THE HAMILTON PROJECT

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Modernizing Bonding Requirements for Natural Gas Producers

Lucas Davis

MISSION STATEMENT

The Hamilton Project seeks to advance America's promise of opportunity, prosperity, and growth.

We believe that today's increasingly competitive global economy demands public policy ideas commensurate with the challenges of the 21st Century. The Project's economic strategy reflects a judgment that long-term prosperity is best achieved by fostering economic growth and broad participation in that growth, by enhancing individual economic security, and by embracing a role for effective government in making needed public investments.

Our strategy calls for combining public investment, a secure social safety net, and fiscal discipline. In that framework, the Project puts forward innovative proposals from leading economic thinkers — based on credible evidence and experience, not ideology or doctrine — to introduce new and effective policy options into the national debate.

The Project is named after Alexander Hamilton, the nation's first Treasury Secretary, who laid the foundation for the modern American economy. Hamilton stood for sound fiscal policy, believed that broad-based opportunity for advancement would drive American economic growth, and recognized that "prudent aids and encouragements on the part of government" are necessary to enhance and guide market forces. The guiding principles of the Project remain consistent with these views.

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NOTE: This discussion paper is a proposal from the author. As emphasized in The Hamilton Project's original strategy paper, the Project was designed in part to provide a forum for leading thinkers across the nation to put forward innovative and potentially important economic policy ideas that share the Project's broad goals of promoting economic growth, broad-based participation in growth, and economic security. The authors are invited to express their own ideas in discussion papers, whether or not the Project's staff or advisory council agrees with the specific proposals. This discussion paper is offered in that spirit.

BROOKINGS

Abstract

Hydraulic fracturing and other recent technological advances have dramatically increased the availability of natural gas, potentially providing tremendous benefits to the U.S. economy. At the same time, however, these new forms of drilling raise a number of potential environmental concerns. Legislation dating back to the 1920s requires natural gas producers to post a bond prior to drilling to clean up sites when accidents occur, and to guarantee that producers adequately reclaim drilling sites after production is completed. This approach makes sense, but current minimum bond amounts provide inadequate levels of protection. Minimum bond amounts were set in 1960 and have never been updated for inflation.

This proposal would increase federal minimum bond amounts to adjust for inflation and encourage states to adopt similar minimum bond amounts for drilling on non-federal land. In addition, this proposal would eliminate provisions that currently allow companies to meet bonding requirements by posting a single "blanket" bond. Stronger bonding requirements would help ensure that funds would be available to clean up sites when accidents occur. But more importantly, stronger requirements would also incentivize producers to work hard to avoid environmental damages in the first place.

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Chapter 1: Introduction

Hydraulic fracturing and other recent technological advances have dramatically increased the availability of natural gas. After peaking in 2008, U.S. natural gas prices have fallen dramatically and industry analysts are forecasting that prices will remain low for the next several decades. This increase in the supply of natural gas has broad implications for energy markets in the United States and abroad. Energy is a key input in virtually all sectors of the economy, and inexpensive natural gas is good for growth. Natural gas is also less carbon-intensive than other fossil fuels, leading some to describe the fuel as the "blue bridge to a green future."

At the same time, these new forms of natural gas production raise a number of potential environmental concerns. Hydraulic fracturing requires injecting large quantities of water, sand, and chemicals at high pressure into horizontally drilled wells. Environmental groups are concerned, in particular, about potential contamination of groundwater and about the increased scope for large-volume surface spills. The U.S. Environmental Protection Agency (EPA) and other organizations are working to better understand the potential risks to human health and the environment, but it will be years before comprehensive analyses are available.

Although the scope for environmental damages is still poorly understood, it is not too early to examine the incentives produced by current policies. Currently, misaligned incentives lead natural gas producers to underinvest in environmental protection. Revenues from drilling are realized immediately. Environmental damages, however, may not become evident immediately. And by the time damages are well understood, producers may no longer exist or may no longer have the resources to finance necessary cleanups or to compensate those who have been affected.

The tort system is designed to recover damages in these cases. However, bankruptcy laws limit producers' liability significantly. This is particularly true with natural gas producers because the industry is composed primarily of small and medium-sized companies. In the United States there are hundreds of natural gas producers, none with more than a small share of the total market. Consequently, the tort system does not work as well as a deterrent as it does in many other industries.

Policymakers have long been aware of this misalignment of incentives. Since the 1920s, the U.S. Bureau of Land Management (BLM) has required that natural gas producers operating on public lands post a bond prior to drilling. Many states have bonding requirements that exceed the minimum federal requirements. These funds are used to clean up sites when accidents occur, and to guarantee that the producer adequately reclaims the drilling site after production is completed.

This approach makes sense, but current requirements are unreasonably low to counter these risks. The current minimum bond amount—$10,000 per lease—was set in 1960 and has never been updated for inflation. This amount is not enough to pay even for routine site reclamation expenses. One of the aims of this proposal is to increase the minimum bond amount to $60,000 per lease to adjust for inflation. This minimum bond amount would be indexed permanently to inflation, preventing the real value of bonds from eroding over time. States would, of course, continue to be able to impose bonding requirements that exceed the federal minimum.

Additional evidence supports further increasing minimum bond amounts above that implied by the inflation adjustment. Advanced drilling techniques involve larger and riskier drilling operations than the shallow vertical wells for which the legislation was originally designed. And the large quantity of chemically treated water used in hydraulic fracturing introduces new risks that are simply not present in traditional drilling. Determining the correct minimum bond amount is a challenging problem. Presently, the empirical evidence on potential environmental damages is extremely limited, and as better information becomes available, it will be important to revisit these minimum bond amounts with a view toward further increases.

This proposal would also eliminate provisions that allow companies to meet their bonding requirements by posting a single "blanket" bond. These provisions decrease significantly the average bond amount per well, and have often led to situations in which the available bond was insufficient to pay for necessary cleanups at multiple sites. This is particularly problematic for old wells. Natural gas production declines quickly after a well is first constructed, but most wells continue to produce at least a small amount for many years or even decades. It is important to ensure that funds are available to reclaim these sites even if the original drilling companies have long since disappeared.

Bonding requirements effectively complement traditional regulation by ensuring that standards are followed, even when it is impossible to assign regulators on the ground at all drilling sites. Bonding is particularly well-suited for addressing low-probability, high-cost environmental risks such as surface spills and blowouts. For other types of environmental concerns such as local pollutants from road traffic and methane emissions, policymakers should continue to focus on traditional regulation as the primary policy tool.

Strengthening bonding requirements would help motivate producers to work hard to avoid environmental damages. A producer that makes choices that minimize risks to the environment gets this bond back with interest. A producer that makes choices that lead to environmental damages does not. This is a market-based solution for a market failure—a balanced approach that supports the continued growth of this valuable energy resource, while also forcing producers to become responsible for their choices and how they impact the environment.

Chapter 2: The Misalignment of Incentives

A PERVASIVE PROBLEM

Companies constantly make decisions that affect the environment, and investments in environmental protection are expensive, so companies must make tradeoffs between profits and the risk of environmental damages. Revenues are typically realized quickly, but environmental damages impose costs over many years. By the time damages are well understood, the company may no longer exist or may no longer have the resources to finance necessary cleanups or to compensate those who have been affected. The costs of cleaning up may have to be borne by the public. Bankruptcy laws limit companies' liabilities, and there is a long and unfortunate history in the United States of public funds being used to clean up environmental damages caused by industry (Boyd 2001).

Probably the best known example is the EPA's Superfund Program. Over the past several decades, the EPA has spent approximately $35 billion to clean up 800 sites through its Superfund, which is an average cost of about $43 million per site (see Box 1). The costs of cleanups depend on the sizes and characteristics of nearby groundwater and surface water resources, and the sites' proximity to towns and cities.

Policymakers can use a variety of tools to help prevent these outcomes. With some types of environmental damages, it makes sense to target policies at the very beginning, before environmental damages are realized. The tools used most often in this context are taxes, cap-and-trade and command-and-control regulations. The tool that works best depends on the context. Emissions of criteria air pollutants (e.g., sulfur dioxide and nitrogen oxides), for example, are typically best addressed using taxes or cap-and-trade regulations. The damages from criteria air pollutants are well understood, emissions are relatively easy to monitor, and these market-based tools facilitate reduced emissions at minimum cost.

In other cases, traditional regulations make more sense. For example, the insecticide DDT has been banned in the United States since 1972. Environmental damages associated with its use are so large, and there are such good substitutes, that no person or company would use DDT if they faced the full social costs of its use. In these cases, an outright ban makes sense.

A different set of tools is used when there are low-probability, high-cost environmental risks. Again, command-and-control regulation is a primary tool, but policymakers also may use mandated insurance and bonding requirements. Mandated

BOX 1.

Environmental Cleanups Paid for by U.S. Taxpayers

Over the past several decades, $35 billion of federal money has been spent cleaning up 800 of the most hazardous waste sites in the country through the U.S. EPA's Superfund Program (Greenstone and Gallagher 2008). But these 800 sites are just the beginning. The EPA has identified 47,000 hazardous waste sites across the United States potentially requiring clean up. The National Priorities List names hundreds of seriously contaminated sites that require immediate attention (GAO 2010b).

