REGULATING THE UPSTREAM ENERGY INDUSTRY:

GETTING THE BALANCE RIGHT

Wayne Winegarden

MAY 2016

PACIFIC RESEARCH INSTITUTE

REGULATING THE UPSTREAM ENERGY INDUSTRY:
GETTING THE BALANCE RIGHT

Wayne Winegarden, Ph.D.

May 2016

ISBN: 978-1-934276-25-9

Pacific Research Institute
101 Montgomery Street
Suite 1300
San Francisco, CA 94104
Tel: 415-989-0833
Fax: 415-989-2411
www.pacificresearch.org

Download copies of this study at www.pacificresearch.org.

Nothing contained in this report is to be construed as necessarily reflecting the views of the Pacific Research Institute or as an attempt to thwart or aid the passage of any legislation.

©2016 Pacific Research Institute. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopy, recording, or otherwise, without prior written consent of the publisher.

REGULATING THE UPSTREAM ENERGY INDUSTRY:
GETTING THE BALANCE RIGHT

Wayne Winegarden, Ph.D.

Sr. Fellow, Business and Economics, Pacific Research Institute

Contents

Introduction

The domestic oil and natural gas industry (the upstream energy industry) is one of the most heavily regulated industries in the country. Upstream energy producers must comply with federal regulations including the:

- Safe Drinking Water Act (SDWA)
- Clean Water Act (CWA)
- Clean Air Act (CAA)
- Endangered Species Act (ESA)
- Toxic Substances Control Act (TSCA)
- Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)
- National Environmental Policy Act (NEPA)
- Comprehensive Environmental Response Compensation and Liability Act (CERCLA)
- Resource Conservation and Recovery Act (RCRA)
- Emergency Planning and Community Right-to-Know Act (EPCRA)
- Occupational Safety and Health Act (OSHA) , and
- National Historic Preservation Act.[1]

Firms operating in the upstream energy industry also face regulatory-created time delays, which are excessively long on federal lands; as well as state and local regulations that can vary significantly. For instance, all states with active fracking operations (i.e. hydraulic fracturing techniques that inject fluids into the cracks of rock formations allowing more oil and gas to be extracted) impose comprehensive regulations on the practice – in the extreme, some states, such as New York, impose effective or actual bans on fracking.

The overall state regulatory environment (i.e. regulations that are not specifically targeted toward the upstream energy industry) also impact overall business costs and, if overly-burdensome, will also discourage economic activity in the upstream energy industry.

Overly-burdensome regulatory environments limit the economic benefits that the upstream energy industry can create and accentuate the price volatility already inherent in the fossil fuels market.

While there are some sound reasons for regulatory oversight of the upstream energy industry, as Hale et al. (2011) noted, "in general, there is a structural tendency for regulation to increase over time, creating increasing rigidity within regulated firms and increasing costs for new entrants. These factors tend to reduce innovation both in the discovery of more efficient rules and in companies' production processes."[2] Such considerations impact the upstream energy industry.

In the jurisdictions with excessive upstream energy industry regulations, the production costs are higher, the industry is more rigid, the oil and natural gas production is lower, and the incentives to explore for new fossil fuel reserves is smaller. Overly-burdensome regulatory environments limit the economic benefits that the upstream energy industry can create and accentuate the price volatility already inherent in the fossil fuels market.

The regulatory differences between state lands and federal lands, as well as variations between the states, create an opportunity to evaluate which regulatory approaches are associated with larger discouragements to oil and natural gas exploration and drilling (and, therefore, greater pricing volatility for consumers) and which regulatory approaches are associated with smaller discouragements to oil and natural gas exploration and drilling.

The purpose of this report is to connect alternative regulatory environments to the growth in exploration and production between state lands and federal lands, and between key states. The report illustrates that, as would be expected from economic theory, there is a clear association between states (or federal lands) imposing higher regulatory burdens and the amount of economic activity that follows.

It is important to note upfront that regulatory costs are only one consideration regarding where an upstream energy production will occur – other considerations include variations in production costs due to geology and the physical location of the oil and natural gas within a specific oil or natural gas basin. Due to these considerations, greater production will not always occur on the low-regulatory cost lands of a basin; and, when greater production does occur on the low regulatory cost lands, other factors may also be playing a role. Even with this caveat, the consistent correlation between more burdensome regulations and less oil and natural gas exploration and production indicates that greater regulatory costs discourages fossil fuel production and economic activity.

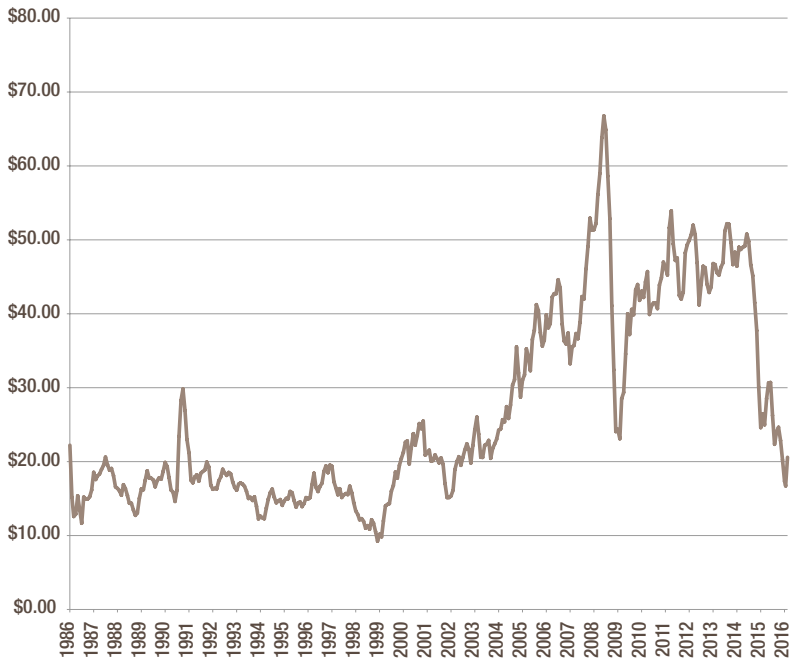
Fossil fuels: an important economic contributor in a volatile environment

Fossil fuels remain an indispensable fuel source for the U.S. Thanks to new shale drilling techniques, the U.S. has become the largest oil and natural gas producer in the world.[3] The plentiful supply of affordable natural gas has also increased natural gas' share of electricity generation. Natural gas now accounts for around one-third of all electricity generation – approximately equal to coal's share, and, in some months, natural gas consumption surpasses coal consumption.

The past two years also exemplifies the extreme volatility inherent in the fossil fuels market. Adjusted for inflation, and even accounting for the recent price increase, oil prices are around lows that have not been seen for decades. Yet, just two years ago, oil prices were approaching historical highs, see Figure 1. Natural gas prices have also followed a similar pattern as of late.

Natural gas now accounts for around one-third of all electricity generation – approximately equal to coal's share, and, in some months, natural gas consumption surpasses coal consumption.

Figure 1
Monthly Inflation Adjusted Oil Prices January 1986 through January 2016[4]



Source: Energy Information Administration

Historically low prices are, arguably, the largest obstacle facing the upstream energy industry. Persistently low oil and natural gas prices have started a process of retrenchment that is driving the returns from many new oil and natural gas exploration projects below their break-even levels.

The break-even retail price for upstream oil and natural gas production varies across geographies for many reasons. Geological variations make it more difficult (and, therefore, more costly) for the upstream industry to operate in some regions compared to others. In other regions an efficient transportation infrastructure is lacking, raising the costs of production. Additionally, the break-even price varies depending upon whether the well has already been drilled or not.

For wells that have already been drilled, in the relatively lower cost area of North Dakota's Bakken region for instance, prices as low as $15 per barrel will still cover the ongoing costs of operation and maintenance – and, therefore, operations are expected to continue in these wells.[5] But, such costs are insufficient to incent any increase in production. Typically, prices need to be in the range of $30 per barrel (at a bare minimum) to $70 per barrel to incent exploration and production.[6]

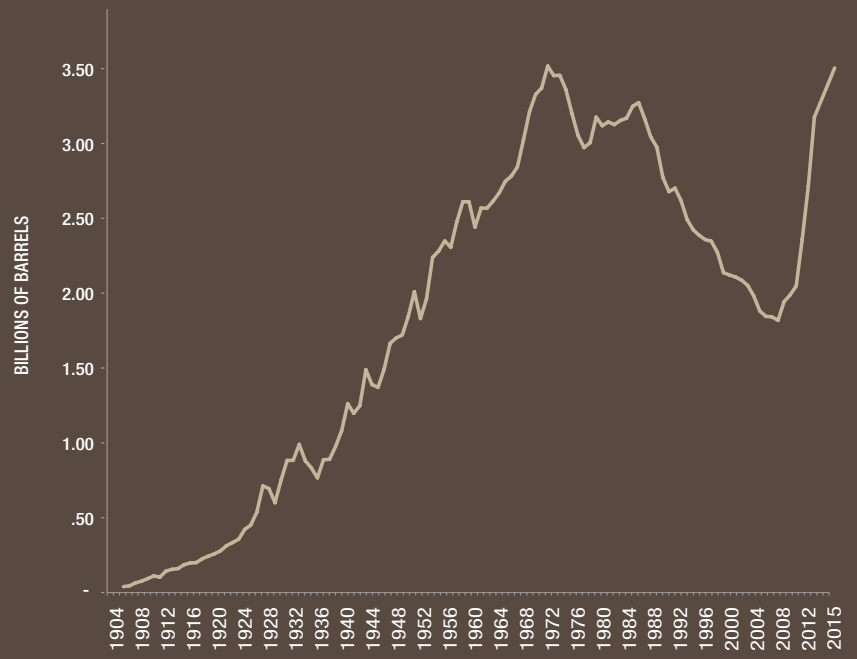
According to a 2014 Manhattan Institute report, relying on U.S. Census data, "since 2003, more than 400,000 jobs have been created in the direct production of oil & gas and some 2 million more in indirect employment in industries such as transportation, construction, and information services associated with finding, transporting, and storing fuels from the new shale bounty.

The current pricing volatility and subsequent industry retrenchment does not diminish the contribution that the upstream energy industry made to the U.S. economy immediately following the 2007-09 recession. Thanks to fracking, the natural gas industry experienced an economic renaissance that was a key driver in the otherwise lackluster U.S. economy. A Merrill Lynch research note estimated that the new energy extraction technologies, and the resulting increase in energy supplies, contributed 2.2 percentage points of growth to U.S. GDP between January 2010 and the end of 2011.[7]

And, this growth was a major job creator. According to a 2014 Manhattan Institute report, relying on U.S. Census data, "since 2003, more than 400,000 jobs have been created in the direct production of oil & gas and some 2 million more in indirect employment in industries such as transportation, construction, and information services associated with finding, transporting, and storing fuels from the new shale bounty."[8] As an *Investor's Business Daily* (*IBD*) story noted, "Employment is up 40 percent in the oil and gas fields since the recession began in late 2007."[9] The *IBD* story also noted that the industry is investing hundreds of billions of dollars into state-of-the-art production facilities.

