Energy Economics 34 (2012) 1580–1588

Contents lists available at SciVerse ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming ☆

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ARTICLE INFO

Article history:
Received 9 May 2011
Received in revised form 21 November 2011
Accepted 26 November 2011
Available online 21 December 2011

JEL codes:
Q32
Q33
O13

Keywords:
Shale gas
Resource extraction
Economic growth

ABSTRACT

Improvements in technology have made it profitable to tap unconventional gas reservoirs in relatively impermeable shale and sandstone deposits, which are spread throughout the U.S., mostly in rural areas. Proponents of gas drilling point to the activity's local economic benefits yet no empirical studies have systematically documented the magnitude or distribution of economic gains. I estimate these gains for counties in Colorado, Texas, and Wyoming, three states where natural gas production expanded substantially since the late 1990s. I find that a large increase in the value of gas production caused modest increases in employment, wage and salary income, and median household income. The results suggest that each million dollars in gas production created 2.35 jobs in the county of production, which led to an annualized increase in employment that was 1.5% of the pre-boom level for the average gas boom county. Comparisons show that ex-ante estimates of the number of jobs created by developing the Fayetteville and Marcellus shale gas formations may have been too large.

Published by Elsevier B.V.

1. Introduction

Improvements in drilling technology have made it profitable to exploit unconventional gas reservoirs in relatively impermeable media. In part because of the greater feasibility of tapping these new reservoirs through hydraulic fracturing – shooting a mix of water and chemicals into the formation – the Potential Gas Committee recently increased its estimate of gas reserves in the U.S. by 35%, the largest increase in the 44 year history of the committee's report (Colorado School of Mines, 2009). Long term projections of high energy prices suggest that the natural gas industry will have a persistent and growing influence on the economy in the many areas of the U.S. with large gas reservoirs.[1]

Substantial gas exploration is occurring in Pennsylvania (Marcellus Shale Formation) and production has already spiked in Arkansas (Fayetteville Shale Formation) where gas production increased by 2.5 times from 2007 to 2009 (Energy Information Agency, 2011). Growth is expected to continue with Chevron, Exxon Mobile, and Royal Dutch Shell investing heavily in developing the Marcellus Shale (Kaplan, 2010). The trends emerging in Pennsylvania and Arkansas started earlier and are more mature in Colorado, Texas, and Wyoming where gas production increased markedly from 1999 to 2008 (Fig. 1). Over the same period, wellhead prices more than doubled. The combination of production and price increases imply that the value of gas produced in each state more than quadrupled in less than a decade – clear evidence of a boom in natural gas (Table 1).

Estimates of the economic gains to local economies from a boom in natural gas extraction can inform policy makers considering how much incentive to provide (or disincentives to remove) to encourage extraction. The magnitude of gains is especially important for unconventional gas as it must be considered in light of possible negative externalities associated with extraction, including deterioration of roads caused by heavy trucks transporting water and possible health and environmental consequences from hydraulic fracturing. Some have used input–output models to project how gas development and extraction will affect local and state economies (Center for Business and Economic Research, 2008; Considine et al., 2010), however, the results of the models hinge on assumptions about economic multipliers and may deviate substantially from actual effects. To my knowledge, this is the first study to empirically estimate the local employment and income effects from the large expansion in natural gas extraction in several U.S. states in the last decade. In addition to studying aggregate economic outcomes, I explore how economic gains are distributed among the local population – a topic of interest since gains from extractive resource booms are sometimes skewed away from the poor (Brabant and Gramling, 1997).

I use gas deposit and production data combined with economic data to estimate how a substantial increase in the value of gas

☆ The views expressed are those of the author and should not be attributed to the USDA or the Economic Research Service.

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[1] Maps of the geographic distribution of unconventional reserves can be found on the website of the Energy Information Agency: http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm#pdf.

0140-9883/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.eneco.2011.11.013

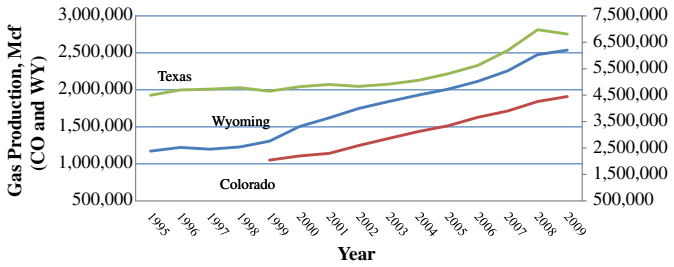

Fig. 1. The evolution of gas production in Colorado, Texas, and Wyoming (the left axis is for Colorado and Wyoming; the right axis is for Texas) Source: Colorado Oil and Gas Conservation Commission; Texas Railroad Commission; Wyoming Oil and Gas Conservation Commission, author's tabulation from county-level data.

production from 1998/99 to 2007/08 affected total employment, total wage and salary income, median household income, and poverty rates in the county of production in Colorado, Wyoming, and Texas. The empirics, which control for long-term growth trends and the potential endogeneity of gas production, provide the first ex-post analysis of the number of local jobs created by expanding gas production and are compared to ex-ante projections of the jobs created by developing the Fayetteville and Marcellus shale gas formations.