No responsible party can be found to finance the cleanup at most of these sites. During the early years of the Superfund Program, the EPA was able to recover from responsible parties only $1.2 billion of the $8.7 billion it spent on cleanups (GAO 1994). This rate has continued to date. As of 2010, there are 416 sites on the National Priority List requiring cleanups, but the EPA has been able to identify potentially responsible parties for only 206 of those sites. At 27 of these 206 sites, the EPA is not confident that the responsible party will be able to fund cleanups, for example, because the responsible party has entered bankruptcy (GAO 2010b). Moreover, even in cases where a responsible party has been identified and is not bankrupt, it may not have the financial resources to finance 100 percent of the cleanup.

TABLE 1.

Existing Minimum Bonding Requirements for Drilling on Federal Lands

	Minimum Bonding Amount Required by Law:
Per Lease	$10,000
Blanket Bonds	
Statewide	$25,000
Nationwide	$150,000
Average number of wells per lease	5.3

insurance is important in the nuclear power sector. Over the fifty-plus-year history of nuclear power, several serious accidents have imposed immense environmental damages over wide geographic areas. In the United States, these risks are partially addressed by mandated insurance. All nuclear plants must buy private insurance covering public liability from accidents up to a particular dollar amount that has changed over time. Mandated insurance is an important complement to traditional regulation. The Nuclear Regulatory Commission establishes standards for all elements of nuclear power plant construction, operation, and storage of waste fuel. Mandated insurance is not a substitute for these regulations, but instead serves a different role, helping to finance costs when accidents occur.

Bonding requirements work similarly but address the misalignment of incentives. If no environmental damages occur, the company gets the bond back with accrued interest. This makes bonding requirements different from insurance, which partially insulates agents from the consequences of their actions. When a company pays an insurance premium, this money is gone forever, regardless of what happens. In contrast, a bond is the producer's own money at stake, which increases the incentive to make good choices.

EXISTING POLICIES FOR NATURAL GAS PRODUCERS

The misalignment-of-incentives problem is ubiquitous in mineral extraction of energy products such as oil, natural gas, and coal, and other mined minerals such as iron, uranium, and limestone. Mineral extraction is risky—there is always the risk of environmental damage to local areas, property, and the health of nearby communities. At the same time, these resources have tremendous benefits to our well-being and economy—resources such as coal, oil and gas literally power our lives. We need to extract these resources in a way that balances benefits and risks. The challenge for policymakers is to motivate producers to take appropriate care in deciding when and where to operate, how to operate, and how to dispose of wastes.

Policymakers have long been aware of this misalignment of incentives. Oil and natural gas drilling has a particularly long history. Since the Mineral Leasing Act of 1920, oil and natural gas producers in the United States have been required to post

BOX 2.

Types of Bonds Currently Issued

Bonds must be one of two types: a personal bond or a surety bond. To date, existing bonds have fallen about equally in both categories (GAO 2010a). With a personal bond the producer deposits the required amount of financial assets with the BLM. Personal bonds can take the form of low-risk assets such as certificates of deposit or negotiable U.S. Treasury securities. Thus the producer earns interest on the bond year after year. If the market value of the asset ever falls below the required minimum level, the producer is required to pledge additional assets.

A surety bond is a third-party guarantee that the producer purchases from an insurance company. If there are no environmental damages, then the insurance company pays nothing. Surety bonds are typically "experience-rated," so a producer that has a good record of environmental protection pays lower premiums. This experience rating helps mitigate the misalignment of incentives because a forward-looking producer takes into account potential changes in premium levels when making decisions that affect the environment.

TABLE 2.

Existing State Bonding Requirements and the Growth in Proven Shale Reserves

State	Bond amount depends on well depth	Minimum bond amount per well ($)	Blanket bond amounts ($)	Proven shale reserves, billions of cubic feet (where available) 2007	2009
Alabama	Y	5,000-50,000	100,000	1	0
Alaska	N	100,000	200,000	0	0
Arizona	Y	10,000-20,000	25,000-250,000		
Arkansas	n.s.	Not to exceed $100,000	n.s.	1,460	9,070
California	Y	15,000-30,000	100,000-1,000,000		
Colorado	Y	10,000-20,000	60,000-100,000	0	4
Delaware	N	n.s.	n.s.		
Florida	Y	50,000-200,000	1,000,000		
Georgia	N	not to exceed $50,000	50,000		
Idaho	N	10,000	25,000		
Illinois	Y	1,500-3,000	25,000-100,000		
Indiana	N	2,500	45,000		
Kansas	Y	7,500-30,000	30,000-45,000		
Kentucky	Y	500-5,000	10,000-100,000	21	55
Louisiana	N	n.s.	n.s.	6	9,307
Maryland	N	Not to exceed 100,000	Not to exceed 500,000		
Michigan	Y	10,000-30,000	100,000-250,000	3,281	2,499
Mississippi	Y	10,000-50,000	100,000		
Missouri	Y	1,000-4,000	20,000-30,000		
Montana	Y	1,500-10,000	50,000	140	137
Nebraska	N	5,000	25,000		
Nevada	N	10,000	50,000		
New Mexico	Y	5,000-12,500	50,000	12	36
New York	Y	2,500-250,000	25,000-2,000,000		
North Carolina	Y	5,000 + 1 dollar per foot	n.s.		
North Dakota	N	50,000	100,000	21	368
Ohio	N	5,000	15,000	0	0
Oklahoma	N	Plugging cost	25,000-50,000	944	6,389
Oregon	Y	10,000-25,000	100,000-no limit		
Pennsylvania	Y	Varies	250,000-600,000	96	3,790
South Dakota	N	5,000	20,000		
Tennessee	N	2,000	10,000		
Texas	Y	2 dollars per foot	25,000-250,000	17,256	28,167
Utah	Y	1,500-60,000	15,000-120,000		
Virginia	N	10,000	25,000-100,000		
Washington	N	Not less than 50,000	Not less than 250,000		
West Virginia	N	50,000	250,000	0	688
Wyoming	Y	10,000-20,000	75,000	0	0
29 states that specify minimum amount	Mean	15,534			
	Median	10,000			
33 states that specify blanket bond amount	Mean	239,242			
	Median	100,000			
US Total				**23,304**	**60,644**

Note: "n.s." - not specified in legislation.

Source: DOE (2010b); GAO (2010a); Groundwater Protection Council n.d.; Pennsylvania Legislature, H.B. 1950, §3225; West Virginia Legislature H.B. 401, §22-6A-15.; MDE's Office of the Secretary, n.d.

bonds before drilling on federal lands. These bonds were designed to ensure that producers fulfilled their obligations to clean up the site after production was completed. Producers can post one of two types of bonds (see Box 2) to ameliorate environmental damages that occur during the course of the project. In many cases, drilling results in no significant environmental damage, and the producers adequately reclaim the drilling site. In these cases, the producer receives the bond back in entirety along with accrued interest.

The Mineral Leasing Act and its subsequent revisions establish a federal minimum bond amount of $10,000 for an individual lease on federal lands (Table 1). On average there are about five wells per lease, which implies a minimum bond per well of $2,000. This dollar amount was set in 1960 and has never been updated for inflation. Alternatively, producers can post blanket bonds that cover all wells within a given state or even nationwide. A producer can post a $25,000 bond to cover all of the leases in a given state, or $150,000 to cover all leases in all states. These dollar amounts for blanket bonds were set in 1951 and have never been updated for inflation.

Many states have bonding requirements for oil and gas drilling that exceed the minimum federal requirements. State-level requirements extend bonding requirements to drilling on non-federal lands, and in most cases increase the required bond amounts above the federal minimum levels (GAO 2010a). Like the federal requirements, most states allow producers to post either bonds for individual wells or blanket bonds that cover all drilling activity in the state. Some states use a single minimum bond amount regardless of the well's characteristics, while others determine minimum amounts based on the depth of the well. The minimum dollar amounts range from $500 (Kentucky) to $100,000 (Alaska). In light of recent discoveries in proved shale reserves (see last two columns of Table 2), many states are currently considering increasing bonding requirements, while some states, such as Pennsylvania and West Virginia, already have.

Federal and state laws determine what happens when there are changes in well ownership. Bonds stay with wells and not with producers, so when a well is sold, the ownership of the bond transfers at the same time, and there is no lapse in bond coverage. In cases of bankruptcy, the bonds cannot be used to pay generic company debts until such time that the funds are returned according to the normal rules for returning bonds—after a well has finished production.

With natural gas wells, production declines quickly after a well is first constructed, but most wells continue to produce at least a small amount of natural gas for years to come. When production is completely finished, the BLM inspects the site and verifies that reclamation efforts have been successful. Similar procedures are used with state-level bonds.

Chapter 3: Prospects and Challenges

Shale gas and other unconventional sources of natural gas have tremendous potential benefits for the U.S. economy, but they also pose new and unknown risks. This section begins with a discussion of hydraulic fracturing ("fracking") and why traditional bonding requirements may be inadequate to address the potential environmental risks from this form of drilling. The section then examines the industry more closely, showing that companies involved in hydraulic fracturing tend to be small and medium-sized companies, and argues that this market structure likely exacerbates the misalignment of incentives.