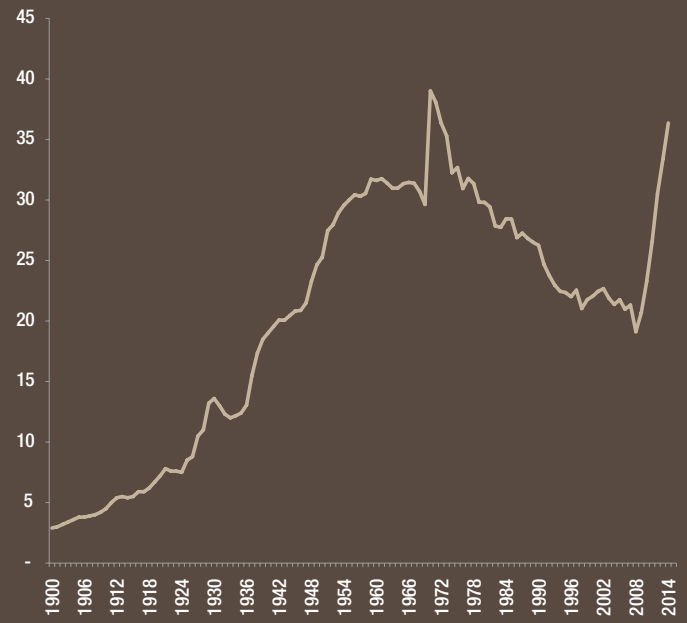
The economic contribution of the upstream energy industry can also be illustrated by examining the turnaround in overall U.S. production and overall U.S. reserves. As Figure 2 illustrates, total U.S. production of crude oil peaked in 1971 and then declined relatively steadily until 2008. The fracking revolution altered this long-term trend, however, and by 2015 total U.S. production was nearly at historical highs once again. A similar pattern is also evident in the total U.S. proved crude oil reserves, see Figure 3.

Figure 2
U.S. Field Production of Crude Oil — 1900–2015[10]



Source: Energy Information Administration

Figure 3
U.S. Crude Oil Proved Reserves —1900–2014[11]



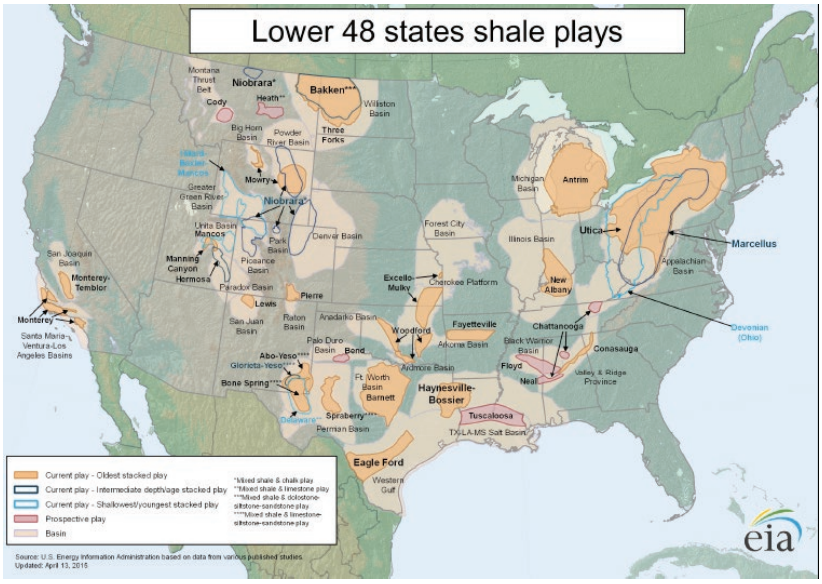
Source: Energy Information Administration

Rising oil and natural gas production in the U.S. from innovative drilling techniques was also a major contributor to the rising affordability of motor fuels. More affordable motor fuel improves overall consumer finances, which is especially important due to the weak U.S. economic expansion that has failed to raise incomes for far too many families.

Regulating the Upstream Energy Industry

The upstream energy industry operates on lands owned by the federal government (federal lands), lands owned by the states, and private lands. The majority of the onshore oil and natural gas production in the U.S. occurs on a set number of large resource basins. Map 1, reproduced from the Energy Information Administration (EIA), is an example and summarizes the major shale gas plays in the Continental U.S.

Map 1
Shale Plays in the Continental U.S.



Source: Energy Information Administration, as of March 2016.

In order to produce oil and natural gas, the upstream energy industry must obtain the rights (typically through a lease) from the owner of the mineral rights (either the federal government, state government, or a private entity). This development process begins long before any fossil fuels are extracted from the ground and includes:

- An initial geological survey that determines if recoverable fossil fuels exist;
- The development, planning, and permitting processes that create a plan to effectively recover the fossil fuels while minimizing any potential environmental impacts;
- The drilling and completion processes that create the oil or natural gas well from which the fossil fuels will be extracted;

- The production and transportation processes that extract the fossil fuel and transport it to processors, typically through pipelines; and,
- The reclamation process that attempts to minimize the environmental footprint of the production operations.[12]

Both federal and state regulations will impact the entire fossil fuel development process. It is important to note that all oil and natural gas production, whether on federal or state/private lands, are subject to a litany of federal regulations. According to the Government Accountability Office (GAO), "as with conventional oil and gas development, requirements from eight federal environmental and public health laws apply to unconventional oil and gas development."[13] Many of these federal requirements were listed in the introduction of this paper. Production on federal lands are then subject to additional regulations.

The regulations that each state will impose on production that occurs on state lands will vary across the states. States with energy resources all impose different regulations and restrictions on production on lands within their jurisdictions. Defining which of these regulatory structures are more restrictive is complicated, however, because the stringency of different regulations will (and should) vary across the states due to geological differences.

There are some lessons, however, that can be gleaned through a review of the different regulations between the federal lands and state lands, and between states. The most important lesson is that regulations that impose higher costs, impose unnecessary (and costly) time delays, or that prohibit cutting edge fracking techniques are associated with significantly less production activity.

Federal Lands: Greater Volatility, Less Activity

The Bureau of Land Management (BLM) is responsible for overseeing upstream activity and managing the leases on the over 570 million acres of BLM and other federal lands and includes over 63,000 onshore oil and gas wells on federal lands.[14] Overall, "8 percent of all oil and 11 percent of all natural gas on federal lands are available for extraction through leasing."[15]

The growth renaissance in the oil and natural gas industry has not occurred on these federal lands. According to a 2015 report by the Congressional Research Service (CRS),

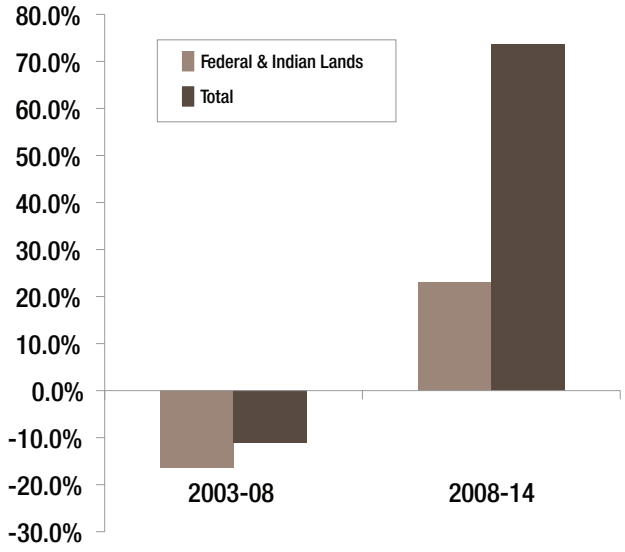
> Oil production has fluctuated on federal lands over the past five fiscal years but has increased dramatically on non-federal lands. Non-federal crude oil production has been rapidly increasing in the past few years, partly due to favorable geology and the ease of leasing, rising by 3.0 million barrels per day (mbd) between FY2010 and FY2014, causing the federal share of total U.S. crude oil production to fall from 36.4 percent to 21.4 percent.[16]

Summarizing the CRS' findings, the Institute for Energy Research stated that "since fiscal year 2010, oil production on federal lands is down by 10 percent and natural gas production on federal lands is down 31 percent. This contrasts to oil production on non-federal lands, which is up by 89 percent, and natural gas production on non-federal lands, which is up by 37 percent since fiscal year 2010."[17]

Figures 4 & 5 present the data that illustrate that the renaissance in U.S. oil and natural gas production has not occurred on federal lands. Figure 4 illustrates that in the six years prior to the fracking revolution, oil production on federal lands declined slightly more than total oil production (-16.5 percent versus -11.2 percent). Since the fracking revolution, a large divide has developed. While overall oil production in the U.S. rose 73.7 percent between 2008 and 2014, production on federal lands only rose 23.0 percent. Clearly, production on state and private lands were the main driver of the oil production revolution. And, the differences in natural gas production are even more stark.

Figure 4 illustrates that in the six years prior to the fracking revolution, oil production on federal lands declined slightly more than total oil production (-16.5 percent versus -11.2 percent).

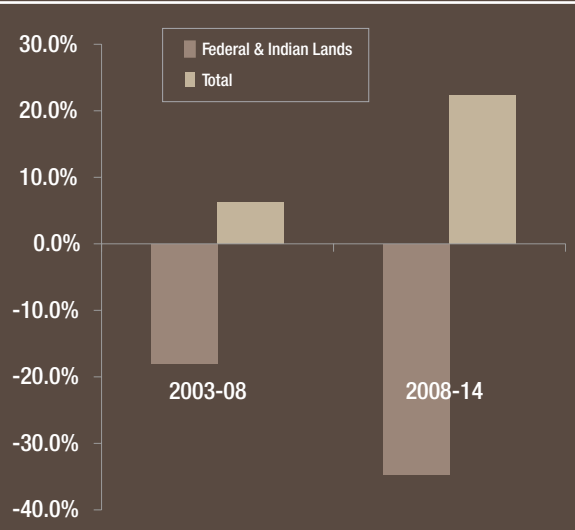
Figure 4
Percent Change in Oil Production: Federal Lands Compared to Total Production[18]



Source: Energy Information Administration

As illustrated in Figure 5, natural gas production in the U.S. was already growing between 2003 and 2008 (by 6.3 percent); but, not on federal lands. On federal lands, natural gas production declined 18.0 percent. That decline accelerated between 2008 and 2014 (-34.7 percent) while overall natural gas production growth accelerated to 22.3 percent. Natural gas production on state and private lands was the only driver of natural gas production during one of the largest energy booms in U.S. history. More broadly, there is less exploration, less production relative to known reserves, and less overall economic activity on federal lands compared to state lands.

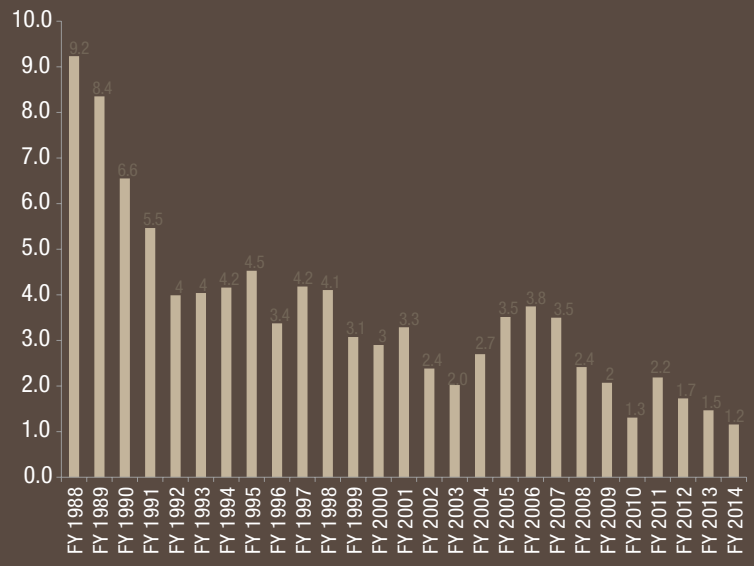
Figure 5
Percent Change in Natural Gas Production: Federal Lands Compared to Total Production[19]



Source: Energy Information Administration

The lower production volumes are also evident in the declining number of new leases on federal lands. According to the Bureau of Land Management (BLM), the total number of new production leases the BLM issued in FY2014 hit a quarter century low – and were declining throughout the shale oil boom.[20]

Figure 6
Total Number of New Leases Issued During the Year[21]



Source: Bureau of Land Management

Natural gas production on state and private lands was the only driver of natural gas production during one of the largest energy booms in U.S. history.

