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Strict Liability for Fracking: Risks Should Fall on Wall Street, Not Main Street

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Executive Summary

A new method of oil and natural gas extraction offers promise as a way to keep energy supplies abundant and costs low. This method, commonly known as "fracking," hydraulically fractures shale rock formations by injecting enormous quantities of water and smaller quantities of chemicals underground to access trapped oil and natural gas. However, environmentalists have raised concerns that fracking could contaminate aquifers and cause earthquakes, posing prospective danger for communities concerned with businesses experimenting with new technologies under their homes.

The potential for these negative externalities, particularly extreme events such as significant earthquakes poses liability concerns as to who is responsible for damages. If a firm with limited liability can declare bankruptcy before paying for all the damages caused by fracking, it may have the incentive to partake in excessively risky behavior.

The economically efficient solution to potential damages caused by fracking is to enforce a strict liability standard for such potential risks. This standard holds anyone engaging in fracking to pay all third-party damages that may happen, regardless of whether or not they had any expectation of them happening. This standard forces costs caused by fracking, namely earthquakes and the contamination of aquifers to be incurred by such firms. Profit-maximizing behavior becomes socially optimal under this institutional arrangement.

We recommend requiring firms to be underwritten by well-capitalized financial firms who can shoulder the burden should an extreme disaster hit. In instituting this very simple and unobtrusive regulation, lawmakers avert the principle cause behind the failures of "capitalism" in the 2008 financial crisis: privatizing gains and socializing losses. The key for good behaviors by markets are getting the incentives right, and that means privatizing both gains *and* losses. This is the basis for conceptualizing the risks of fracking in terms of who must pay when something goes terribly wrong.

The immense social benefits available in the form of cheap power demonstrate the importance of attaining good policy for fracking. Preliminary analysis conducted by the Yale Graduates in Energy Study Group suggests consumer surplus – that is, benefits for those purchasing

natural gas – is in the scope of $100 billion per year.[1] Using a statistical method which takes into consideration the possibility that fracking may cause an event like a severe earthquake, we still find that potential benefits outweigh actuarial costs. And this cost-benefit analysis ignores the institutional arrangement proposed in the paper. If strict liability with an insurance requirement in place were to be implemented, society (except the financial firms and firms using fracking methods) would only be in a position to receive benefits from fracking, since anyone harmed by fracking would be made whole by the courts. With the correct institutions in place, fracking offers tremendous benefits at minimal costs.

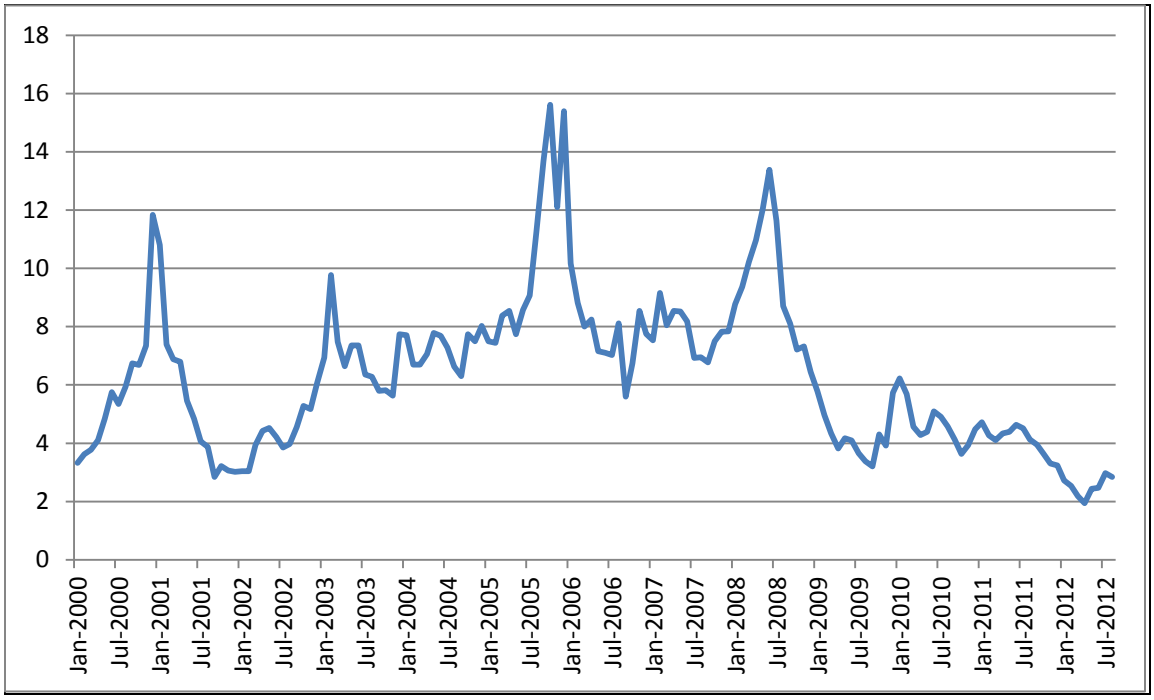
[1] Ames, Robert M., Anthony Corridore, Joel Nathan Ephross, Edward Hirs, Paul W. MacAvoy, and Richard Tavelli. 2012. "The Arithmetic of Shale Gas." Working Paper. Available at SSRN: http://ssrn.com/abstract=2085027 or http://dx.doi.org/10.2139/ssrn.2085027