2. Resource extraction booms: theory and empirics

2.1. Theory

Corden and Neary (1982) developed a useful and influential model to understand the effects of a boom in an extractive export sector of a small open economy. As the extractive sector grows, it demands more labor, which increases wages. Some of the extra income from higher wages is spent on non-tradable goods like housing, whose prices increase because of their relatively inelastic supply. The non-booming export sector suffers as labor costs rises and the real exchange rate (price of non-tradables/price of tradables) appreciates, both of which lessen its competitiveness in the world market, an effect commonly referred to as Dutch Disease. Economists have applied the model to many national economies experiencing a boom in resource exports (e.g. natural gas in Norway, oil in Venezuela).

Applied to local economies within a national economy, the model can still be useful. How a boom affects the poverty rate, for example, will depend on how much labor the booming sector demands, how integrated the local economy is with larger markets, and the extent that local residents have the skills required by the booming sector. Thus, the economic impact of a particular boom is largely an empirical question, though a theoretical framework can be helpful in understanding how a boom can play out in a local economy.

Consider a rural economy with some unemployment and where residents commonly commute long distances to work. Depending on how much labor the booming sector demands, it could attract workers without increasing local wages. Local residents would stop commuting elsewhere and work locally for a wage similar to the one they previously earned further away, in which case welfare would increase (due to less time spent commuting) without an increase in wages or income. But if the booming sector offers work to people who could not previously find a job at the market wage, the boom would increase total income and likely decrease poverty.

Now consider a tight local labor market where residents do not have to commute far to find work. To attract workers, the booming sector must offer higher wages. As wages rise total income would increase and poverty would also likely decrease. It is important to note, however, that a poverty line defined in terms of local prices would change as living costs change. An influx of gas workers, for example, may push housing rental rates upward. If the cost of living increases more than the nominal income gain from greater employment, the cost-of-living adjusted poverty rate may increase.

If the booming sector requires special skills that local residents lack and are costly to acquire, then workers would have to come from outside the community (assuming that the cost of bringing in outside workers does not exceed the cost of training local workers). As skilled workers move to the community, total income generated increases. Per capita income would also likely increase, either because of rising wages across sectors or because the newly created jobs are higher skilled and therefore higher paying jobs.[2] Even if people living below the poverty line lack the skills to find jobs in the booming sector, spillovers into sectors like services (e.g. hotels and restaurants) would increase employment and perhaps wages for low income persons.

Resource booms likely have their largest economic effects on employment and wages, but other channels of economic stimulus include rents paid to private and public entities. In the U.S., most states that produce a lot of gas apply a severance tax on gas extracted. Gas companies drilling on private land also pay landowners for leasing the land and often a royalty based on how much gas they extract from the property. If land ownership is concentrated in the hands of a few, the gains from private resource rents would also be concentrated. Tax revenues from gas extraction, on the other hand, would likely have broader effects, either by lowering tax rates, increasing public services and investment, or both.

To summarize, a natural gas boom should increase total employment and income because of higher wages caused by a combination of greater demand for labor, an increase in the number of jobs (which may be filled by local or outside workers), and rent payments to private and public resource owners. Growth in aggregate employment and income, however, does not imply that median income will increase or that the poverty rate will decrease. The distribution of the gains will depend heavily on the skills of local residents and where they fall in the distribution of income, the extent that local and regional labor markets are integrated, and the size of spillovers into non-booming sectors.

Although this paper focuses on the short-term effects of a natural gas boom, a pertinent issue for policy makers is how to manage the cyclical aspect of extractive industries and possible negative spillovers into industries with high long-term growth potential. The long-term effects of a resource boom are less clear as resource-abundant countries appear to grow more slowly (Rodriguez and Sachs, 1999). Corden and Neary (1982) show how an export boom of an extractive sector could lead to de-industrialization as the boom erodes the competitiveness of the manufacturing sector in the world market. Alternatively, Sachs and Warner (1999) extend the booming sector model to show how a boom could be a catalyst for long-run growth when the non-tradable sector exhibits increasing returns to scale that can only be realized at certain market sizes. Both the industrialization and de-industrialization scenarios play out through a non-tradable goods sector, which may be small in most local economies in the U.S. that are well integrated with broader markets.

Table 1
Gas production and price increases for Colorado, Texas, and Wyoming, 1999–2008.

State	Percent increase, 1999–2008		
	Production[a]	Wellhead price[b]	Combined effect on the value of production[c]
Colorado	76	146	433
Texas	50	185	428
Wyoming	90	169	511

[a] Source: Colorado Oil and Gas Conservation Commission; Texas Railroad Commission; Wyoming Oil and Gas Conservation Commission, author's tabulation.
[b] Wellhead prices are from the Energy Information Agency.
[c] The combined effect on the value of production for Colorado, for example, is calculated as $1.73 \times 2.46 = 4.26$.

[2] An exception would be in a segmented labor market consisting of high skill-high wage jobs and low skill-low wage jobs. If the booming sector increases the share of low skill-low wage jobs in the economy, per capita income would fall.

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