While many factors help explain why production is lower on federal lands compared to state lands, the excessive costs due to higher regulatory burdens from federal regulations are one of them.

According to the Government Accountability Office (GAO), "oil and gas development on federal lands must comply with applicable federal environmental and state laws, ***as well as additional requirements***. These requirements are the same for conventional and unconventional oil and gas development."[22] These additional requirements impose extra costs that have been impacting federal lands for many years.

A 2002 study that examined the costs of an area of land in Wyoming that alternates between federal land and private lands quantified the impact from federal regulations on overall production costs.[23] Due to a unique historical development, the tracts of land in a significant oil play in Wyoming is divided equally between federal and private lands in a roughly checkerboard fashion. Due to the random division and geographical similarity, the authors noted that the region "serves as an experimental control that may be used to identify differences in drilling cost on federal and private property. Estimates presented suggest that average drilling costs per well are about $200,000 higher on federal property than on private property. *This difference is attributed to more stringent enforcement of environmental and land use regulations on federal land.*"[24]

One of the costliest regulatory burdens from operating on federal lands is the time it takes to acquire a permit to begin the drilling process – what is termed an application for permits to drill (APD). Figure 7 presents the average time delays between Fiscal Year 2005 and Fiscal Year 2014. As Figure 7 illustrates, it takes at least a half a year to receive a permit approval on federal lands, and in 2011 it took nearly a year.

Figure 7
Average Application for Permit to Drill (APD) Approval Timeframes[25]

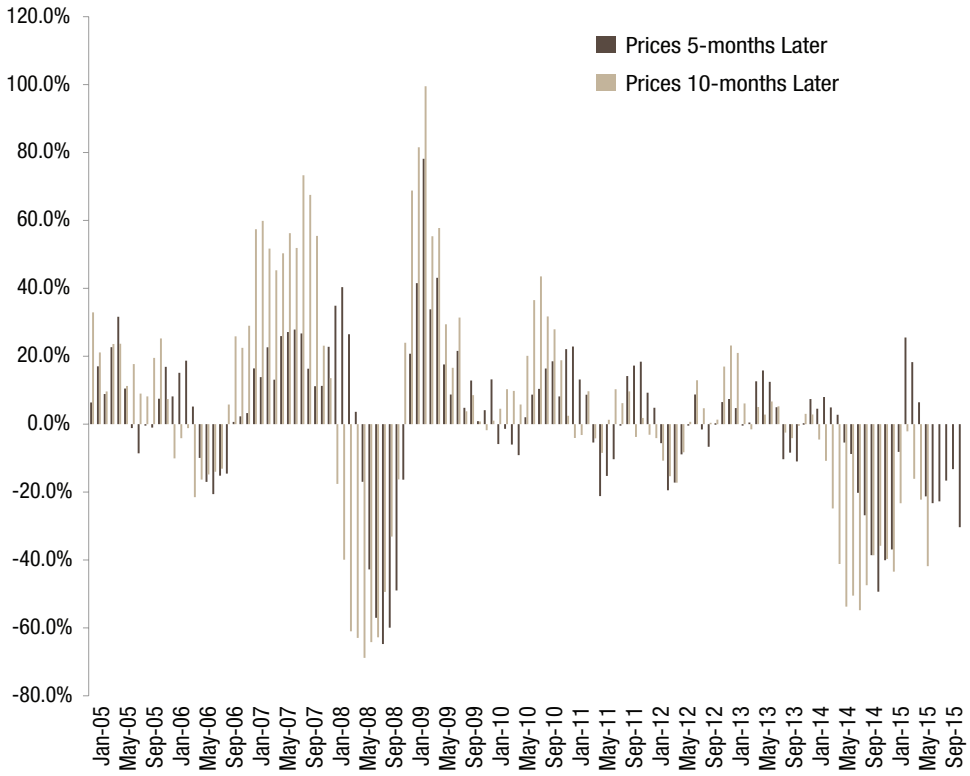
Source: Bureau of Land Management

The long time delays on federal lands stand in stark contrast to the time it takes to have a permit approved on state lands. As compiled by Loris (2013), "North Dakota processes a permit in an average of 10 days. Other states have similarly short time frames: Colorado's average is 27 days (and improving), Ohio's average is 14 days, Texas's average is five days (expedited permits are two days), and even California is seven days and by law must be processed within 10 days or the permit is automatically approved."[26]

Compared to the processing times on state and private lands, time delays significantly increase the risks from operating on federal lands. Figure 8 illustrates these potential risks. The black bars in Figure 8 show the percentage change in average monthly oil prices (Cushing, OK WTI Spot Price) five months following the assumed beginning of a federal permit approval process (the low end APD approval time delay). The gold bars show the percentage change in average monthly oil prices 10 months following the assumed beginning of a federal permit approval process (the high end APD approval time delay).

As Figure 8 illustrates, there is wide variability in the actual oil prices a producer will face following a permit approval compared to the actual oil prices that existed when the producer started the permit approval process. Sometimes, such as during early 2011, prices will be similar. Other times, such as during 2007, prices will be significantly higher; however there are also times, such as today, when oil prices are significantly lower. This variability of outcomes creates additional risks from producing on federal lands compared to state lands – where the timeframes to approve a permit to drill is measured in weeks, not months.

Figure 8
Percentage Change in Average Monthly Oil Prices within the Average Application for Permit to Drill (APD) Approval Timeframes[27]



Source: Author calculations based on data from the Bureau of Land Management and Energy Information Administration

When the time delays coincide with declining prices, the lost potential revenues can be significant. For instance, based on 2014 production productivity in the Bakken region, the 227 day permit delay is associated with an annualized loss of $6.1 million in potential revenues per oil rig.[28] Of course, such potential revenue losses will not always occur. However, the extreme oil price volatility creates additional revenue risks for oil and natural gas producers when operating on federal lands. Such additional regulatory risks, increases the costs on oil and natural gas producers and discourages production on federal lands.

There are even more barriers to producing on federal lands. Producing oil or natural gas on federal lands face restrictions such as the environmental analyses required by the National Environmental Policy Act.[29] Drilling on federal lands are also subject to more legal challenges from anti-drilling advocates.[30] These additional burdens create unnecessary, and often lengthy, delays on top of those delays already cited. These types of restrictions are also growing. According to the Western Energy Alliance (WEA), "policy changes made in 2010 have added three layers of leasing analysis onto a system which already had five layers of analysis. As a result, BLM offered 81 percent less acreage in FY 2011 than in FY 2008."[31]

The WEA has tallied up the costs from these delays, which are very large: "environmental analyses under the National Environmental Policy Act (NEPA) regularly take the government five to eight years to complete, despite companies paying for the contractors to perform the analysis. Delays of three years or more are preventing 1,600 wells and the creation of 64,805 jobs, $4.3 billion in wages, and $14.9 billion in economic impact every year."[32] Overall, according to the WEA, getting to the production stage takes at least three years, and typically ranges from five to 10 years.

These regulatory costs and uncertainties are excessive relative to producing on state and private lands, diminishing the incentives to produce oil and natural gas on federal lands. These diminished incentives are manifested in the declining share of total oil and natural gas production on federal lands reviewed at the beginning of this section.

Producing oil or natural gas on federal lands face restrictions such as the environmental analyses required by the National Environmental Policy Act.

Comparing and Contrasting State Regulatory Environments

While the regulatory environment on federal lands creates a competitive disadvantage relative to the production opportunities on state and private lands, that advantage is not universal. Several states impose stricter regulations than others.

All states with significant oil or natural gas production regulate these activities. According to the GAO, these regulations are "related to a variety of activities involved in developing unconventional reservoirs, including siting and site preparation; drilling, casing, and cementing; hydraulic frac-

turing; well plugging; site reclamation; waste management and disposal; and managing air emissions."[33] The regulations create comprehensive rules across the entire production process including issues such as review and approval of permits, setting setback regulations (or the required distance) from water sources, establishing requirements relating to the cementing of the well, establishing disclosure requirements of fracking fluids, setting rules regarding how the well is plugged, and setting requirements for reclaiming the site. These rules are also evolving along with the industry.

For instance, due to the growth in what is termed unconventional sources (e.g. shale oil and gas), "in recent years, many oil and gas producing states have revised laws and regulations governing oil and gas production in response to changes in production practices as producers have expanded into tight oil, shale gas, and other unconventional hydrocarbon formations."[34] There is, however, a wide divergence across the states regarding how the specific rules and requirements are applied.

There is also substantial evidence that the individual states, due to their superior local knowledge, are better positioned to implement the right regulations that both safeguard the local environment while also promoting the responsible development of the local oil and natural gas resources.

These discrepancies have increased calls for greater federal regulation of oil and natural gas production in the name of uniformity. The excessively large regulatory burdens on federal lands discussed above argues against a greater federal role. There is also substantial evidence that the individual states, due to their superior local knowledge, are better positioned to implement the right regulations that both safeguard the local environment while also promoting the responsible development of the local oil and natural gas resources. For instance, Loris (2013) argues that

> State regulators and private land owners have the local knowledge and the proper incentives to promote economic growth while protecting their environment. They understand site-specific challenges and can address concerns efficiently. They are the ones who have the most to gain when the management of natural resources and economic activity is done properly—but also the most to lose if they are mismanaged and handled without care for the environment. Land is a significant asset for a state, but if it is mishandled, that asset can turn into a liability. State and local governments and private landowners have the proper incentive structure to use the land as an asset.[35]

As University of Texas at Austin Professor David Spence argues none of the criteria that law and economics scholars uses to justify federal regulation over state or local regulation apply when it comes to the new production techniques. Specifically, he argues:

> First, most of the impacts of fracking do not cross state boundaries. Problems of groundwater contamination, wastewater disposal, impacts to local character, and seismic impacts are essentially local in nature. Indeed, this may be

> one reason why we have traditionally left the regulation of onshore natural gas production to the states. ...
>
> Nor does the "race to the bottom" rationale apply here. Normally, federal regulation is required to avoid a race to the bottom where multiple states are competing for a limited supply of capital investment, as when a manufacturer pits states against one another to compete for the jobs associated with the new factory. By contrast, there is ample capital available to develop shale gas wherever it is found. Indeed, shale gas production is booming wherever it is permitted, and the glut has driven the price of natural gas to historic lows. Nor do states or local governments appear to be competing for this capital. Many local communities (as well as the state of New York and the nation of France) have banned certain kinds of shale gas production within their borders. They can do so secure in the knowledge that if they change their minds, they will not have foregone the option to develop their shale gas resources because of limited capital.
>
> Finally, shale gas development doesn't seem to implicate the kinds of national interests that have motivated federal licensing regimes for other energy facilities. The national hydroelectric licensing regime, for example, was part of a New Deal package of legislation designed to promote economic development during the depression. Likewise, Congress created the nuclear power licensing regime after World War II to manage the development of this strategically important new resource. Shale gas production, by contrast, does not seem to implicate any national interest of similar magnitude. …
>
> In sum, for these reasons and others, there is no need for a new comprehensive federal regulatory regime addressing the risks of shale gas production.[36]

Due to the strong justification for state regulation of oil and natural gas production, it is important to learn from the alternative state approaches.