Introduction

A new method of energy extraction offers promise as a way to keep energy costs low. This method, commonly known as "fracking," hydraulically fractures shale rock formations by injecting enormous quantities of water and smaller quantities of chemicals underground to access trapped natural gas. In addition, energy firms have perfected directional drilling that allows gas drillers to turn a vertical well 90° and drill horizontal to the surface. This combination of fracking and horizontal drilling has unlocked vast new natural gas resources that have profoundly changed the U.S. energy market.

Fracking has allowed natural gas prices to return to prices unseen since the 1990s. In 2012 dollars, natural gas surpassed $15 per million BTU in 2005 and was generally over $6 per million BTU throughout the first decade of the 21st century until the gains from fracking began appearing in prices. In August 2012, the price was $2.84, despite a recent uptick in prices.[2]

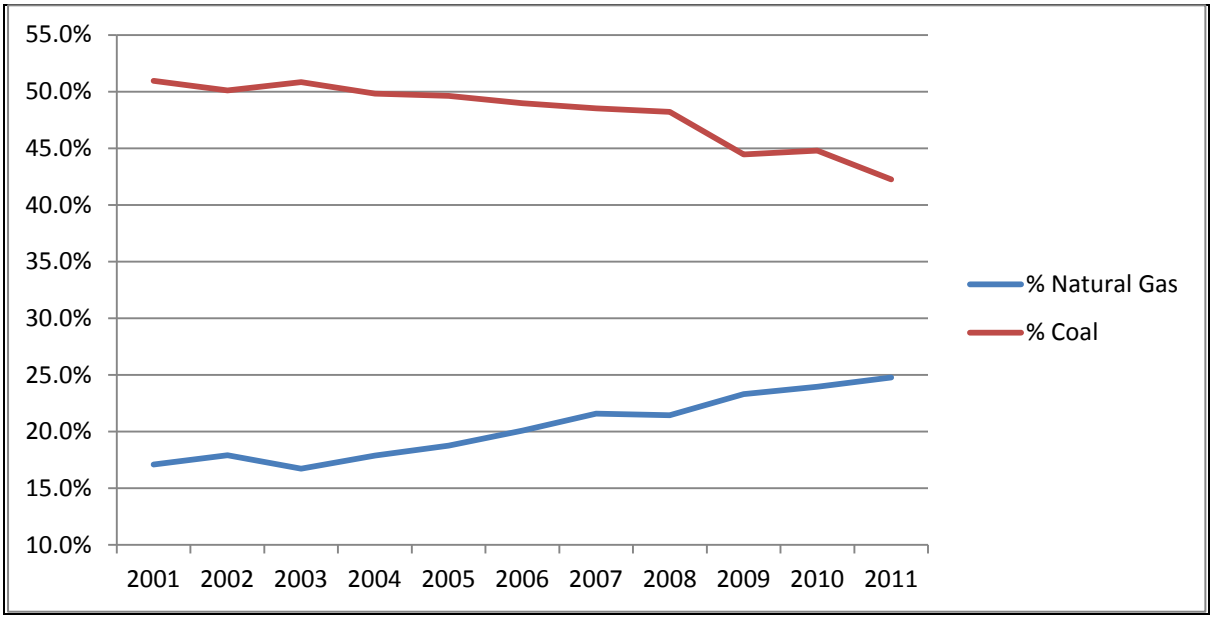
Figure 1: Natural Gas Spot Price per Million BTU, in 2012 Dollars