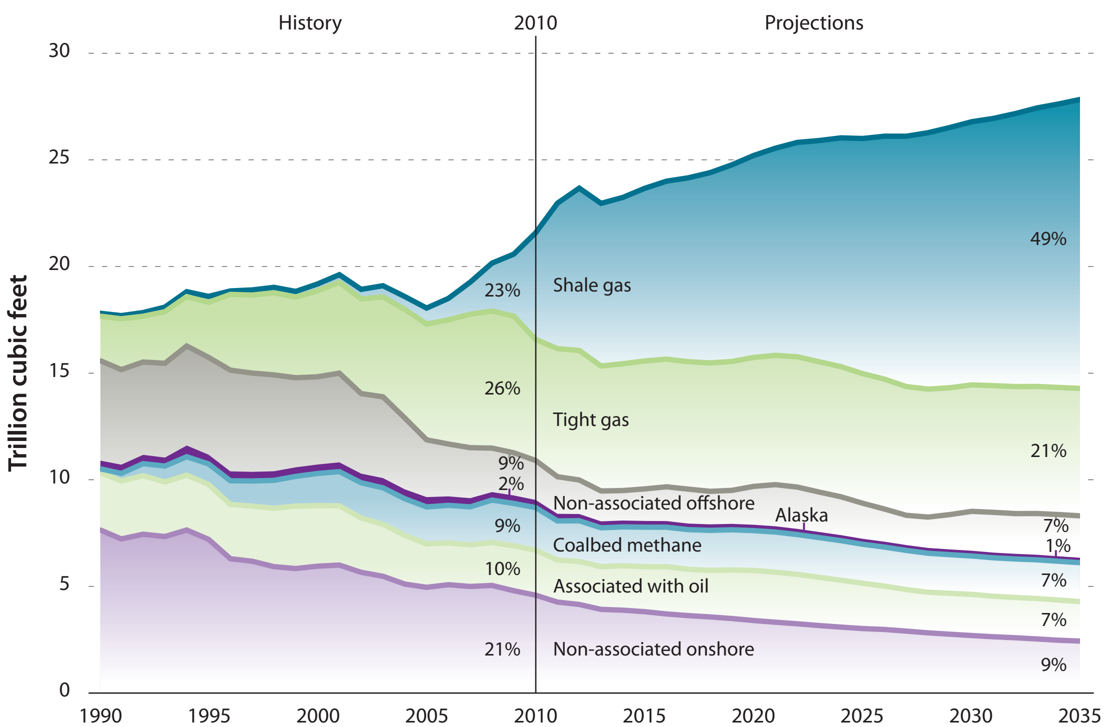
PROSPECTS FOR NATURAL GAS

Natural gas producers have long known that shale and other rock deposits contain large amounts of natural gas, but only recently did it become known how these reserves could be accessed at low cost. Hydraulic fracturing is made possible by the combination of two technologies. First, improvements in horizontal drilling techniques now allow drillers to control drilling operations thousands of feet below the earth's surface. Second, computer applications can map these underground resources with a high degree of detail.[1]

Unconventional natural gas sources, including shale gas, coal-bed methane, and "tight" gas sands, represented more than half of U.S. natural gas production in 2010. Looking to the future, shale gas is probably the most important of the three. Virtually non-existent just a few years ago, shale gas has grown to represent 23 percent of all U.S. natural gas production (see Figure 1) and is forecast to more than double by 2035 and make up almost half of total U.S. production. Based on current estimates of recoverable reserves, the United States has enough shale gas to meet current levels of demand for the next one-hundred years.

FIGURE 1.

U.S. Natural Gas Production, 1990–2035



Source: DOE (2012); production is reported in trillions of cubic feet per year.

This dramatic increase in the supply of natural gas has broad implications for energy markets in the United States and abroad. Since 2008, U.S. natural gas prices have fallen dramatically and, as of May 2012, are at about one-quarter the level that was observed at the peak in 2008. Figure 2 plots natural gas prices from 1990 to 2011, with predicted prices through 2035. The U.S. Department of Energy (DOE) (2011a) predicts that natural gas prices will remain low for the next two decades.

Low prices mean that natural gas has become the dominant choice in many sectors of the U.S. economy. Even before the recent price decreases, natural gas was the overwhelming choice for residential and commercial heating. In addition, natural gas has become the fuel of choice for investments in new electricity generation. At current natural gas prices, the total lifetime cost of electricity from combined-cycle natural gas plants is $66 per megawatt hour, compared to $94 for coal, and even more for renewable forms of electricity generation such as wind and solar (DOE 2010a). And natural gas is increasingly important to industrial customers as well.

The increase in the supply of natural gas also has important implications for the environment. Natural gas is less carbon-intensive than other fossil fuels; it produces about half the carbon dioxide emissions as coal does. The differences are even greater for criteria pollutants such as sulfur dioxide, nitrogen oxides, and particulates. Economists refer to the damages to health and environment from these pollutants as negative externalities, or "external costs," because they are not included in the price of the goods produced. Muller, Mendelsohn, and Nordhaus (2011), for example, calculate that the external costs from criteria pollutants of natural-gas–fired electricity generation are about one-thirtieth the size of the external costs of coal-fired electricity generation.

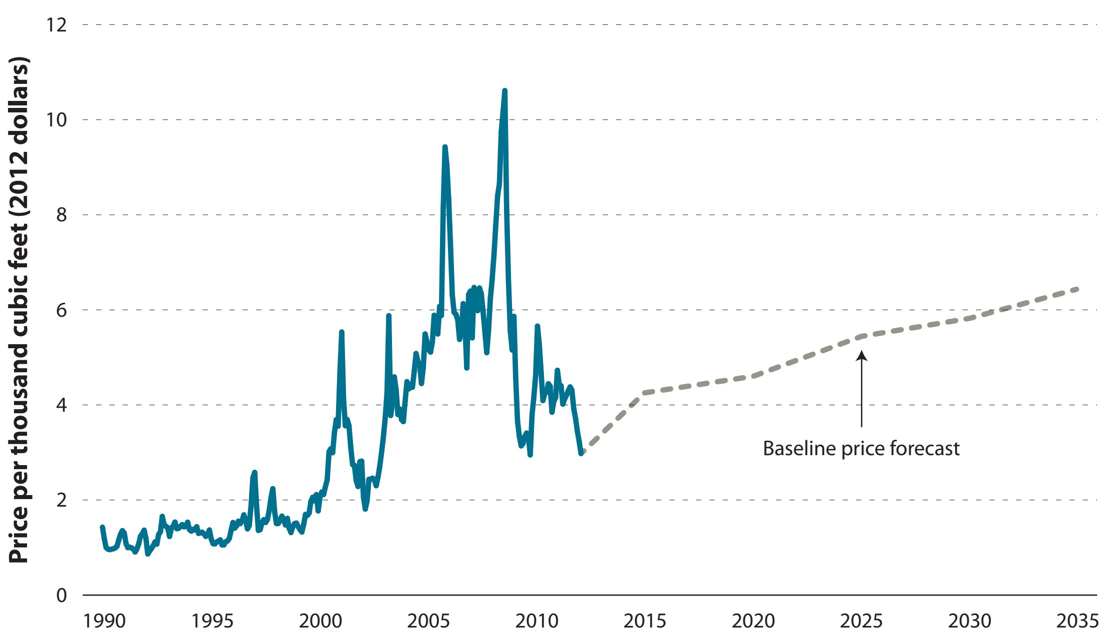
POTENTIAL ENVIRONMENTAL RISKS

There are many environmental concerns about hydraulic fracturing, and there is much that is unknown about potential environmental risks. This section provides a brief overview. While it is true that hydraulic fracturing has been performed for many years, the techniques are evolving too rapidly to make strong statements based on the historical record. The EPA is conducting a large-scale national study on the potential environmental effects of hydraulic fracturing and plans to make available an initial study during 2012, with a full report scheduled for 2014.

Risks to groundwater. To understand environmental concerns about hydraulic fracturing, it is necessary to understand the well construction process. Shale gas and other unconventional natural gas resources are accumulations of natural gas trapped within rock or sand formations with low permeability (see Figure 3). Conventional natural gas fields, in contrast, are large, open reservoirs of natural gas. Conventional natural gas resources can be extracted using vertical wells, but unconventional resources usually require horizontal drilling

FIGURE 2.

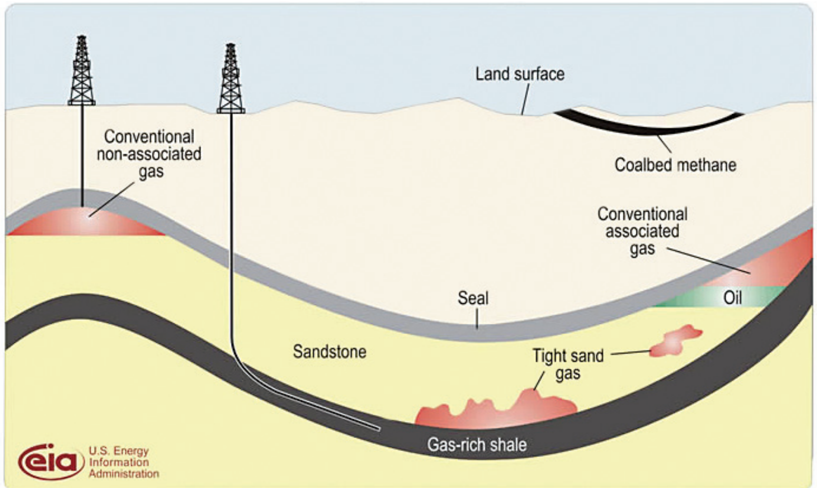
U.S. Natural Gas Prices, 1990–2011



Source: Author's tabulation based on data from DOE (2011a, 2011b).