The combination of the lack of a clear rationale for federal preemption of state regulators, the lost economic opportunities for oil and natural gas production on federal lands versus state/private lands, and the wide divergence of state regulatory approaches that enable observational costs and benefits from alternative regulatory approaches creates a strong argument in favor of state regulatory authority.

Due to the strong justification for state regulation of oil and natural gas production, it is important to learn from the alternative state approaches. While some states will apply rules that safeguard the environment while still promoting oil and natural gas production, other states enforce the regulations in such a manner that these rules either significantly deter energy production or, while not bans, have that effect in practice.

State barriers to energy production are not only caused by energy-specific regulations. A state's broader regulatory environment will also impact oil and natural gas production – states that impose sensible regulations will promote greater business activity and growth while states that impose overly-burdensome or wrongheaded regulations will create an environment that is hostile to business growth and activity.

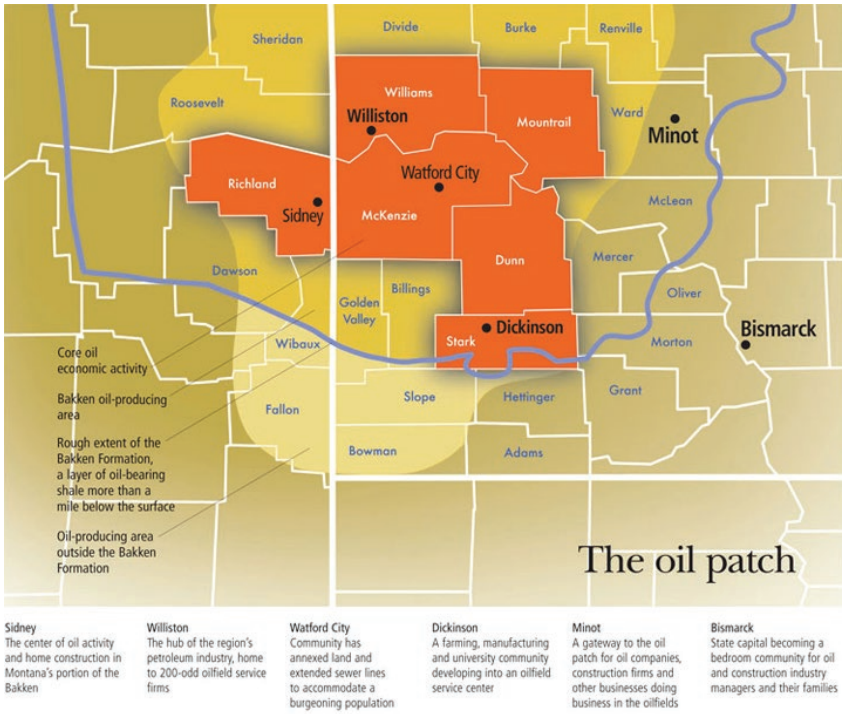
The general pattern across the states is the same pattern that is observed between federal lands and state/private lands. Those states that enforce overly burdensome regulatory environments discourage oil and natural gas production. Therefore, a much larger share of the economic benefits (including greater investment and jobs) are drawn to the states imposing a less burdensome regulatory environment.

To illustrate these differences, this section evaluates three state case studies. Two of these case studies evaluate the different regulatory environments across one geological formation – the Bakken Formation (in North Dakota and Montana) and the Marcellus Formation (focusing on Pennsylvania and New York). The formation case studies are used so the regulatory differences can be evaluated within the same geological landscape. The third case study – examines the regulatory environment in California.

The Bakken Formation – North Dakota v. Montana

Innovations in drilling techniques (i.e. the fracking revolution) have turned the counties located on the Bakken formation into oil and natural gas boom towns. Total recoverable reserves of the formation are currently estimated to be four billion barrels with an additional two billion barrels estimated at the Three Forks formation (an oil formation just below the Bakken formation).[37]

Map 2[38]

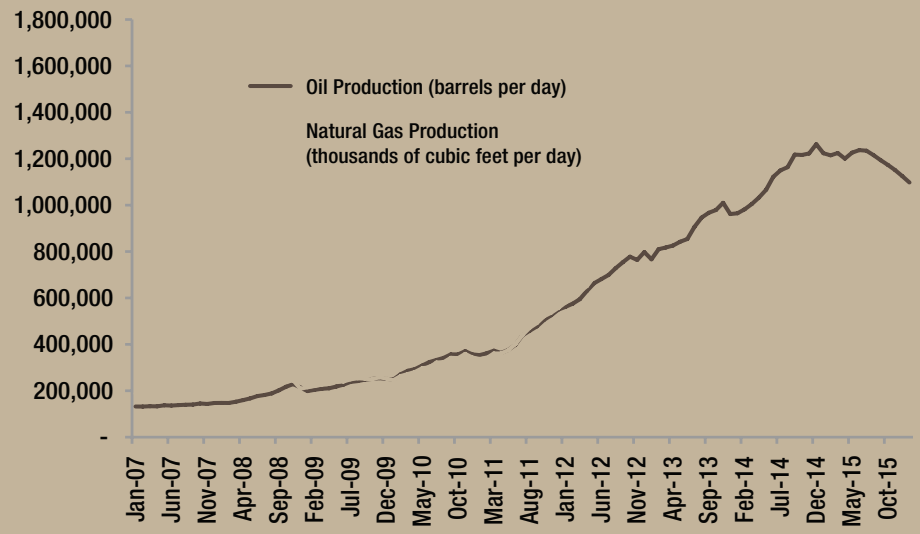


According to Bakkenshale.com, "The Bakken shale ranks as one of the largest oil developments in the U.S. in the past 40 years. The play has single-handedly driven North Dakota's oil production to levels four times higher than previous peaks in the 1980s. As of June 2015, North Dakota is second to Texas in terms of oil production and boasts the lowest unemployment rate in the country at 3.1 percent."[39]

Current production levels from the Bakken shale, which are down from all-time highs, are over eight times as large as the production levels back in 2007, see Figure 9. A similar dynamic is also evident in the production of natural gas from the Bakken region, see Figure 9.

Current production levels from the Bakken shale, which are down from all-time highs, are over eight times as large as the production levels back in 2007.

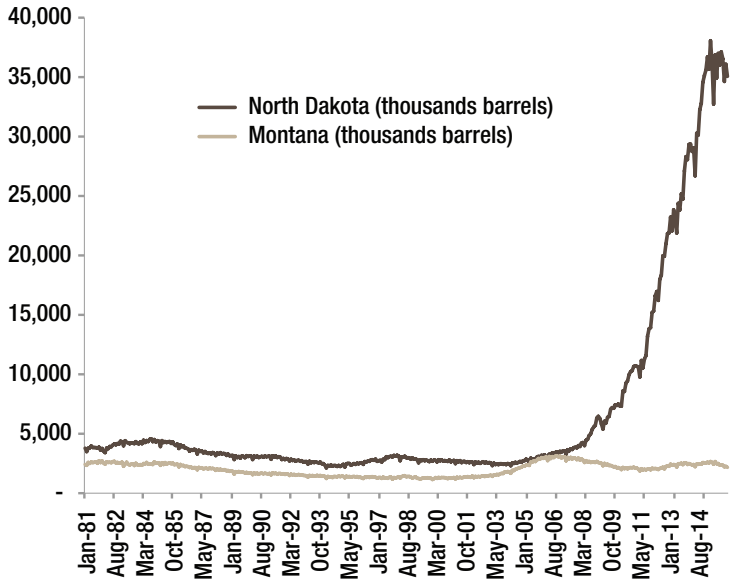
Figure 9
Monthly Oil and Natural Gas Production, Bakken Formation January 2007 – January 2016[40]



Source: Energy Information Administration

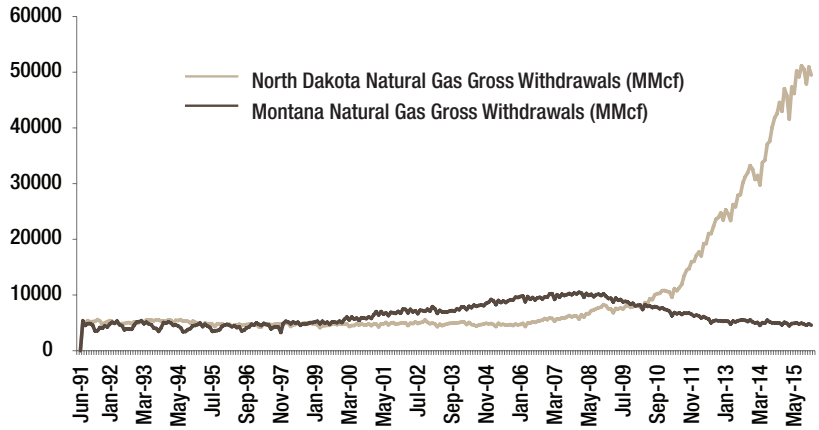
As Figures 10 and 11 illustrate, prior to the latest boom, production growth in both Montana and North Dakota had been flat for decades. However, the production revolution that has turned the Bakken formation into a major oil and natural gas producer has been, essentially, an economic event that has occurred in North Dakota, but not Montana.

Figure 10
Monthly Oil Production, North Dakota and Montana
January 1981 – November 2015[41]



Source: Energy Information Administration

Figure 11
Monthly Natural Gas Production, North Dakota and Montana
January 1991 – November 2015[42]



Source: Energy Information Administration

There are geological reasons that favor fossil fuel production on the North Dakota side of the border compared to the Montana side – specifically, the oil shale layer is generally thicker and, therefore, more productive on the North Dakota side of the border.[43] There are also about three times as many proven oil reserves on the North Dakota side of the border compared to the Montana side.[44] Although North Dakota has three times the proven oil reserves of Montana's, it also has 10 times the drilling and production – a value that is conspicuously disproportionate to the known reserves.[45]

There are differences in federal land ownership between Montana and North Dakota that explain some of these discrepancies. About 29 percent of the land in Montana is owned by the federal government, and Montana is one of the 12 states where the federal government owns the most land.[46] In North Dakota, on the other hand, the federal government owns only 3.9 percent of the land. As discussed above, overly burdensome federal regulations significantly reduce the incentive to produce on federal lands compared to state lands. Thus, greater federal ownership will create a greater disincentive to produce in Montana than North Dakota.

With respect to regulations on oil and natural gas production, regulations are often proposed with the goal of limiting production rather than implementing effective regulations.

There are also significant regulatory differences between Montana and North Dakota. The regulatory environment in Montana (just like the federal regulatory environment) imposes high costs on oil and natural gas production (particularly in comparison to North Dakota). As noted by Anderson (2012) "the difference in how oil producers are treated by Montana and North Dakota is clear, according to industry consultant and former GOP state Senator Roy Brown. In North Dakota, he says, regulators work in collaboration with oil producers. In Montana, not so much."[47]

Take taxes. "While production taxes are favorable in Montana, the same cannot be said of other Montana taxes…. Large pipeline systems [in Montana, for instance,] are centrally assessed, and are taxed more than four times the rate of similar systems in North Dakota and South Dakota."[48]

With respect to regulations on oil and natural gas production, regulations are often proposed with the goal of limiting production rather than implementing effective regulations. For instance, the Northern Plains Resource Council supported legislation, which ultimately failed, that would have pushed all production back from "inhabitable real property" by up to a quarter mile, compared to 500 feet in North Dakota.[49] However, there is no scientific need to expand Montana's setback regulations:

> There is simply no proven public health or environmental necessity, nor is there substantiated evidence that the status quo is ineffective in its consideration of operators, mineral owners or surface owners.