[2] U.S. Department of Energy, Energy Information Administration, Natural Gas Spot and Future Prices, NYMEX, available at http://www.eia.gov/dnav/ng/ng_pri_fut_s1_m.htm (accessed September 20, 2012)

This has provided the economic incentive to shift energy production in the United States from coal to natural gas, leading to improved environmental outcomes. Natural gas has steadily increased its share of the energy market from 17.1% in 2001 to 24.8% in 2011. Meanwhile, coal has fallen from 51.0% to 42.2%.[3] While natural gas is not quite a green energy, is a far less damaging to the environment than coal is.

Figure 2: Shares in US Energy Production



In addition to changing the nature of energy production in the United States for the better, fracking offers tremendous benefits for consumers. A reasonable estimate of these benefits is $100 billion per year. At the same time, fracking also presents a potential danger for communities concerned with businesses experimenting with new technologies under their homes. The lack of experience with this new industrial process risks potentially disastrous aquifer contamination and earthquakes. A "free market" view of fracking may appear to take a callous disregard of these dangers in the eyes of environmentalists.

The purpose of this policy study is to offer a "market" solution that accounts for such dangers.

[33] U.S. Department of Energy, Energy Information Administration, Electricity Data Browser http://www.eia.gov/beta/enerdat/#/topic/0?sec=g&geo=g&fuel=vvg&agg=2,0,1 (accessed September 20, 2012).

Fracking Concerns as Externalities

The proper economic framework for environmental issues is to conceive of them as externalities. Externalities are the results of actions performed by individuals or firms causing costs or benefits for third parties that do not take part in the transaction. For instance, a factory owner spewing noxious smoke over a neighborhood is imposing a *negative externality* on the neighborhood. Once we consider concerns about fracking in terms of externalities, we may apply standard economic logic to them. With one exception, a solution to the potential risks of fracking is readily available without the heavy hand of top-down regulation.

Noise may be a nuisance for those living or working in the proximity of fracking. If neither the firms engaged in fracking nor those purchasing the natural gas compensate people affected by the noise, too much fracking will take place. We should note that the mere existence of the noise is not grounds for eliminating fracking altogether. The law regularly allows reasonable amounts of noise everyone expects to happen; otherwise, no one would be able to mow their lawns. For that reason, if fracking takes place in distant industrial areas, there may be no grounds for intervening. If the noise caused by fracking is more analogous to a next-door-neighbor blaring music late at night, then there are grounds for some form of intervention, for the same reason it is reasonable to complain to the police about that neighbor.

Other concerns about fracking involve risks, not concrete costs on third parties. This can be thought of as the risk of a nuclear power plant meltdown. A family living in a neighborhood five miles from a newly-opened nuclear power plant may live there all their lives without a meltdown, but their property values likely dropped the second the groundwork for the power plant was laid; homeowners do not want to bear such a risk. Both the risks of earthquakes and of aquifer pollution are externalities in the same sense as the nuclear power plant and should be thought of that way.