FIGURE 3.

Natural Gas Resources



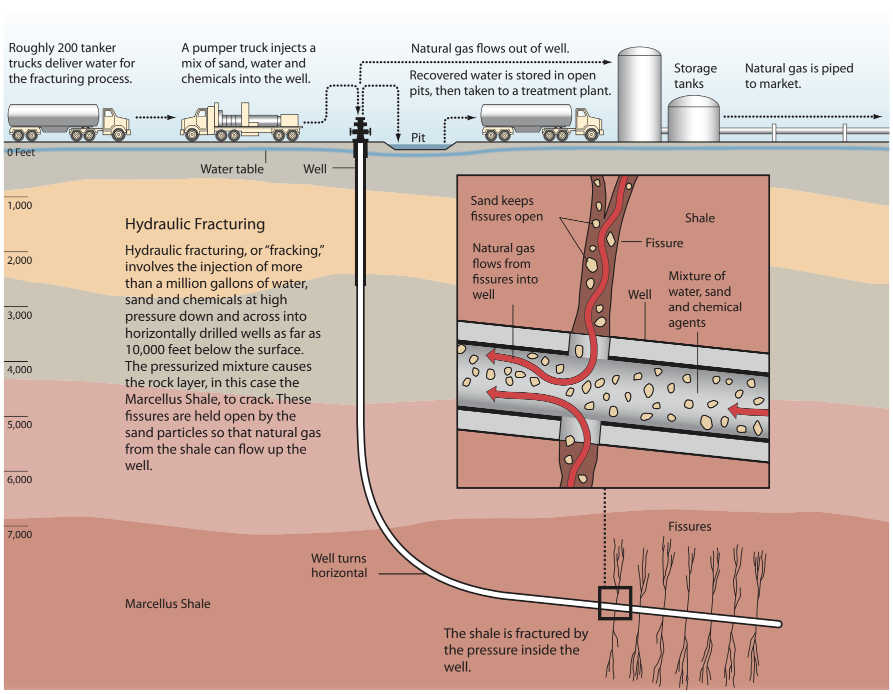
Source: DOE (2010c)

and hydraulic fracturing. The objective of hydraulic fracturing is to open these rock or sand formations and create pathways through which natural gas can move.

Drilling a well consists of several steps (see Figure 4). The producer first drills a shallow well, lines the well with high-strength, steel pipe called casing, and then cements the pipe by pumping cement between the casing and the wellbore wall. This process of drilling, casing, and cementing is repeated several times at progressively lower depths. These first steps are critical from an environmental perspective because it is only at these shallow depths (less than 1,000 feet) that groundwater is present. The drilling turns horizontal once the target zone has been reached. For shale gas this typically occurs between 5,000 and 10,000 feet. At this point hydraulic fracturing is performed. The producer injects large quantities of water,

FIGURE 4.

Well Construction



Source: Al Granberg/ProPublica

sand, and chemicals at high pressure into the horizontal well to break apart rock and sand formations, opening pathways through which the natural gas can move.

Hydraulic fracturing occurs deep underground, far from groundwater, and most experts believe there is limited scope for natural gas to migrate through the rock up to groundwater. The fractures created during the process can be hundreds of feet long, but in most cases will be thousands of feet from the shallow freshwater resources. Reported cases of groundwater contamination are likely due to hydraulic fracturing at shallower depths than is typically performed today, unexpected encounters with more shallow natural gas accumulations, or failures in the integrity of the wellbore as it passes through the shallow surface areas.[2]

Proper well construction technique and risk mitigation can minimize the risk of failures in the wellbore. Casing and cementing have been used for decades, and most producers are well-skilled in these techniques. And high-pressure and sonic tests exist that allow producers to evaluate the integrity of the wellbore before hydraulic fracturing begins. If the cementing has not adhered adequately to the steel casing, for example, then additional techniques are available to re-cement the well. Regulations exist that govern proper techniques in well construction that, if used in all cases, should provide an adequate level of protection for groundwater.

The value of these groundwater resources is high, so these concerns merit close attention even when the underlying level of risk for a given project is low. The Department of Energy is forecasting a doubling in shale gas production between now and 2035, implying tens of thousands of new wells. Even if the risk per well is extremely small, this means that there will likely be unusual cases in which groundwater contamination occurs. Strengthening bonding requirements would provide extra incentives for natural gas producers to act prudently in well construction, particularly when drilling, casing, and cementing at shallow depths, to reduce this risk as much as possible.

Other Environmental Risks. Another environmental concern is the volume of water consumption. Millions of gallons of water are injected into wells during hydraulic fracturing. Supporters of hydraulic fracturing point out that the amount of water used is small compared to, for example, total water consumption at a state level. This is correct. However, in particular regions, the water used in hydraulic fracturing can represent a large fraction of water consumption (Galbraith 2012). In locations where water is in short supply or priced below its social cost, this can be a significant problem.

Environmental advocates also point to the large amount of wastewater produced by the hydraulic fracturing process, which contains hundreds of types of chemicals. For many years, the exact mix of chemicals was regarded as proprietary, but today information about the amounts and types of chemicals used in hydraulic fracturing is becoming more available. It makes sense to require disclosure of this information and to work to reduce the use of toxic chemicals.

Many of these chemicals are hazardous to human health, and there are concerns that the wastewater could enter drinking water reservoirs. Some of the water stays in the wells or can be re-injected into the wells after natural gas has been extracted. Large amounts of contaminated water, however, come up to the surface and must either be treated or stored on-site.[3] Surface pits are often used to store wastewater, so ensuring that these pits are large enough and constructed well enough to avoid spills is a high priority.

If not handled appropriately, the concern is that an on-surface spill could lead to contamination of local waterways. The contamination of a major water source could easily impose hundreds of millions of dollars in damages. A recent oil pipeline spill in near Marshall, Michigan, provides a point of comparison. In July 2010, the Enbridge Energy Pipeline spilled 843,000 gallons of oil, contaminating a thirty-five-mile stretch of the Kalamazoo River. It is estimated that cleaning up the spill will cost more than $500 million (Frosch and Roberts 2011).

Existing commercial facilities may not be equipped to handle this wastewater. Although many of the chemicals used in hydraulic fracturing are relatively common, this is not what the facilities were designed for. There is also the question of whether existing facilities can treat the volume of wastewater produced. Some states have moved to impose controls on what producers can do with their wastewater. Pennsylvania requires that wastewater from hydraulic fracturing be pre-treated before it is sent to a public wastewater facility (Brown 2011).

With natural gas drilling there is also the small risk of a blowout. Natural gas accumulations are highly pressurized. Blowout preventers and other pressure control equipment are designed to control natural gas as it exits the well, but equipment failure or operator error can lead to an uncontrolled release. This happens occasionally with oil drilling as well, as was recently witnessed with the British Petroleum Deepwater Horizon accident. Blowouts signal enormous emissions of natural gas, which, as we discuss below, is a problem in itself. And a blowout causes drilling fluids to be spewed over a wide area, potentially contaminating nearby surface water and causing widespread land contamination.

For example, in April 2011, there was a blowout in a well in northern Pennsylvania owned by Chesapeake Energy Corp. According to media reports, the well spewed drilling fluids and brine for more than twelve hours, leaking into the Susquehanna River, which flows into Chesapeake Bay (Associated Press 2012).

The extent of environmental damages is still not well understood, but the accident suggests that blowouts have the potential to cause land and water contamination over a wide geographic area. When a major body of surface water is contaminated, this can affect thousands or even millions of households.

Bonding requirements are well suited to address both surface spills and blowouts. Both are low-probability, high-cost events for which it is important to ensure that funds are available when accidents occur. Moreover, in both cases, industry best practices (maintaining sufficient surface storage for wastewater, investing in high-quality blowout preventers, etc.) can substantially reduce the probability that accidents occur, and strengthening bonding requirements would increase the incentives for this behavior.

Air Pollution. Finally, hydraulic fracturing raises concerns about air pollution, including local pollutants from road traffic, regional pollutants (volatile organic compounds), and uncaptured methane. Methane is a potent greenhouse gas, and some scientists report that hydraulic fracturing releases large amounts of methane into the atmosphere (Tollefson 2012). Many producers have taken steps to reduce these emissions to the extent possible because uncaptured methane represents lost profits.

Bonding requirements are less well suited to address air pollution. For example, road traffic is predictable and easily measured, and vehicle emissions are already regulated under existing federal and state legislation. Thus while it makes sense for communities to consider these costs when deciding whether or not to allow production in some areas, it does not make sense to think about using a bond to perform an environmental cleanup of damages from road traffic.