> Moreover, air and water quality, as tested extensively in the Williston Basin since the recent boom, have been found unharmed by oil and gas development; with Richland County earning an A grade from the American Heart and Lung Association for air quality.
>
> Multiple state agencies have deployed recent water testing programs in the Bakken without any alarming results.[50]

Expanding regulations unnecessarily increases costs on producers without creating additional benefits. And, even though these regulations were not ultimately passed, continued attempts to impose unnecessarily burdensome regulations discourages current production activities in the event that such regulations are eventually passed in the future.

Then there is the broader business environment. According to the Pacific Research Institute's *the 50-State Small Business Regulation Index*, North Dakota was ranked as having the 2nd most pro-growth regulatory environment, Montana ranked 40th (or 11th worst).[51] And, when it comes to the regulatory areas most relevant to oil and natural gas production, Montana performs just as poorly.

Expanding regulations unnecessarily increases costs on producers without creating additional benefits.

Workers compensation premiums, adjusted for industry risk profiles, are $2.21 per $100 of payrolls in Montana (the 11th most expensive in the country), significantly more expensive than the $0.88 per $100 of payrolls in North Dakota (the least expensive in the country).[52] Workers compensation programs in Montana mandate expensive one-size fits all costs on all oil and natural gas producers. Producers can avoid these excessively high workers' compensation costs by locating their operations across the border in North Dakota.

A similar pattern holds with respect to Montana's litigation climate. Montana's ranking improved between 2012 (where it ranked 45th or 6th worst) and 2015 (where it ranked 34th).[53] The litigation climate still creates excessive uncertainty and costs for current and potential oil and natural gas producers, and thus discourages greater production activity. These costs are even more problematic for Montana when its tort environment is compared to North Dakota, which ranked 8th best in the country in 2012 and 15th best in 2015.

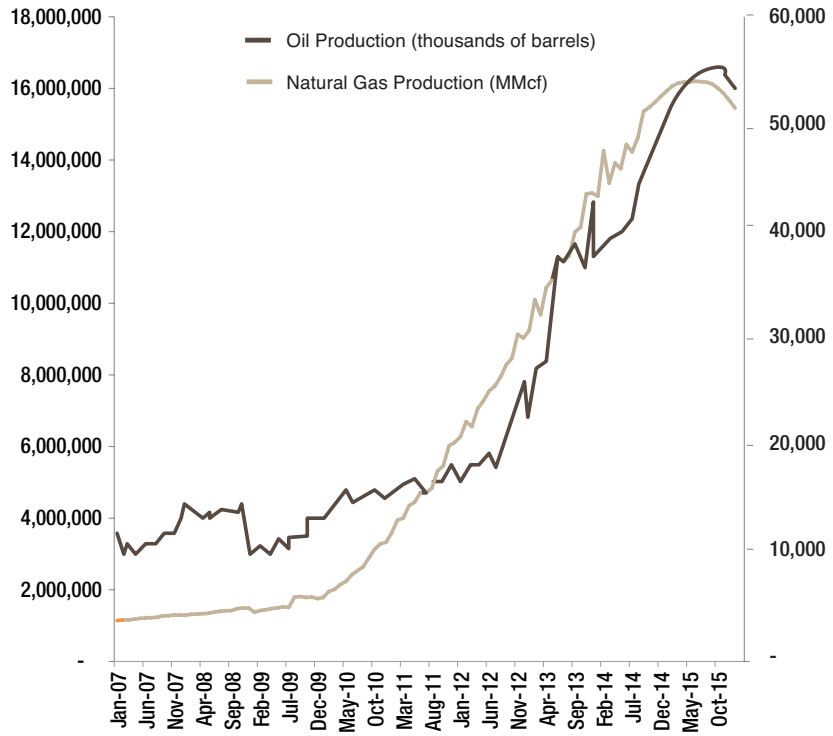
While there are other disadvantages that matter too, the higher taxes (and tax-induced infrastructure deficit) and higher regulatory burdens for producing in Montana, particularly in comparison to these costs in North Dakota, diminishes the economic incentives to produce in oil and natural gas in Montana. The large discrepancy between North Dakota's oil and natural gas revolution compared to Montana's stagnant production levels is the logical outcome.

The Marcellus Shale

The Marcellus Shale has seen astronomical growth in its production, particularly natural gas, see Figure 12. The majority of the new production has occurred in Pennsylvania (see Figure 13), and Pennsylvania (due to the Marcellus Shale) now has the second largest amount of proven natural gas reserves behind only Texas.[54] Figure 13 also illustrates that while natural gas production increased in West Virginia and Ohio, there has been an actual decline in the amount of natural gas produced in New York.

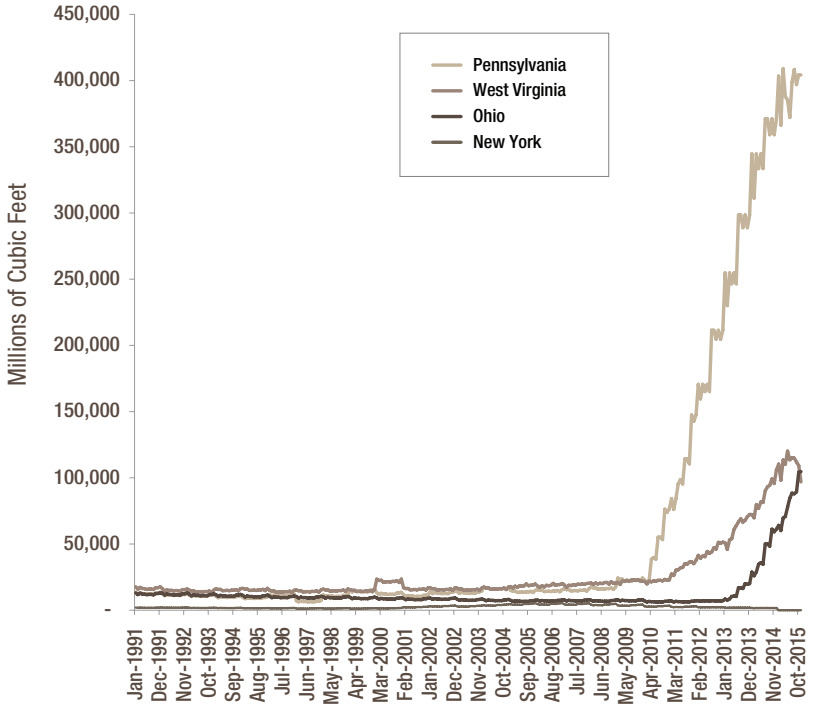
The Marcellus Shale has seen astronomical growth in its production, particularly natural gas.

Figure 12
Monthly Oil and Natural Gas Production, Marcellus Formation
January 2007 – January 2016[55]



Source: Energy Information Administration

Figure 13
Monthly Natural Gas Production
Pennsylvania, West Virginia, Ohio, and New York
January 2007 – January 2016[56]



Source: Energy Information Administration

Focusing on the extreme cases, the overall regulatory environment in Pennsylvania and New York, unlike the differences between Montana and North Dakota, does not explain why Pennsylvania is experiencing a production boom while production levels in New York continue to decline. Unlike North Dakota, Pennsylvania's overall business environment is only slightly better than New York's.[57] Additionally, there are not any known geological disadvantages along the New York side of the Marcellus Shale; nor are there a disproportionate amount of federal lands in New York that would create an inherent disadvantage.

Instead, the difference in each state's energy regulations, specifically each state's approach to the new fracking technology, is the most important difference between the natural gas boom in Pennsylvania and the declining industry in New York.

To understand why, it is important to note that knowledge of natural gas' existence in the Marcellus Shale is not new. According to geology.com,

> Twenty years ago every geologist involved in Appalachian Basin oil and gas knew about the Devonian black shale called the Marcellus. Its black color made it easy to spot in the field and its slightly radioactive signature made it a very easy pick on a geophysical well log.
>
> However, very few of these geologists were excited about the Marcellus Shale as a major source of natural gas. Wells drilled through it produced some gas but rarely in commercial amounts. Few if any in the natural gas industry suspected that the Marcellus might soon be a major contributor to the natural gas supply of the United States - large enough to be spoken of as a "super giant" gas field.[58]

Without modern drilling techniques, accurately measuring the amount of natural gas in the Marcellus Shale was not possible; nor was it possible to economically recover these reserves. Modern drilling techniques, including fracking, eliminated these constraints. By applying the modern techniques to the Marcellus Shale (in 2008), geologists were able to discover how vast the recoverable reserves that exist in the resource basin actually were.[59] The Marcellus Shale is now estimated to contain the largest amount of natural gas reserves (84.5 trillion cubic feet) in the country compared to any other shale play.[60]

Natural resources do not abide by state boundaries – they abide by geology. In order for any of the states atop the Marcellus Shale to discover, and then economically produce, the vast quantities of natural gas found there requires fracking technologies. And, this is where the regulatory differences between Pennsylvania and New York matter.

Pennsylvania is embracing the new technology and has established extensive regulations of the fracking process (for example requiring disclosure of the fracking fluids). New York currently bans fracking – the production technology necessary to discover and then profitably produce natural gas from the Marcellus shale formation. New York's energy regulatory environment effectively prohibits natural gas producers from economically producing on the New York side of the Marcellus Shale resulting in the stark contrast in natural gas production between New York and Pennsylvania. The lost economic opportunities from New York's regulatory ban are staggering.

According to Pennsylvaniafracking.com, citing Pennsylvania Department of Labor and Industry statistics, fracking has created more than 72,000 gas and oil jobs, and accounting for the economic multiplier, a total of 214,000 jobs have been created by industries tied to the Marcellus Shale.[61]

A 2013 report by the Manhattan Institute documented the economic boost to those Pennsylvania counties with fracking activity.[62] The authors found that "between 2007 and 2011, per capita personal income levels rose about 8 percent in those counties with no unconventional wells drilled; and 12 percent where fewer than 20 wells were drilled. In contrast, income levels rose 14 percent in counties with more than 20, but fewer than 200, wells; and 19 percent in the counties with the most hydrofracturing wells."[63] Simply put, the Manhattan Institute study found that those counties that were blessed with natural gas resources, and then supported the development of those resources, saw significant income growth.

The impact on jobs was similar.

> Where there was no such drilling, the number of jobs shrank in each county by an average of 3.27 percent. Counties with fewer than 20 unconventional wells improved only marginally on this number, losing 3.23 percent of jobs on average.
>
> However, those counties with between 20 and 200 wells lost, on average, less than one percent of their jobs. Finally, the most striking value is the growth of employment in the heavy-drilling group. These counties added jobs at an average rate of 7.67 percent. None of the six counties with more than 200 unconventional wells failed to add jobs in 2007–11, despite the economic turmoil that gripped the rest of the state—and the nation—during this period.[64]

While Pennsylvania experienced robust income and job growth due to fracking, New York's upstate economy has missed out on these benefits. A 2011 study by the Public Policy Institute of New York State (PPI) outlined the opportunities the state was foregoing by banning fracking. Specifically, PPI predicted that "the state stands to lose over $11 billion in economic output and thousands of private sector jobs between 2011 and 2020. By conservative estimates the development of the Marcellus shale has the potential to create 37,572 new jobs each year in New York, jobs that may pay over $79,184 annually — over double the average private sector wage upstate."[65]

By applying the modern techniques to the Marcellus Shale (in 2008), geologists were able to discover how vast the recoverable reserves that exist in the resource basin actually were.

Interviews in two rural counties along the Pennsylvania-New York border in 2015, when coupled with the positive impact experienced in Pennsylvania, provides further context on the potential economic benefits that New York continues to miss due to its fracking ban.

