widely, even when using similar modeling frameworks. One likely reason for these differences is that existing studies employ a wide-ranging set of assumptions that can dramatically affect the findings. Because policy makers and voters consider such studies when making their own decisions regarding their support for drilling activities, it is essential that any analysis uses as realistic of a set of assumptions as possible.

In a review of six impact reports of shale gas development, all in the "gray literature", Kinnaman (2011) identifies several major issues worth scrutiny. Most concerns stem from the fact that these studies typically use input-output (IO) models. Accordingly, the results are sensitive to how exogenous changes to final demand are modeled. Kinnaman's central critique focuses on the assumptions of how industry spending is represented and how leasing and royalty dollars are spent. In the six shale impact reports identified, authors initiated their simulations through a wide range in related spending patterns.

Kinnaman dedicates much of his paper to closely examining Considine et al.'s two studies of the economic impacts of Marcellus Shale in Pennsylvania: *Emerging Giant* (2009) and its *Update* (2010). These studies are particularly important because they were widely referenced in the policy debate in Pennsylvania surrounding regulation and taxation as the nascent industry started to expand. Although the *Emerging Giant* study was released under Penn State letterhead, it sparked a firestorm of criticism because it initially was not clearly identified as being industry sponsored (See, for example, Bogle, 2011; StateImpact, 2012).

Because the *Emerging Giant* study was so controversial, Pennsylvania's Department of Community and Economic Development sought an alternative study of the economic impacts of Marcellus Shale development in the Commonwealth, and provided funding for the research we describe in this paper. In our work we use detailed county records and results from a survey in two Marcellus counties to directly address two of Kinnaman's three concerns with the Considine reports: 1) the spatial distribution of the owners of the land receiving leasing and royalties and 2) how households are spending those dollars. We also consider the effects of an industry that traditionally employs many transient laborers, whose spending patterns differ from Pennsylvania residents. Doing this allows us to specifically identify how those assumptions affect the results, a major concern of Kinnaman, leading to a more grounded estimate of the potential economic impact of shale gas development in Pennsylvania.

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2. Marcellus Shale Background

As the birthplace to the oil industry, Pennsylvania has a long history of resource extraction. Although oil production peaked long ago, recent advances in unconventional drilling technology (particularly hydraulic fracturing) rendered the Marcellus Shale gas play economically viable. From 2000 to 2006, approximately 50 unconventional wells were spudded statewide. But then the industry established a foothold, and annual activity steadily increased. In 2007 112 wells were spudded and 332 were spudded in 2008. Annual growth continued to accelerate, peaking at 1960 spudded wells in 2011. Concomitant gas production from unconventional wells follows a strong upward trend, with roughly 1.9 million mcf extracted in 2007 and booming to 175.2 million mcf in 2009. In 2011 production surpassed 1 billion mcf, significantly outpacing the 262 million mcf produced from conventional wells. In 2013, about 3.3 billion mcf were extracted. The number of wells spudded has dropped since the 2011 peak, largely due to falling natural gas prices, to 1351 in 2012, 1207 in 2013, and 1371 in 2014 (all data from Pennsylvania Department of Environmental Protection, 2015).[1]

Prior to the Marcellus boom, Pennsylvania's industry experience was limited to traditional extraction processes. One important consequence of the sudden growth in unconventional drilling was a significant dearth of information to aid local and state policy makers charged with overseeing the industry's expansion. This was especially true in counties with little history of gas and oil development. For example, Bradford and Tioga counties each had over 100 unconventional gas wells spudded in 2009; yet before that neither county had a particularly robust conventional gas industry. Because of this, local policy makers found themselves needing timely, credible information to assess and manage local industry growth.

Despite an urgent need, relevant academic studies were scant during the early years of Marcellus development. The substantial lag between the peer review process and knowledge dissemination compounded the problem, forcing information seekers to turn to the so-called gray literature. Because these studies were not peer reviewed, the critical assumptions underlying them might be unrealistic and unscrutinized.

3. Literature Review

3.1. Impact Reports and Kinnaman's (2011) Critique

In addition to the aforementioned critiques of the expenditure assumptions of prior shale gas related economic impact reports, Kinnaman (2011) raises concerns about the general use of the commercial input-out-put modeling software and database package known as IMPLAN (IMpact analysis for PLANning). One levied criticism is that IMPLAN's unconstrained Leontief production functions do not account for the potential effects of crowding out: when a local economy is at full employment, productive resources and employees may simply shift from one use to another, limiting the positive, productive impact of the shale gas industry. Accordingly, Kinnaman argues "the economic impacts estimated in both reports (Considine et al. 2009 and 2010) are only possible in an economy operating below full employment" (p 1247).