Similarly, all drilling projects will cause some emissions of criteria pollutants and methane at the wellhead, and these externalities are probably best addressed with traditional regulation. Volatile organic compounds are already regulated under the Clean Air Act, and the social costs of these emissions are well understood. Moreover, the EPA recently enacted minimum standards that will require all natural gas producers to capture or combust emissions from well completions and all producers to use gas-capture equipment by 2015.[4]

Bonding requirements are best suited for addressing low-probability, highly localized risks such as groundwater contamination, surface spills, and blowouts. These events can be minimized with best practices, and bonding requirements strengthen incentives for producers to use industry best practices. In addition, bonding requirements also help guarantee that, upon completion of production, the producer adequately plugs the well, removes all equipment, and restores the land to the extent possible to its original condition. In the United States there are thousands of abandoned hazardous waste sites, and one objective of bonding requirements is to prevent these drilling sites from ending up requiring public funds for cleanups.[5]

MARKET STRUCTURE

The misalignment of incentives is particularly acute with natural gas drilling because most hydraulic fracturing is performed by small and medium-sized companies. Figure 5 describes market concentration for hydraulic fracturing and compares it with market concentration in deepwater oil drilling. These data describe wells that were being actively drilled as of March 2012. The area of the circles is proportional to the number of wells being drilled.

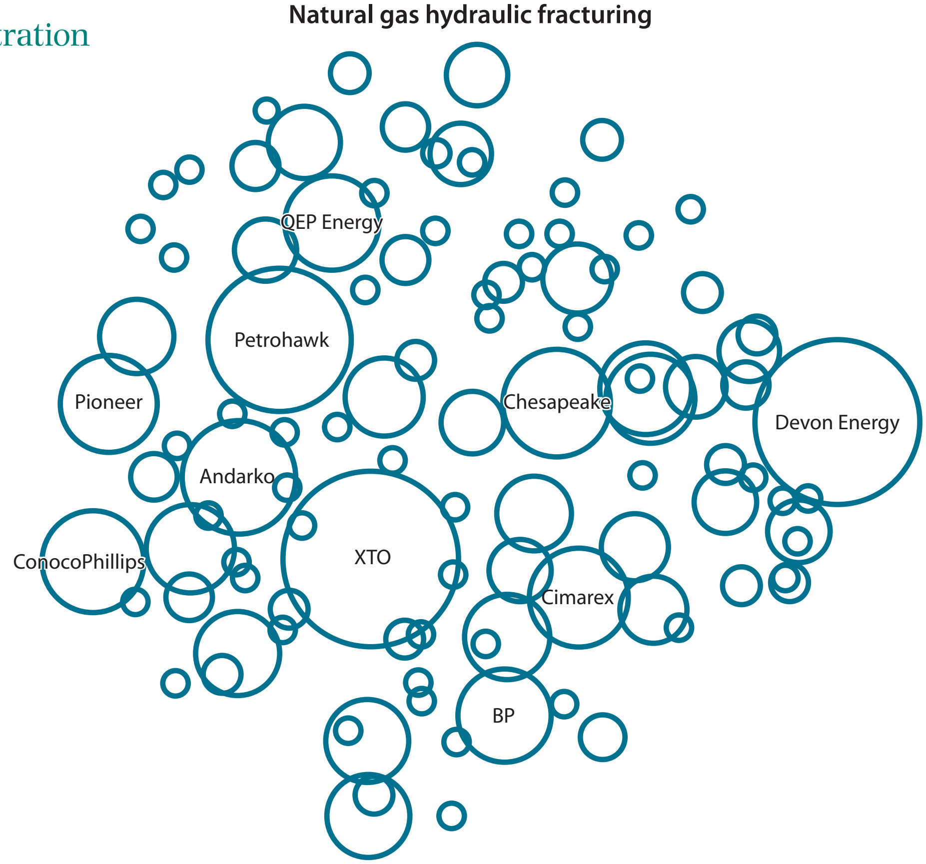
The presence of so many small and medium-sized firms in hydraulic fracturing raises concerns about the ability to finance environmental cleanups. When environmental damages occur, small producers may lack the resources to finance necessary cleanups and to compensate those who have been affected.

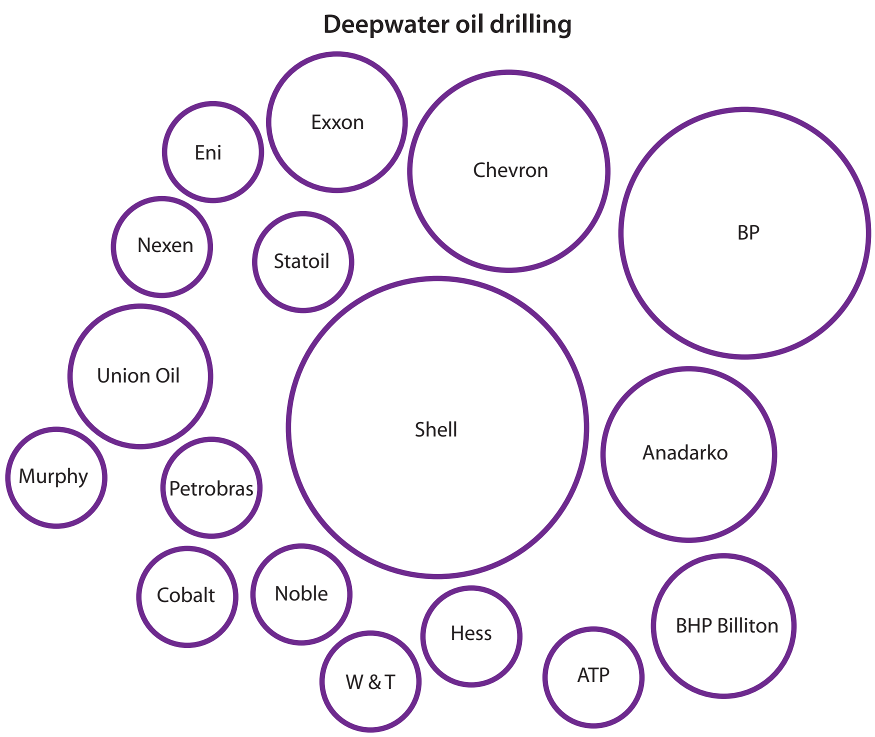
Figure 5 shows that there are a large number of companies involved in hydraulic fracturing. Although there are a few large producers, the market is relatively unconcentrated. The largest producer, XTO Energy Inc., has 9 percent of the market; the ten largest producers have 41 percent. Moreover, as of March 2012, fifty-one producers were drilling only a single well.[6] In contrast, deepwater oil drilling in the Gulf of Mexico is more concentrated. The largest producer as of March 2012 (Shell) has 24 percent of the market, and the ten largest producers have 78 percent. Deepwater drilling is capital and technology intensive, and a limited number of producers worldwide has the level of sophistication necessary for these projects.

The presence of so many small and medium-sized firms in hydraulic fracturing raises concerns about the ability

FIGURE 5.

Market Concentration





Note: This figure describes market concentration in natural gas hydraulic fracturing and deepwater oil drilling, respectively. The figure was constructed by the author using data from SmithBits "U.S. Weekly Rig Detail Report" for March 23, 2012, and Bureau of Ocean Energy Management, Regulation and Enforcement, "Current Deepwater Activity" for April 2, 2012. These data describe wells that are actively being drilled. To focus on hydraulic fracturing we restricted the sample to all horizontal and directional development wells for natural gas with a target depth in excess of 5,000 feet, leaving 442 total wells being produced by 104 producers. Each circle represents one company, and the area of the circles is proportional to the number of wells being drilled.

BOX 3.

Case Study: Exxon-Valdez and the Deepwater Horizon

In 1989, the Exxon Valdez oil tanker struck a reef off Prince William Sound, Alaska, and spilled more than 11 million gallons of crude oil. The spill was the largest in U.S. history until 2010, when an explosion on the Deepwater Horizon drilling rig led to a gushing underwater wellhead from which an estimated 210 million gallons of crude oil were released over three months.

Following the Exxon Valdez oil spill, the Oil Pollution Act (OPA) was passed in 1990, establishing the Oil Spill Liability Trust Fund (OSLTF) to pay for emergency cleanup of oil spills. The OSLTF is funded through a tax on domestic and imported oil, which is currently 8 cents per barrel. This legislation also set liability caps on oil producers that are not adjusted for inflation; the caps have decreased in value over time.

Both of these key provisions of the OPA serve to exacerbate the misalignment of incentives (Greenstone 2010). Although it sounds similar to a bond, the OSLTF is actually one single communal fund for the entire industry. Producers pay into the fund but are not the residual claimants for these funds. Unlike a bond, a producer that exercises best practices does not get this money back. And when accidents occur, the fund is available to help pay for damages. Moreover, the liability caps ensure that producers do not face the full costs of accidents.

Following the Deepwater Horizon oil spill, President Obama asked BP to establish a multibillion-dollar escrow account administered by an independent third party to compensate victims. BP responded by establishing a $20 billion fund to reimburse individuals or groups that have been affected by the spill. Again, this is a fund that, at least superficially, seems similar to bonding requirements. BP's fund is very different, however, because it was established after the damages had occurred.

to finance environmental cleanups. When environmental damages occur, small producers may lack the resources to finance necessary cleanups and to compensate those who have been affected. After the Deepwater Horizon accident, British Petroleum (BP) immediately established a $20 billion fund from which to pay for the cleanup and to compensate individuals or groups that would be affected (see Box 3). Most companies that perform hydraulic fracturing do not have this level of financial resources. It is relatively easy for small producers to enter and exit the market, and bankruptcy laws limit the liability of any producer to the total value of the company. A single severe accident for most of these producers would put them into bankruptcy, leaving the cleanup to be financed with public funds.