> In the rural Pennsylvania counties across the border [from New York], the taxes have been cut. Property values have risen. The county budgets are balanced and schools have been able to afford expansions and improvements. The roads get fixed. New small businesses open to support the workers who move to the area and take jobs in the gas fields.
>
> Meanwhile, in Broome County, New York, the population has dropped by more than 2 percent in the last five years. To make this crystal clear, we're not talking about a region where population growth fails to keep up with the rest of the state or nation. They've actually had a net loss of people. The 2014 unemployment rate in the county stubbornly stayed at almost 8 percent. In the same period, a stone's throw away in Bradford County, PA it had already dropped to 5.8 percent and continues to fall.[66]

In the case of the Marcellus Shale, the large divergence in the production of natural gas is clearly associated with the different approaches of Pennsylvania and New York to modern drilling techniques. Pennsylvania embraced, then regulated, modern drilling techniques enabling the growth of the industry. New York, on the other hand, has banned the modern drilling techniques, which has had the effect of banning the industry, and its subsequent economic benefits, from New York.

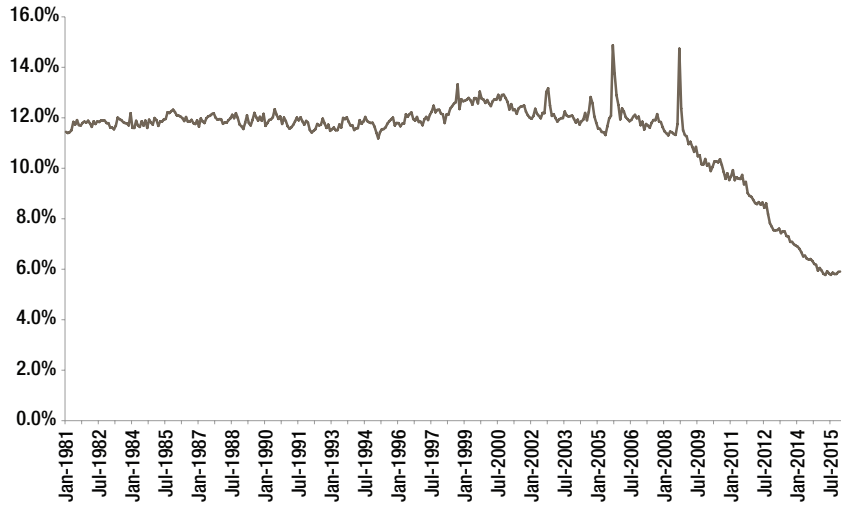
California's Production Possibilities

Total production of California's crude oil industry is the third largest compared to all other states – and California's proven oil reserves are also the third largest among the 50 states.

California, like the states discussed above, is blessed with large reserves of fossil fuels. Leveraging that base, California is already a major energy producer. Total production of California's crude oil industry is the third largest compared to all other states – and California's proven oil reserves are also the third largest among the 50 states.[67] According to the Energy Information Administration, "the most prolific oil-producing area is the San Joaquin basin in the southern half of the Central Valley."[68] Additionally, "California's offshore areas indicate the potential for large, undiscovered recoverable crude oil resources in the federally administered Outer Continental Shelf (OCS)."[69] The offshore resources, however, are not currently under development (an issue discussed below).

Like most major U.S. based oil producing states, oil production in California was on a steady decline prior to 2008. The decline was on par with the overall decline in U.S. production, therefore, California maintained a constant share of total national production between 11 percent and 13, see Figure 14.

Figure 14
California's Share on National Oil Production
January 1981 – December 2015



Source: Energy Information Administration

Circumstances changed in 2008 due to the fracking revolution. The production decline in California continued unabated post 2008 even as the new fracking technologies revitalized oil and natural gas production in places like North Dakota, Pennsylvania, and Texas. The result has been California's significant decline in the share of national production, which has fallen in half, see Figure 14.

Despite declining output and share of national output, the economic activity created by the upstream oil industry benefits the broader Californian economy, particularly the economy in the San Joaquin Valley (SJV) where 75 percent of the total oil in California is produced.[70] In the San Joaquin Valley alone, "the petroleum industry along with the industries linked to it supports 52,271 jobs in the SJV (3.1 percentof total employment in the region), paying a total of $4.08 billion in annual labor income."[71] In addition, the industry creates $23.6 billion in business sales (10 percent of total sales in the San Joaquin Valley) and generates $365 million in sales taxes and $386 million in property taxes.[72]

Despite declining output and share of national output, the economic activity created by the upstream oil industry benefits the broader Californian economy, particularly the economy in the San Joaquin Valley (SJV) where 75 percent of the total oil produced in California is produced.

There are other onshore opportunities as well, particularly the vast potential of the Monterey shale. Earlier Energy Information Administration studies estimated that the Monterey shale could yield 15.4 billion barrels of oil.[73] For perspective, the Bakken shale, which has transformed North Dakota's economy and made North Dakota the second largest oil producing state in the nation, is only one-half the size of these earlier estimates for the Monterey shale.[74] While an updated analysis in 2014 lowered these estimates by 96 percent to 600 million barrels,[75] according to the Western States Petroleum Association President, Catherine Reheis-Boyd:

> The U.S. Energy Information Administration's (EIA) revision does not change the estimate of the amount of oil present. It only changes their estimate for how much of that oil can be produced given the current state of technology in California… This change in the estimate of recoverable oil indicates the need to continue to invest in research and exploration in this area to adapt technologies that have proved successful at producing oil from shale resources elsewhere to California's unique geology.
>
> We have a great deal of confidence that the skill, experience, and innovative spirit by the men and women of the petroleum industry will ultimately solve this puzzle and improve production from the Monterey Shale.
>
> It is not uncommon for estimates of 'technically recoverable' resources to change in the early stages of production activity. For example, the USGS initially estimated Bakken Shale in North Dakota had just 151 million barrels of oil in 1995. Today, the EIA puts that estimate at 4 billion barrels.[76]

If such technological innovation is going to occur, it will require leveraging the current advances in drilling technology. The regulatory environment in California is not supportive of these cutting edge drilling technologies, and has become a large impediment to the industry's growth and development.

The most impactful regulatory costs on the oil production industry are due to the regulations that directly target the oil production industry.

Like Montana, California's overall tax and regulatory environment is a significant competitive disadvantage. According to the Pacific Research Institute's t*he 50-State Small Business Regulation Index*, California's state regulatory environment was the most burdensome in the country.[77] California also has the 47th worst lawsuit climate according to the Institute for Legal Reform,[78] and the highest workers compensation costs of any state once the state costs are adjusted to a comparable basis.[79] California's high cost zoning regulations, costly labor regulations, highest top personal income tax rate in the country (13.3 percent) and, according to the Tax Foundation, the 6th highest overall tax burden further reduce the attractiveness of the Golden State.[80] All of these tax and regulatory costs burden the oil production industry, just as it burdens most other industries across the state.

The most impactful regulatory costs on the oil production industry are due to the regulations that directly target the oil production industry, however. These regulations make expanding California's vast energy productive capacity very difficult and very costly.

California's offshore regions (the zone within three miles from shore belongs to the state, beyond three miles, the zone belongs to the federal government) contain potentially large deposits of oil and natural gas that has been estimated to be as high as "10.13 billion barrels of oil and 11.73 trillion cubic feet of natural gas."[81] Oil and gas production continues offshore of California in 29 active platforms that were leased prior to 1969,[82] but any significant expansion of these operations has been prevented by federal and state drilling moratoriums. Due to the state moratorium, California has not issued any new leases in new areas since 1969.[83] These drilling moratoriums have made any expansion of offshore oil production virtually impossible.

Drilling onshore occurs mostly on private or federal lands – a stark contrast to most states where drilling occurs mostly on private or state lands.[84] The manner in which California is regulating oil production on state and private lands, when coupled with regulations that overly empower interest groups opposed to drilling, imposes large, and growing, costs on oil producers.

For starters, California's fracking regulations are the strictest in the country (outside of a total ban on the practice).[85] These strictest in the nation regulations are viewed as insufficient to many anti-fracking groups who, despite Governor Brown's resistance, continue to pursue a statewide ban on fracking and other modern drilling techniques.

The continued pressure to ban fracking, and other modern drilling techniques, has been occurring at the local levels as well – and in a few instances, these local bans have passed. "Both Santa Cruz County and Mendocino County

banned fracking [two years ago], although neither are active areas of the oil industry — the victories are symbolic. San Benito County, however, also voted in November 2015 to ban fracking and other "high intensity" oil production methods as it was set to be the site of potentially hundreds of new wells for an oil recovery project using cyclic steaming, a kind of enhanced recovery technique where the rock is heated in order to move viscous oil."[86] The combination of strict state regulation and local bans creates uncertainty for producers who need to use these, and other, modern drilling techniques in order to profitably operate in California.

Applying modern drilling technologies is necessary if California is going to reverse its current declining share of national production. The state's regulatory environment stands in the way, however.

Applying modern drilling technologies is necessary if California is going to reverse its current declining share of national production.

Driller uncertainty is furthered by environmental and land use laws that empower opponents of proposed projects to delay or derail these activities. "This past March, to take one example, the planning commission in San Luis Obispo County rejected a plan to drill a dozen new wells, with one commissioner arguing that "the isolated and pastoral Huasna Valley" was "not a suitable place for oil production," as the local *Tribune* put it."[87]

On top of the uncertainty regarding production, delays for acquiring the necessary permits are increasing. As an example,

> between Jan. 1, 2014, and the third week in December, DOGGR [Division of Oil, Gas and Geothermal Resources] said, it issued approvals for 74 percent of the 561 applications it received for what are known as Class II Underground Injection Control projects, which can be for disposal activity or the oil well stimulation activity known as cyclic steaming.
>
> By comparison, the division said, it approved 817, or 89 percent, of the UIC Class II applications it received during the same period a year before.[88]

Broader environmental regulations, such as California's AB 32 (cap and trade) passed in 2006, are also negatively impacting production in California. Producing oil in California requires the energy intensive process of steam injection. As a consequence, the oil produced from California's wells will have a higher carbon intensity than crude from other sources placing California produced oil at a competitive disadvantage in its home market.[89]

The large number of regulatory obstacles California imposes on its oil production industry raises the costs to produce in the state and limits the potential opportunities. When contrasted with states such as Texas, North Dakota, and Pennsylvania, which have embraced the technology revolution, California's decline in national output share is the inevitable result.

Lessons for the Optimal Tax and Regulatory Structure

Regulations on the upstream energy industry are necessary – and companies in the industry must comply with a long list of federal and state regulations. When the regulatory environment is excessive, there are consequences in terms of lost jobs, lost income, and lost economic vibrancy. Due to the consistency of these negative impacts, several lessons for states with abundant oil and natural gas resources emerge.

First, as the old adage goes, time is money. Drilling on California lands and federal lands are subject to long delays. The large price volatility inherent in the oil and natural gas markets compounds the costs from delays creating significant risks for producers attempting to drill on these lands. The lesson for regulatory policy is clear: regulators should consistently strive for a timely permit application and review process that minimizes potential delays.

Second, prohibitions are costly. Whether it is the fracking ban in New York or the offshore moratorium in California, drilling or technology bans, by definition, eliminate all activity related to the oil and natural gas sector in the banned areas. As illustrated in the border communities between New York and Pennsylvania, or the declining share of national oil output from California, states that impose complete bans face bleaker economic outcomes than those states that enable responsible use of the latest drilling technologies.

Third, regulatory uncertainty matters. As exemplified by California, regulations that overly-empower activists increase the risks from drilling for oil and natural gas. States where the constant threat from local fracking bans hang over producers increase the risks from drilling for oil and natural gas as well. With higher risks come less incentives to expand production.