In their telling of the history of US regional and rural development economic research, Irwin et al. (2010) are similarly cautious of IO modeling in general and IMPLAN in particular. Among their criticisms is inadequate modeling of inter-regional capital and labor flows and the temptation to politicize the results, both of which can lead to overstated impacts. While not dismissing IO methods completely, the authors suggest alternative modeling frameworks that can address both conceptual and modeling shortcomings.

Despite criticisms levied on IO models they remain a fixture in economic policy analysis and are used to justify the allocation of millions of dollars of public and private expenditures (Scott and Johnson, 1998). IMPLAN is especially prominent because it is user-friendly and affords researchers the ability to easily generate easy-to-understand reports at the state or county-level. Kinnaman (2011) warns that assumptions are critically important to these reports, however, as the greater reach an impact report has, the more damage that can be done by questionable results. As IMPLAN based analysis likely skews true economic impacts upward, the onus is on the researcher to put restrictions in place that will provide reasonable estimates for the end users, and to clearly explain the limitations of their analysis.

Kinnaman (2011) suggests three strategies for correcting the shortcoming of the six critiqued reports, and the Considine et al. (2009 and 2010) reports in particular: "including better assumptions of when and where households spend windfall gains, clarifying the process used to determine where suppliers to the industry and royalty earning households are located (in state or not), and developing a more appropriate econometric model to estimate well drilling as a function of current price and other relevant variables" (Kinnaman, 2011 p. 1249).

Scrutinizing these suggestions reveals the possibly large effects the first two can have on an economic impact report. With respect to the temporal aspects, consumption smoothing means households are unlikely to spend the entirety of windfall gains the year they are received. Thus the economic impact will not be concentrated fully in the year of receipt, but rather will be spread out over multiple years, or perhaps decades. With respect to the spatial aspects, households receiving windfall gains have a multitude of options for *where* they spend. If this spending is on goods and services that are produced in Pennsylvania, then there is a positive economic impact in the state. However, if consumers and businesses spend on goods and services produced outside of the Commonwealth then there is a leakage, resulting in little or no local economic impact.

From a modeling perspective, these suggestions highlight the importance of accurately capturing industry and household spending patterns. Because unconventional drilling practices are new to Pennsylvania, it is likely that most, or all of the industry's initial supply chain is located elsewhere. Accordingly, much of the sector's indirect economic effects happen outside the political geography of interest, especially in the early growth phase.[2] Related to this is the issue of the spatial distribution of leasing and royalty income recipients. Although the property is physically located in Pennsylvania, mineral rights owners may live in other states. When payments are made to residents of states other than Pennsylvania, a leakage occurs, resulting in no local impacts.

Of the economic impact reports focusing on Marcellus, the Pennsylvania reports by Considine et al. (2009 and 2010) have received the most attention. Both reports were sponsored by the Marcellus Shale Coalition, an industry lobbying group, though the 2009 report initially lacked any identification that it was industry funded. Considine et al. (2009) provided an outline of the Marcellus industry in Pennsylvania and estimated the industry's economic impacts using IMPLAN. Because the existing state IMPLAN tables did not reflect the Marcellus industry, the researchers introduced it using a process proposed by Miller and Blair (2009). As part of creating this new industry, Considine et al. surveyed 36 Marcellus firms about their spending activities, with 7 responding. The analysis is based on an estimated 364 Marcellus wells drilled in 2008.

From survey responses the authors estimated total industry spending of $3.09 billion. Of this amount, they estimated that nearly $2.95 billion (95%) occurred in Pennsylvania. The largest expenditure was payments to landowners, estimated at just over $2 billion–this was subsequently assumed to go entirely to Pennsylvania households, and be spent entirely in the year it was received. The primary findings of

[1] PA DEP database accessed 8/30/2015. As well data is continually revised, there might be small discrepancies based on access date. Figures may also vary from other sources such as Drilling Info.

[2] Over time firms may relocate to better serve the industry, in which case future spending would create a positive economic impact.