In theory, the tort system is designed to recover damages in the event of an accident. Bankruptcy laws limit this liability significantly, however, because many of these natural gas companies are small. For them, potential environmental damages exceed the total value of the company, so the tort system provides an insufficient deterrent. This is a problem both because it means that the companies may not be able to afford cleanups and because it reduces the incentives for producers to act prudently. The companies may choose higher-risk practices than they would if they were responsible for the full costs of all potential environmental damage.

Chapter 4: Detailed Proposal

This section describes the proposal in detail. Although the basic approach of posting a bond before drilling—a policy already in place in many states and on federal lands—makes sense, this section contends that the minimum required amounts are inadequate and outlines some approaches for considering a more reasonable amount.

INCREASE BOND AMOUNTS FOR DRILLING ON FEDERAL LANDS

Current minimum bond amounts are too low to ensure adequate environmental protection. Minimum bond amounts were set in nominal dollars and have never been adjusted for inflation. During this period the price of everything has gone up, including the price of environmental cleanups. A $10,000 bond per lease is not enough even to pay for routine site reclamation expenses (GAO 2010a, Mitchell and Casman 2011) and is negligible compared to the costs that are incurred when accidents happen.

This proposal would increase the minimum bond amount to adjust for inflation. Since the minimum dollar amount was set more than fifty years ago, prices have increased about six-fold (see Figure 6). Adjusting for inflation, the minimum bond amount would increase to $60,000. With approximately five wells per lease, about $12,000 per well is still a relatively modest bond. This amount would then be permanently indexed against inflation to ensure that the value does not decrease over time. The increase would take effect for new wells only, and the minimum bond amount would remain the same throughout the life of a well. Thus, for example, a gas producer would not be required to post additional assets to existing bonds even if the real value of those bonds falls over time.

Increasing minimum bond amounts to account for inflation is an important first step to protecting the environment from potential damages. A strong argument could be made, moreover, for further increasing minimum bond amounts above $60,000. As discussed above, hydraulic fracturing is riskier than the traditional techniques for which this legislation was designed. Hydraulic fracturing requires injecting large quantities of chemically treated water into the wellbore, which increases the probability of damaging surface spills. These wells also tend to be at higher depths where gas is under higher pressure, thus increasing the chances of groundwater contamination, blowouts, and other types of problems. Of course, some states already have substantially higher minimum bond amounts than what is being proposed. New York State, for example, has a maximum potential bond amount per deep well of $250,000, the highest listed for any state, in addition to stringent water-use restrictions which effectively have created a moratorium on hydraulic fracturing. The only state that has an explicit moratorium is Vermont, which instituted legislation banning hydraulic fracturing in May 2012, although Vermont has few if any known reserves (Gram 2012).

Consequently, a strong argument can be made for imposing a minimum bond amount higher than $60,000 per lease for wells constructed using hydraulic fracturing. Determining what the correct minimum bond amount would be, is difficult. These drilling techniques are evolving rapidly so the empirical evidence on the economic and environmental costs of the potential environmental damages is limited. Moreover the optimal bond amount depends not only on the dollar value of potential damages but also on the probability with which different outcomes occur. Reliable estimates of these probabilities, and how these probabilities would change under different bond amounts, are not available. This uncertainty strengthens the case for increasing minimum bond amounts. Given that the environmental risks from hydraulic fracturing are so poorly understood, larger bonds could be viewed as a conservative approach to policy-making as more information is collected. At a minimum, the increased use of hydraulic fracturing means that this is a particularly opportune time to update these amounts for inflation. Doubling required minimum bond amounts relative to the minimum for traditional wells, for example, would probably make sense given the higher level of environmental risks and higher expected costs of reclaiming these well sites.

The purpose of strengthening bonding requirements is to mitigate, not completely fix, the misalignment of incentives. Even after adjusting for inflation, the bonds would be small compared to the environmental costs from a severe accident. Widespread groundwater contamination, for example, could impose hundreds of millions of dollars in damages, for which a $60,000 bond would be woefully inadequate. States would, as we discuss below, be encouraged to consider bond amounts that exceed federal minimums. This would benefit, in particular, states where natural gas drilling brings large environmental risks. In setting minimum bond amounts, it is important to recognize that to completely eliminate the misalignment of incentives would require companies to post a very large bond, imposing substantial costs on natural gas producers. For example, requiring producers to post a $1 billion bond would segment the market, effectively excluding all small and medium-sized producers. Even just adjusting for inflation, however, would improve incentives for good environmental management. Increasing the liability of gas producers, even modestly, would help induce them to make better choices, and updating minimum bond amounts would help ensure that natural gas producers reclaim drilling sites after production is completed.

Increasing minimum bond amounts would have only a small impact on the natural gas market. There are approximately 18,000 natural gas development wells drilled per year in the United States. At $12,000 per well, this would be $216 million going into bonds annually. But keep in mind that the natural gas market is very large. Total U.S. domestic production in 2010 was 26.9 trillion cubic feet. At $3 per cubic foot, this is an $81 billion market annually. Total domestic production from unconventional sources was 12.8 trillion cubic feet, so at $3 per thousand cubic feet, this is $38 billion annually.[7] The "Costs and Benefits" section below provides additional context.

BLANKET BONDS

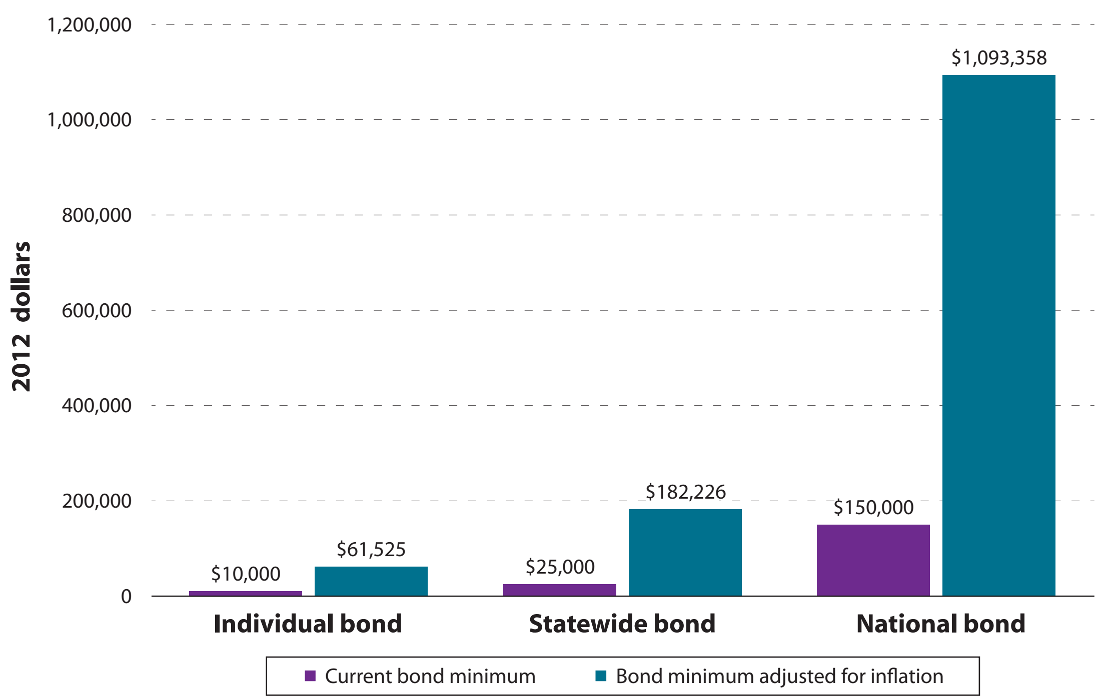
This proposal would eliminate provisions that allow companies to meet bonding requirements by posting a single blanket bond. Under current federal legislation, producers can post a $25,000 bond for all drilling in a given state, or a $150,000 bond for all drilling nationwide. Adjusting for inflation would increase these minimum bond amounts substantially (see Figure 6), but even after an inflation adjustment, blanket bonds imply an unreasonably low bond amount per well.

The economic argument for blanket bonds is that if the total number of wells operated by a company is reasonably low, then blanket bonds can increase incentives for good environmental stewardship. When environmental damages occur, producers stand to risk the entire blanket bond. Thus, a natural gas producer that owns a small number of wells and meets bonding requirements using blanket bonds has more incentive than other producers to make choices that protect the environment.

The problem is that large companies own hundreds or thousands of wells. Consider, for example, a hypothetical

FIGURE 6.

Adjusting Minimum Bond Amounts for Inflation



Note: A similar figure appears in GAO (2010a).

company that owns 500 wells and has satisfied its bonding requirement by posting a single, inflation-adjusted national bond of $1 million. The average bond amount per well in this case would be $2,000, too low to finance routine site reclamation expenses.[8]

Under current federal legislation, the ratio of statewide bond amounts to individual bond amounts is about three to one. This means that any producer that operates on more than three leases will have an average bond amount that falls below the average bond amount implied by the individual bond. For nationwide bonds, the ratio is about seventeen to one, so any company with more than seventeen leases nationwide will have an average bond amount that falls below what is implied by the requirement for individual leases. Even though the industry is relatively unconcentrated, with thousands of leases and about 18,000 development wells drilled annually in the United States, many companies end up with unreasonably low bond amounts per well under blanket bond provisions.