Fourth, states are better positioned to regulate oil and natural gas production in their borders than the federal government. State regulators not only have greater local knowledge, but the divergence in regulatory approaches enables states to learn from one another to implement the most effective regulatory structures. The federal government often defers to one size fits all regulations that are more likely to clash with the actual local needs and environment.

Finally, the overall regulatory environment matters. As the disproportionate production along the North Dakota side of the North Dakota-Montana border exemplifies, the broader regulatory environment can discourage production just as with any business. Higher workers compensation costs, an overly litigious legal environment, and expensive land use regulations all raise the costs on oil and natural gas production leading to less overall production.

These lessons can be summarized in an over-arching theme that emerged across the case studies reviewed above – as would be expected from economic theory when the regulatory authority imposes overly-burdensome costs, or unnecessarily bans modern drilling techniques, the economic contribution from the upstream energy industry is diminished. On the other hand, when the regulatory authority imposes sensible regulations and embraces modern drilling techniques, the economic contributions from the upstream energy industry can be harnessed while still safeguarding the local environment.

Endnotes

1 See the Western Energy Alliance, http://www.westernenergyalliance.org/knowledge-center/regulatory; and, (2012) "Unconventional Oil and Gas Development: Key Environmental and Public Health Requirements" *Government Accountability Office*, GAO-12-874, September.

2 Hale, Andrew; Borys, David; and Adams, Mark (2011) "Regulatory Overload: A Behavioral Analysis of Regulatory Compliance" *Mercatus Center Working Paper*, November, No. 11-47.

3 Katakey, Rakteem (2015) "U.S. Ousts Russia as Top World Oil, Gas Producer in BP Data" *Bloomberg Business*, June 10; http://www.bloomberg.com/news/articles/2015-06-10/u-s-ousts-russia-as-world-s-top-oil-gas-producer-in-bp-report.

4 Spot oil prices are from the Energy Information Administration (www.eia.gov) adjusted for inflation based on the Producer Price Index – Commodities from the Bureau of Labor Statistics (www.bls.gov).

5 Kemp, John (2015) "Breakeven and shut-in prices for oil wells" *Reuters*, January 13; http://www.reuters.com/article/oil-shale-prices-kemp-idUSL6N0US2GE20150113.

6 Nysveen, Magnus; and Wei, Leslie (2015) "Cost deflation and the effect on 2015 breakeven prices" *Oil & Gas Financial Journal*, July 8; http://www.ogfj.com/articles/print/volume-12/issue-7/features/unconventional-resources.html; DiChristopher, Tom (2015) "US crude oil's break-even cost: How low can it go?" *CNBC*, August 20; http://www.cnbc.com/2015/08/20/us-crude-oils-break-even-cost-how-low-can-it-go.html; and Berman, Art (2015) "Less Than 2 Percent of Permian Basin Commercial at $30 Oil" *Forbes.com*, December 18; http://www.forbes.com/sites/arthurberman/2015/12/18/less-than-2-percent-of-permian-basin-commercial-at-30-oil/.

7 Blanch, Francisco (2012) "Energy Carrying America," *Bank of America Merrill Lynch* July; http://wealthmanagement.ml.com/Publish/Content/application/pdf/GWMOL/Energy-carrying-America.pdf.

8 Mills, Mark P. (2014) "Where the Jobs Are: Small Businesses Unleash Energy Employment Boom" *Manhattan Institute for Policy Research, February, No. 4;* http://www.manhattaninstitute.org/html/pgi_04.htm#.Vh1F_zZdGyI.

9 Mills, Mark P. (2014) "America's Shale Boom Is A Major Job Creator" *Investor's Business Daily*, February 19; http://news.investors.com/ibd-editorials-perspective/021914-690504-shale-boom-can-create-jobs-if-government-will-let-it.htm.

10 The Energy Information Administration (www.eia.gov).

11 The Energy Information Administration (www.eia.gov).

12 This description of the production process is based on: (2011) "The Lifespan of a Well" *Encana*, April; www.enana.com; and, "Lifecycle of an Exploratory Oil and Gas Well" http://www.anschutz-exploration.com/docs/anschutz-exploration-well-lifecycle.pdf.

13 (2012) "Unconventional Oil and Gas Development: Key Environmental and Public Health Requirements" *Government Accountability Office* GAO-12-874, September.

14 Data are from: the *Intermountain Oil and Gas BMP Project* http://www.oilandgasbmps.org/laws/federal_law.php; and, the *United States Extractive Industries Transparency Initiative*: https://useiti.doi.gov/how-it-works/onshore-oil-gas/.

15 The *United States Extractive Industries Transparency Initiative*: https://useiti.doi.gov/how-it-works/onshore-oil-gas/.

16 Humphries, Marc (2015) "U.S. Crude Oil and Natural Gas Production in Federal and Non-Federal Areas" *Congressional Research Service*, April 3.

17 (2015) "Oil and Natural Gas Booms on Private and State Lands" *Institute for Energy Research*, April 14.

18 Data for federal production are from (2015) "Sales of Fossil Fuels Produced from Federal and Indian Lands, FY 2003 through FY 2014" *U.S. Energy Information Administration*, July. Total production data are measured as crude oil production and are from www.eia.gov.

19 Data for federal production are from (2015) "Sales of Fossil Fuels Produced from Federal and Indian Lands, FY 2003 through FY 2014" *U.S. Energy Information Administration*, July. Total production data are measured as natural gas withdrawals and production and are from www.eia.gov.

20 Data are from the *Bureau of Land Management*: http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/statistics.html.

21 Data are from the *Bureau of Land Management*: http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/statistics.html.

22 (2012) "Unconventional Oil and Gas Development: Key Environmental and Public Health Requirements" *Government Accountability Office*, September.

23 Kunce, Mitch; Shelby, Gerking; and William, Morgan (2002) "Effects of Environmental and Land Use Regulation in the Oil and Gas Industry Using the Wyoming Checkerboard as an Experimental Design" *American Economic Review*, 92(5): 1588-1593.

24 Kunce, Mitch; Shelby, Gerking; and William, Morgan (2002) "Effects of Environmental and Land Use Regulation in the Oil and Gas Industry Using the Wyoming Checkerboard as an Experimental Design" *American Economic Review*, 92(5): 1588-1593. (emphasis added)

25 Data are from the *Bureau of Land Management*: http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/statistics/apd_chart.html.

26 Loris, Nicolas D. (2013) "Energy Production on Federal Lands: Handing Keys Over to the States" *Heritage Foundation Issue Brief*, No. 3979 June 27.

27 Oil prices are based on Cushing, OK WTI Spot Price from the Energy Information Administration (www.eia.gov); APD approval times are from the Bureau of Land Management (http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/statistics/apd_chart.html).

28 The lost potential revenues are estimated by comparing the average price of oil as of July 2014 (1-month following the application to drill) of $103.59 multiplied by the average output per day per rig in the Bakken region of 433.7 barrels per day to the average price of oil as of January 2015 (7-months following the application to drill, or the average APD delay) of $47.22 multiplied by the average output per day per rig in the Bakken region of 433.7 barrels per day. The difference was annualized based on the assumption of 250 production days per year.

29 Loris, Nicolas D. (2013) "Energy Production on Federal Lands: Handing Keys Over to the States" *Heritage Foundation Issue Brief*, No. 3979 June 27.

30 Loris, Nicolas D. (2013) "Energy Production on Federal Lands: Handing Keys Over to the States" *Heritage Foundation Issue Brief*, No. 3979 June 27.

31 Kathleen Sgamma, "The American Energy Initiative: A Focus on Growing Differences for Energy Development on Federal vs. Non-Federal Lands," testimony before the Subcommittee on Energy and Power, Committee on Energy and Commerce, U.S. House of Representatives, August 2, 2012, http://archives.republicans.energycommerce.house.gov/Media/file/Hearings/Energy/20120802/HHRG-112-IF03-WState-SgammaK-20120802.pdf.

32 Kathleen Sgamma, "The American Energy Initiative: A Focus on Growing Differences for Energy Development on Federal vs. Non-Federal Lands," testimony before the Subcommittee on Energy and Power, Committee on Energy and Commerce, U.S. House of Representatives, August 2, 2012, http://archives.republicans.energycommerce.house.gov/Media/file/Hearings/Energy/20120802/HHRG-112-IF03-WState-SgammaK-20120802.pdf.

33 (2012) "Unconventional Oil and Gas Development: Key Environmental and Public Health Requirements" *Government Accountability Office*, September.

34 Ratner, Michael; and Tiemann, Mary (2015) "An Overview of Unconventional Oil and Natural Gas: Resources and Federal Actions" *Congressional Research Service*, April 22.

35 Loris, Nicolas D. (2013) "Energy Production on Federal Lands: Handing Keys Over to the States" *Heritage Foundation Issue Brief*, No. 3979 June 27.

36 Spence, David "Is It Time for Federal Regulation of Shale Gas Production?" *Energy Management Brief*; https://www.mccombs.utexas.edu/~/media/Files/MSB/Centers/EMIC/Briefs/Energy-Brief-Is-It-Time-for-Federal-Regulation-of-Shale-Gas-Production.pdf.

37 *Bakken Shale: News, Marketplace, Jobs;* http://bakkenshale.com/.

38 Map is reproduced from the Minneapolis Federal Reserve and can be found online at: https://www.minneapolisfed.org/publications/special-studies/bakken/oil-production.

39 *Bakken Shale: News, Marketplace, Jobs;* http://bakkenshale.com/.

40 Data are from the *Energy Information Administration*: www.eia.gov.

41 Figure 10 presents the data for the entire state of North Dakota and the entire state of Montana. The tremendous growth in North Dakota's production is due, however, to growth in the production from North Dakota's border with Montana – the center of the Bakken formation.

42 Figure 11 presents the data for the entire state of North Dakota and the entire state of Montana. The tremendous growth in North Dakota's production is due, however, to growth in the production from North Dakota's border with Montana – the center of the Bakken formation.

43 See for instance, Anderson, Bradley (2012) "Missing the black gold rush: there is much Montanans can learn from the oil boom in neighboring North Dakota" *the American Spectator*, July 5; http://spectator.org/articles/35218/missing-black-gold-rush.

44 Anderson, Bradley (2012) "Missing the Black Gold Rush: there is much Montanans can learn from the oil boom in neighboring North Dakota" *the American Spectator*, July 5; http://spectator.org/articles/35218/missing-black-gold-rush.

45 Anderson, Bradley (2012) "Missing the Black Gold Rush: there is much Montanans can learn from the oil boom in neighboring North Dakota" *the American Spectator*, July 5; http://spectator.org/articles/35218/missing-black-gold-rush. Additionally, because known reserves tend to grow when there is an incentive to produce on the land, the disproportionate amount of production relative to known reserves in North Dakota compared to Montana may be even larger than the figures reported by Anderson.

46 Vincent, Carol Hardy, Hanson, Laura A. and Bjelopera, Jerome P. (2014) "Federal Land Ownership: Overview and Data" *Congressional Research Service*, December 29; https://fas.org/sgp/crs/misc/R42346.pdf.

47 Anderson, Bradley (2012) "Missing the Black Gold Rush: there is much Montanans can learn from the oil boom in neighboring North Dakota" *the American Spectator*, July 5; http://spectator.org/articles/35218/missing-black-gold-rush.

48 Galt, David (2014) "Montana Bakken vs. North Dakota Bakken" *Sidney Herald" May 2;* http://www.sidneyherald.com/news/montana-bakken-vs-north-dakota-bakken/article_20ff0b32-d17d-11e3-b1ad-001a4bcf887a.html.