This is a problem that has often created situations in which the available bond was inadequate to pay for necessary cleanups on multiple sites (GAO 2010a). For example, in 2001 Emerald Restoration and Production Company went bankrupt, leaving 120 wells that needed to be plugged and the sites reclaimed. The company had posted a $125,000 bond, but this was not nearly enough to pay for expected expenses. To date more than $2 million has been used in public funds for this cleanup, and additional expenses are expected (Oil and Gas Accountability Project 2005).

ENCOURAGE STATES TO INCREASE BOND AMOUNTS

States would be encouraged by federal example and with EPA guidance to increase minimum bond amounts as federal requirements increase. This is already an active issue for state legislation. Several states are considering or have passed legislation that strengthens bonding requirements. For example, the West Virginia Legislature passed a bill in December 2011 that establishes a $50,000 bond requirement per well, and a $250,000 blanket bond for all of a producer's wells in the state.[9] The Maryland legislature is considering a bill that would increase the minimum required bond per well to $50,000 and eliminate the rules that allow producers to post a $500,000 blanket bond that covers all wells in the state.

State minimum bond amounts should be increased because even on private lands there is a substantial public interest because of the potential for non-localized environmental damages. Environmental damages cannot be contained within the boundary of the property where drilling occurs. In making drilling decisions, the natural gas producer may take into account potential damages to its property, but does not consider the full extent of broad potential damages.

Most hydraulic fracturing occurs on land under the jurisdiction of states. Current federal legislation provides bonding requirements for 261 million acres of surface federal lands, as well as 700 million acres of sub-surface lands.[10] An estimated 25 percent to 30 percent of hydraulic fracturing occurs on land under the jurisdiction of the BLM.[11] The remainder occurs on land under the jurisdiction of states. Federal requirements can serve as a template for state officials, much like many energy experts believe that the Obama administration's new federal fracking regulations will serve as a template for state-level regulation.

Chapter 5: Costs and Benefits

Current minimum bond amounts are so low that bonding requirements have a negligible impact on the market. For example, as of December 2008, the total value of BLM bonds, including bonds from both natural gas and oil production, was $162 million. In 2010, the total value of U.S. natural gas production was $112 billion, and the total value of U.S. oil production was $135 billion.[12] Thus the total value of bonds held by the BLM is less than one-tenth of 1 percent of the annual revenue in these sectors.

Increasing minimum bond amounts to account for inflation would impose some real economic cost, but this cost would be modest compared to the size of the market. Nationwide there are about 18,000 wells drilled annually for natural gas development.[13] At $60,000 per lease, or approximately $12,000 per well, this would mean about $216 million placed annually into bonds. This is not a small amount, but it is modest compared to the more than $100 billion dollar natural gas market. Moreover, while a bond is in place it earns interest, and most producers will get these funds back with accrued interest.

For large producers with substantial cash reserves or easy access to low-cost credit, this forced savings imposes a cost equal to the difference between their cost of capital and the rate of return offered by these assets. The requirements allow producers to post bonds using their choice of assets including certificates of deposit, Treasury securities, and other low-risk assets; this is the relevant rate of return to which the producer's cost of capital must be compared. These costs would be largest for small and medium-sized producers and any producer with limited access to credit. For more on liquidity constraints and the economic costs of bonding requirements see Shogren, Herriges, and Goviandasamy (1993), and Mitchell and Casman (2011). Increasing bond requirements would likely lead to some consolidation in the sector. Some degree of consolidation is efficient, however, given the potential environmental liabilities involved.

Hypothetically, it is possible to estimate the annual cost of the increased bonding requirements. For example, say that the bond amount per well is $12,000, and the rate-of-return offered by the available instruments is 2 percent, compared to an average cost-of-capital for these companies of 5 percent. If the wells are in production for an average of twenty years, then the present discounted value of the total lifetime cost of the bonding requirements per well is $5,900. For 18,000 wells this is a total lifetime cost of $106 million, about one-tenth of 1 percent of the annual revenue from U.S. natural gas production.

Stronger bonding requirements would have a modest impact on U.S. natural gas production. Most at risk would be projects in locations where there are large potential environmental risks, such as those near important sources of groundwater. Increasing the bonding requirements raises the expected costs of these projects more than other projects because producers take into account the risk of losing the bond. From a producer's perspective, these are more expensive projects. But this is the objective of this policy: to provide incentives for producers to choose more environmentally safe projects. When the social cost of such projects is too high, producers are discouraged from initiating them.

More broadly, the costs should be compared to potential benefits in the form of reduced environmental damages. Given how little is known about the environmental costs of hydraulic fracturing, it is difficult to quantify these benefits. However, even one instance of groundwater contamination could easily impose hundreds of millions of dollars in damages. Even a minimal reduction in the probability of severe accidents would imply large benefits. Moreover, strengthened bonding requirements help ensure proper site reclamation and that drilling sites are returned to their original condition as closely as possible. Again, the benefits are difficult to quantify, but they could be worth tens of thousands of dollars per drilling site.

Chapter 6: Questions and Concerns

WHY NOT MANDATE INSURANCE?

Mandated insurance would complement bonding requirements by providing a mechanism for addressing environmental accidents that impose costs that exceed the amount of the bond. A hybrid plan might involve both increasing minimum bond amounts and requiring producers to purchase insurance for damages that exceed the amount of the bond. Proponents of hydraulic fracturing argue that the risk of accidents is low, so presumably premiums would be small.

Insurance is effective for ensuring that funds are available when accidents occur, but it does not completely address the misalignment of incentives. Insurance insulates agents from the consequences of their actions, leading them to engage in riskier behavior than they would if they bore the full costs of adverse outcomes. Take comprehensive car insurance, for example. Fully-insured car owners are less careful with their cars. They may not be as careful about locking the car or parking it close to other cars, and may even choose to drive more recklessly. The same goes for natural gas producers and decisions about where and how to drill.

Experience-rated insurance helps align incentives because producers take into account the threat of higher premiums when making decisions. However, because producers do not exist forever, an insured producer is still going to underinvest in environmental stewardship relative to the efficient level. After a severe accident, a producer may exit the market rather than pay increased premiums. Understanding this behavior, private insurers will price this increased risk into premiums, which increases the cost of doing business for all gas producers.

In many markets, insurance companies attempt to better align incentives by rewarding customers for good behavior. For example, non-smokers often qualify for lower health insurance premiums than smokers, and people with safe driving records pay less for car insurance than those without safe driving records. These distinctions are possible because such behaviors are observable and measurable. With hydraulic fracturing, however, monitoring is difficult and expensive, limiting the ability of private insurers to efficiently categorize producers according to risk.

One way to view hybrid policies is as an insurance policy with a high deductible. When accidents happen, the bond is used first, and insurance is brought in after the bond has been used. In this way, the bond acts as a deductible. Because drivers are responsible for deductibles, they may be more careful with their cars. A bond works in a similar way. With the bond in place the producer has some of its own money at stake, and the bond increases the incentive to make good choices.

ARE NATURAL GAS PRODUCERS ALREADY REGULATED?

Bonding requirements complement traditional regulation. Natural gas producers are subject to a wide range of environmental regulations. According to the American Petroleum Institute (2010): "A comprehensive set of federal, state, and local laws addresses every aspect of exploration and production operations. These include well design, location, spacing, operation, water and waste management and disposal, air emissions, wildlife protection, surface impacts, and health and safety." In addition, natural gas producers are subject to the Clean Water Act, which regulates surface water discharges and reinjections of water into underground wells.

Since the Mineral Leasing Act of 1920, policymakers have understood that bonding requirements can help ensure enforcement of existing regulations. The regulations describe, for example, how drilling sites must be reclaimed when production has been completed. Regulations outline what needs to be done, but the bond helps ensure that resources are available to pay for it, even if the producer no longer exists or does not have the necessary financial resources.

Bonding also helps with enforcement more broadly. Regulating natural gas producers is challenging because production is geographically dispersed at thousands of sites in more than a dozen states. To have regulators at each location would be prohibitively expensive.[14] Hydraulic fracturing is also highly technical, requiring expert regulators. Regulators could be on a drilling site twenty-four hours a day, but if they do not understand engineering, well construction, and groundwater protection, they are going to be of little use. Moreover, there continues to be rapid technological innovation, so regulators need constant training to keep up with the industry. And if an engineer knows enough to be a good regulator, he or she will be highly valued by producers, and thus command high salaries.

In addition to complementing existing regulation and industry self-policing, bonding requirements help mitigate environmental damages, even when the risks are poorly understood. Every drilling site has unique challenges and issues, and to expect regulators to correctly anticipate all possible environmental risks is unrealistic. Hydraulic fracturing techniques are evolving rapidly—even enumerating the different potential risks is challenging, let alone drafting effective regulations for all dimensions of well construction and production. What a bond does is put gas producers at the center. Producers are in a much better position than regulators to understand the potential environmental risks of particular projects.

WHY NOT HAVE MORE CATEGORIES OF MINIMUM BOND LEVELS?

Some states' minimum bond amounts depend on an observable measure of the level of risk. For example, Texas sets bond amounts according to the depth of the well. The economic argument for using more categories is that different well types have different risks. For example, deeper wells tend to be riskier. Natural gas accumulations at lower depths are at higher pressure levels, and thus more can go wrong, with more significant consequences, during well construction. Having more categories allows for lower bonds on wells where the risks are smaller and using richer formulas for required minimum bond levels also has the advantage of minimizing distortions in producer decisions about what type of wells to drill.