49 Information on North Dakota's setback regulations are from: the North Dakota Industrial Commission (http://www.nd.gov/ndic/ogrp/info/g-015-033-faq.pdf), and the Interstate Oil and Gas Compact (http://iogcc.ok.gov/Websites/iogcc/images/2013_SOS/NorthDakota2012.pdf). Data on the setback proposals in Montana are from: (2015) "Setbacks in Montana should concern everyone" *NENews Now*; http://www.onenewsnow.com/business/2015/05/26/setbacks-in-montana-should-concern-everyone. It is important to note that setback regulations can be implemented differently, therefore direct comparisons should be made with care.

50 Mead, Brent (2015) "Rule is really about shutting down energy development" *Billings Gazette*, August 11; http://billingsgazette.com/news/opinion/guest/mead-rule-is-really-about-shutting-down-energy-development/article_6a7c1fd1-1713-5c02-8aec-a72211944b3f.html.

51 Winegarden, Wayne (2015) "The 50-State Small Business Regulation Index" *Pacific Research Institute*, July; http://www.pacificresearch.org/fileadmin/images/Studies_2015/SmBusinessIndex_UpdatedVersion2_web.pdf.

52 Dotter, Jay; and Manley, Mike (2014) "2014 Oregon Workers' Compensation Premium Rate Ranking Summary" *Oregon Department of Consumer and Business Services*, October; http://www.cbs.state.or.us/external/dir/wc_cost/files/report_summary.pdf.

53 (2015) "2015 Lawsuit Climate Survey: Ranking the States" *Institute for Legal Reform*, September; http://www.instituteforlegalreform.com/uploads/sites/1/executivereport.pdf.

54 (2015) "U.S. Crude Oil and Natural Gas Proved Reserves" *U.S. Energy Information Administration*, November 23; https://www.eia.gov/naturalgas/crudeoilreserves/.

55 *U.S. Energy Information Administration:* www.eia.gov.

56 *U.S. Energy Information Administration:* www.eia.gov.

57 For example, the Pacific Research Institute's 50-State Small Business Regulation Index ranked New York 41 and Pennsylvania 36. See: Winegarden, Wayne (2015) "The 50-State Small Business Regulation Index" *Pacific Research Institute*, July; http://www.pacificresearch.org/fileadmin/images/Studies_2015/SmBusinessIndex_UpdatedVersion2_web.pdf.

58 "Marcellus Shale - Appalachian Basin Natural Gas Play: A resource that moved from "marginal" to "spectacular" as a result of new drilling technology" *Geology.com*, http://geology.com/articles/marcellus-shale.shtml.

59 "Marcellus Shale - Appalachian Basin Natural Gas Play: A resource that moved from "marginal" to "spectacular" as a result of new drilling technology" *Geology.com*, http://geology.com/articles/marcellus-shale.shtml.

60 (2015) "U.S. Crude Oil and Natural Gas Proved Reserves" *U.S. Energy Information Administration*, November 23; https://www.eia.gov/naturalgas/crudeoilreserves/.

61 *Hydraulic Fracturing in Pennsylvania*; http://www.pennsylvaniafracking.com/economic-opportunity/.

62 Furchtgott-Roth, Diana; and Gray, Andrew (2013) "The Economic Effects of Hydrofracturing on Local Economies: A Comparison of New York and Pennsylvania" *Empire Center for New York State Policy*, May; http://www.manhattan-institute.org/pdf/gpr_1.pdf.

63 Furchtgott-Roth, Diana; and Gray, Andrew (2013) "The Economic Effects of Hydrofracturing on Local Economies: A Comparison of New York and Pennsylvania" *Empire Center for New York State Policy*, May; http://www.manhattan-institute.org/pdf/gpr_1.pdf.

64 Furchtgott-Roth, Diana; and Gray, Andrew (2013) "The Economic Effects of Hydrofracturing on Local Economies: A Comparison of New York and Pennsylvania" *Empire Center for New York State Policy*, May; http://www.manhattan-institute.org/pdf/gpr_1.pdf.

65 (2011) "Drilling for Jobs: What the Marcellus Shale could mean for New York" *Public Policy Institute of New York State, Inc.*, July; http://www.co.chenango.ny.us/planning/natural-gas/documents/Drilling-for-jobs-what-marcellus-shale-could-mean-for-NY.pdf.

66 Shaw, Jazz (2015) "Pennsylvania vs New York: A tale of two counties…and fracking" *Free Republic*, May 30; http://www.freerepublic.com/focus/news/3295650/posts.

67 See: http://www.eia.gov/naturalgas/crudeoilreserves/; and http://californiapolicycenter.org/the-benefits-and-costs-of-oil-and-gas-development-in-california/.

68 (2015) "Profile Analysis: California" *U.S. Energy Information Administration*, Last Updated September 17; https://www.eia.gov/state/analysis.cfm?sid=CA.

69 (2015) "Profile Analysis: California" *U.S. Energy Information Administration*, Last Updated September 17; https://www.eia.gov/state/analysis.cfm?sid=CA.

70 Avalos, Antonio; and Vera, David (2013) "The Petroleum Industry and the Monterey Shale: Current Economic Impact and the Economic Future of the San Joaquin Valley" *Western States Petroleum Association*, August 31; http://www.wspa.org/sites/default/files/uploads/The%20Petroleum%20Industry%20and%20the%20Monterey%20Shale%20-%20Fresno%20State%20Study.pdf.

71 Avalos, Antonio; and Vera, David (2013) "The Petroleum Industry and the Monterey Shale: Current Economic Impact and the Economic Future of the San Joaquin Valley" *Western States Petroleum Association*, August 31; http://www.wspa.org/sites/default/files/uploads/The%20Petroleum%20Industry%20and%20the%20Monterey%20Shale%20-%20Fresno%20State%20Study.pdf.

72 Avalos, Antonio; and Vera, David (2013) "The Petroleum Industry and the Monterey Shale: Current Economic Impact and the Economic Future of the San Joaquin Valley" *Western States Petroleum Association*, August 31; http://www.wspa.org/sites/default/files/uploads/The%20Petroleum%20Industry%20and%20the%20Monterey%20Shale%20-%20Fresno%20State%20Study.pdf.

73 Garthwaite, Josie (2013) "Monterey Shale Shakes Up California's Energy Future" *National Geographic* May 29; http://news.nationalgeographic.com/news/energy/2013/05/130528-monterey-shale-california-fracking/.

74 Garthwaite, Josie (2013) "Monterey Shale Shakes Up California's Energy Future" *National Geographic* May 29; http://news.nationalgeographic.com/news/energy/2013/05/130528-monterey-shale-california-fracking/.

75 Shauk, Zain; and Malik, Naureen S. (2014) "EIA Cuts Monterey Shale estimates on Extraction Challenges" *BloombergBusinesss*, May 21; http://www.bloomberg.com/news/articles/2014-05-21/eia-cuts-monterey-shale-estimates-on-extraction-challenges-1-.

76 Sharp, Dan (2014) "Technically recoverable oil in California Monterey shale severely downgraded" *Bismarck Tribune*, July 29; http://bismarcktribune.com/bakken/breakout/technically-recoverable-oil-in-california-monterey-shale-severely-downgraded/article_b36fcf50-1751-11e4-8e1b-0019bb2963f4.html.

77 Winegarden, Wayne (2015) "The 50-State Small Business Regulation Index" *Pacific Research Institute*, July; http://www.pacificresearch.org/fileadmin/images/Studies_2015/SmBusinessIndex_UpdatedVersion2_web.pdf.

78 (2015) "2015 Lawsuit Climate Survey: Ranking the States" *Institute for Legal Reform*, September; http://www.instituteforlegalreform.com/uploads/sites/1/executivereport.pdf.

79 Dotter, Jay; and Manley, Mike (2014) "2014 Oregon Workers' Compensation Premium Rate Ranking Summary" *Oregon Department of Consumer and Business Services*, October; http://www.cbs.state.or.us/external/dir/wc_cost/files/report_summary.pdf.

80 Tax burden data are from: (2016) "State-Local tax Burden Rankings FY 2012" *Tax Foundation*, January 20; http://taxfoundation.org/article/state-local-tax-burden-rankings-fy-2012.

81 Considine, Tim (2014) "The Benefits and Costs of Oil and Gas Development in California" *California Policy Center*, March 31; http://californiapolicycenter.org/the-benefits-and-costs-of-oil-and-gas-development-in-california/.

82 (2016) "Fracking in California" *Pacific Institute Issue Brief*, February; http://pacinst.org/wp-content/uploads/sites/21/2016/02/PI_IssueBrief_FrackinginCalifornia_Overview.pdf.

83 "The Story of California Crude" *Independent Petroleum Association of America*; http://oilindependents.org/the-story-of-california-crude/.

84 Gray, Tom (2012) "California Needs a Crude Awakening" *City Journal*, Summer; http://www.city-journal.org/2012/22_3_oil.html.

85 Johnson, Natalie (2015) "California Implements Strictest Fracking Regulations in the U.S." *the Daily Signal*, July 2; http://dailysignal.com/2015/07/02/california-implements-strictest-fracking-regulations-in-us/.

86 Lohan, Tara (2015) "Has California's Fracking Boom Already Gone Bust?" *Moyers & Company*, February 6; http://billmoyers.com/content/californias-fracking-boom-already-gone-bust/.

87 Gray, Tom (2012) "California Needs a Crude Awakening" *City Journal*, Summer; http://www.city-journal.org/2012/22_3_oil.html.

88 Cox, John (2015) "Political uproar over oil permitting resurfaces" *The Bakersfield Californian*, January 10; http://www.bakersfield.com/Blogs/2015/01/11/Political-uproar-over-oil-permitting-resurfaces.html.

89 Gray, Tom (2012) "California Needs a Crude Awakening" *City Journal*, Summer; http://www.city-journal.org/2012/22_3_oil.html.

About the Author

Wayne Winegarden

Wayne H. Winegarden, Ph.D. is a Sr. Fellow in Business & Economics, Pacific Research Institute, as well as the Principal of Capitol Economic Advisors and a Contributing Editor for EconoSTATS at George Mason University.

Dr. Winegarden has 20 years of business, economic, and policy experience with an expertise in applying quantitative and macroeconomic analyses to create greater insights on corporate strategy, public policy, and strategic planning. He advises clients on the economic, business, and investment implications from changes in broader macroeconomic trends and government policies. Clients have included Fortune 500 companies, financial organizations, small businesses, state legislative leaders, political candidates and trade associations.

Dr. Winegarden's columns have been published in the *Wall Street Journal, Chicago Tribune, Investor's Business Daily,* Forbes.com, and Townhall.com. He was previously economics faculty at Marymount University, has testified before the U.S. Congress, has been interviewed and quoted in such media as CNN and Bloomberg Radio, and is asked to present his research findings at policy conferences and meetings. Previously, Dr. Winegarden worked as a business economist in Hong Kong and New York City; and a policy economist for policy and trade associations in Washington D.C. Dr. Winegarden received his Ph.D. in Economics from George Mason University.

About Pacific Research Institute

The Pacific Research Institute (PRI) champions freedom, opportunity, and personal responsibility by advancing free-market policy solutions. It provides practical solutions for the policy issues that impact the daily lives of all Americans, and demonstrates why the free market is more effective than the government at providing the important results we all seek: good schools, quality health care, a clean environment, and a robust economy.

Founded in 1979 and based in San Francisco, PRI is a non-profit, non-partisan organization supported by private contributions. Its activities include publications, public events, media commentary, community leadership, legislative testimony, and academic outreach.

www.pacificresearch.org