> Bonding requirements complement traditional regulation…Regulations outline what needs to be done, but the bond helps ensure that resources are available to pay for it, even if the producer no longer exists or does not have the necessary financial resources.

This proposal does not call for introducing different categories of risk. Although the economic argument is reasonable, deciding exactly which criteria to use is difficult. With depth, for example, there is a counter argument. Whereas deeper wells are under more pressure, shallow wells present risks because hydraulic fracturing occurs closer to groundwater reserves. And for every categorization that a policymaker includes there will be exceptions. Some deep wells are safe because, for example, they are in locations far from populated areas and water resources. Some shallow wells are quite risky because of nearby groundwater reserves or some other characteristic. The advantage of the current federal system, which does not distinguish by depth or other measure of risk, is that it is easy to administer. This simplicity avoids the problem of opening bonding requirements to negotiation. In some states, minimum bond amounts are negotiated on a well-by-well basis. In theory, these negotiations could lead to more efficient bond amounts, but in practice, it adds substantially to the overall economic cost of bonding requirements, causing resources to be directed toward non-productive uses such as bargaining over bond amounts.

SHOULD BONDS BE REQUIRED FOR CONTRACTORS?

No. Under the existing legislation, bonds are required for natural gas producers, but not for the companies with whom they contract. This makes sense. There is a long history of contracting in oil and gas drilling. For example, with the Deepwater Horizon accident, the drilling was a BP project, but the drilling rig was owned by a company called Transocean, and BP had, in addition, contracted with Halliburton Energy Services for the cementing of the well. These relationships are typical in natural gas drilling as well. Producers plan where and how to drill, but then contract with drilling companies for the actual construction of the well. The drilling rigs are owned by the drilling companies, and move from site to site throughout the year. Rigs consist of a tall derrick and a motor the spins the drill bit during drilling. Because unconventional natural gas accumulations are found at great depth and development uses horizontal and diagonal drilling techniques, these drilling rigs are among the largest and most advanced in the oil and gas industry.

For hydraulic fracturing, most drilling companies use a day-rate contract. With this contract, the company is paid per day regardless of the amount of progress that is made. The workers on the rig are employed by the drilling company, but they are under the direction of a representative of the producer—the company man. This representative has final authority about day-to-day operations such as the composition of the drilling mud, techniques used for casing and cementing, and whether or not to use pressure tests and other diagnostic tools (Kellogg 2011). Thus the responsibility for environmental risks must lie with the producer. The drilling company is hired to perform a particular job under very carefully contracted conditions, and it is the producer that makes all of the key decisions. In some cases, a producer may wish to transfer some risk to the drilling company, and this is achieved through contracts.

Chapter 7: Conclusion

The immense supply of natural gas made possible by hydraulic fracturing is an enormous boon to the United States. Just when it seemed the United States would be crippled under mounting energy costs into the distant future, technological innovations opened up the natural gas equivalent of Saudi Arabia right under our feet. The challenge for policymakers is how to allow the continued development of these valuable resources while ensuring environmentally safe drilling.

The purpose of bonding requirements is to force producers to take potential environmental damages into account when making decisions. Bonds provide a source of funds for cleanups when necessary, but, more importantly, bonds provide an incentive for producers to avoid environmental damages altogether.

This approach makes a great deal of sense, but the legislation has not been updated in more than fifty years. Minimum bond amounts are woefully inadequate, particularly given the risks associated with advanced drilling techniques. This proposal outlines concrete steps to take to modernize bonding requirements. Minimum bond amounts would be increased substantially for drilling on federal lands, and states would be encouraged to adopt similar minimum bond amounts for non-federal lands. In addition, provisions that now allow companies to meet requirements with blanket bonds would be eliminated, preventing average bond amounts per well from falling to unreasonably low levels.

Much is at stake both for the environment and for the economy. For natural gas producers, this proposal represents a much-preferred alternative to the drilling moratoria that have been enacted, for example, in the state of New York. Supporting stronger bonding requirements would demonstrate the industry's commitment to environmental protection, and reduce the risk of more states taking steps to ban hydraulic fracturing altogether. Stronger bonding requirements also could help broaden the market for natural gas. There has been much discussion, for example, about increasing the use of natural gas in transportation, and about constructing liquefied natural gas (LNG) terminals for exporting natural gas. Much of the reticence among policymakers goes back to environmental risks, and these concerns can be reduced by committing to stronger bonding requirements.

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Endnotes

1. See Yergin and Ineson (2009) and Rotman (2009) for additional discussion.
2. In perhaps the most comprehensive investigation of a hydraulic fracturing site to date, EPA (2011a) finds that chemicals used in a site in central Wyoming likely caused contamination of local water supplies. The EPA found in deep aquifers concentrations of several synthetic chemicals far above safe drinking water standards. As with many environmental investigations, a number of complicating factors make it difficult to definitively link these elevated concentrations with hydraulic fracturing. Also, the study emphasizes that the wells in this area are unusually shallow, making it unclear to what extent the experience at this site in Wyoming can be generalized.
3. The American Petroleum Institute (2010) explains: "Spent or used fracturing fluids are normally recovered at the initial stage of well production and recycled in a closed system for future use or disposed of under regulation, either by surface discharge where authorized under the Clean Water Act or by injection into Class II wells as authorized under the Safe Drinking Water Act. Regulation may also allow recovered fracturing fluids to be disposed of at appropriate commercial facilities."
4. See EPA (2012b).
5. To date, billions of dollars in public funds have been used to clean up abandoned hazardous waste sites through the Superfund Program. See, e.g., EPA (2011b).
6. Economists often use the Herfindahl Index (HHI) as a measure of market concentration. The HHI among these natural gas producers is 0.029, compared to 0.106 for deepwater oil drilling in the Gulf of Mexico.
7. See DOE 2011a, Table A14 "Oil and Gas Supply," and DOE 2011b, Table 6.2 "Natural Gas Production, Selected Years, 1949–2010." In 2010, U.S. natural gas production from shale gas wells totaled 4.4 trillion cubic feet, with an additional 6.6 trillion cubic feet from tight gas, and 1.8 trillion cubic feet from coalbed methane. These three unconventional sources of natural gas together, therefore, represent about 12.8 trillion cubic feet of natural gas production annually.
8. GAO (2010a), p. 16, reports an average cost of site reclamation per well of $12,788 per well.
9. West Virginia Legislature H.B. 401, §22-6A-15. "Performance Bonds: Corporate Surety or Other Security," December 2011.
10. The federal bonding requirements extend to more than 300 million acres of sub-surface lands not directly under federal lands, including 58 million acres of sub-surface lands under privately owned lands (GAO 2010a).
11. Baird Equity Research, quoted in Tracy (2012).
12. DOE 2011b, Table 6.2 "Natural Gas Production, Selected Years, 1949–2010" reports that in 2010 total U.S. natural gas production was 26.9 trillion cubic feet. Table 6.7 "Natural Gas Wellhead, City Gate, and Imports Prices, Selected Years, 1949-2010" reports an average wellhead price in 2010 of $4.16 per thousand cubic feet. Table 5.1b "Petroleum Overview, Selected Years, 1949–2010" reports that in 2010 total U.S. crude oil production was 2.0 billion barrels. Table 5.18 "Crude Oil Domestic First Purchase Prices" reports a U.S. average price of $67.51 per barrel.
13. DOE 2011b, Table 4.7 "Crude Oil and Natural Gas Development Wells, Selected Years, 1949–2010." According to Table 4.6 "Crude Oil and Natural Gas Exploratory Wells, Selected Years, 1949–2010," another 1,269 natural gas wells were drilled for exploration.
14. Similar challenges are faced in offshore oil drilling. At the time of the BP Deepwater Horizon oil spill, there were only 60 federal inspectors for 4,000 drilling facilities in the Gulf of Mexico (Calmes and Cooper, 2010).

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Highlights

Lucas Davis of the University of California, Berkeley, proposes increasing existing federal and state bonding requirements to reflect the new risks specific to recent technological developments and the market organization of the natural gas industry.

The Proposal

A. Increase Bonding Requirements for All Drilling on Federal Lands

For drilling on federal lands, Davis proposes adjusting the minimum bond values last set in 1960 for inflation, raising them to $60,000.

B. Impose Higher Bonds for Fracked Wells

Davis also proposes higher bond amounts when fracking is used, to be set at an amount that is commensurate with the risk and scope of potential environmental damages and large enough to alter driller behavior to take proper precautions. Doubling required minimum bond amounts relative to the minimum for traditional wells, for example, would probably make sense given the higher level of environmental risks and higher expected costs of reclaiming these well sites.

C. Encourage States to Increase Bond Amounts

Many states have bonding requirements. Davis argues that these should first be updated for inflation. Following the federal model, states should also update bonding amounts to reflect risks associated with fracking.

D. Eliminate Blanket Bonds

Davis proposes to eliminate blanket bonds. These act as a liability cap and are particularly problematic in cases of bankruptcy.

Benefits

The objective of Davis' policy is to provide incentives for producers to choose more environmentally safe projects and to follow appropriate safety procedures while drilling. If the social cost of these projects is too high, then producers should be discouraged from initiating them. Increased bonding requirements would shift projects from risky locations to sites where potential social costs are smaller.

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