Certain other concerns have been raised that appear to be costs imposed by fracking, but are illusory from the economic point of view. Surface spills are costs for third parties only if they affect land not owned by the firms engaging in fracking. But it isn't an externality if the firm *owns* the land where the spill takes place because the cost will be borne only by that firm. The

cost of the surface spill can be measured by the fall in property values that takes place when the firm decides to later sell the property. In this sense, the costs of surface spills, so long as they do not affect others' property, have already been *internalized* by the firm.[4]

Secondly, some have voiced concerns over the effect of water usage on certain localities. This is not considered to be important for economic analysis because it is what is known as a *pecuniary externality*. If the demand for water increases and causes the price of water to rise,[5] then concomitantly the demand for something else will fall. If money is not invested in fracking, it will be invested elsewhere, whether in steel, coal, labor, machines, or any number of things. The rise in certain resource costs caused by fracking will cut costs in others. If our concern is to increase the overall size of the pie, a pecuniary externality which only shifts around the distribution of the pie is not an immediate concern.

However, just as we should think of fracking in terms of externalities in general, the legal structure should not favor fracking in any particular way. That is why we agree with environmentalists that the Halliburton Loophole, a small part of the Energy Policy of 2005, must be eliminated. This loophole does not hold energy firms to the same regulatory and emissions standards as other industrial processes.[6] If we arbitrarily grant such an exception, too much fracking will take place relative to other ways of producing energy. Instead, for "traditional" environmental concerns, fracking should merely be governed by the same regulatory regime as are other types of mining. While we do not necessarily endorse any subsidy for green energy, we certainly do not endorse giving an unnatural advantage to particular types of fossil fuels. Firms should compete in the marketplace, not in lobbying for special privileges.

So long as one accepts the economic principle that our choices in the public sphere should reflect consumers' underlying preferences, the externality approach allows us to clarify the concerns of citizens over fracking. Certain externalities, such as air pollution and noise, are known costs imposed on certain individuals in the proximity of fracking. Such externalities

[4] However, surface spills that negatively affect neighbors' property values are not necessarily internalized. If they are not internalized, these too are grounds for intervention.

[5] Although a separate issue, authorities regulating water supplies demonstrate poor resource governance if they seek to stop the price of water from rising.

[6] Hines, David A. 2012. "The 'Halliburton Loophole': Exemption of Hydraulic Fracturing Fluids from Regulation under the Federal Safe Drinking Water Act." Wilkes-Barre, PA: The Institute for Energy and Environmental Research for Northeastern Pennsylvania.

should merely be solved with the various well-worn methods for maintaining a clean environment. However, it is not reasonable to include surface spills on a firm's own land or pecuniary externalities. Others are risks of externalities taking place, although if they do take place, they may be very large. These concerns constitute the real problems with fracking, but they are concerns with a legal solution.

The Solution: Strict Liability for Fracking

No matter how stringent the regulations are that we place on fracking, there will still be risks involved whenever fracking takes place. We should look at the recent financial crisis as a guide for what *not* to do. Wall Street acted recklessly with other people's money, and when the risks came to fruition, they got bailed out. Wall Street privatized their gains and socialized their losses. There are few better templates for guaranteeing a bad outcome from capitalism.

Instead, we should privatize both gains and losses. The costs from an earthquake, the risk of which we have little scientific basis to calculate confidently, should fall on those who were in the position to profit from fracking, not the local community or taxpayers in general. There is an underutilized legal standard for putting the legal burdens on firms who engage in such risks. This is the *strict liability* standard. Strict liability means that, whether or not the firm engaging in fracking was in the position to "really" know that their practices would result in an earthquake or the poisoning of the aquifer, courts still require the firm to pay. For risks that policymakers or regulators truly have no way of grasping accurately, strict liability is the best solution. This characterizes the situation for both earthquakes and aquifer contamination.

If our goal is to maximize overall wealth in the economy, the strict liability standard aligns the goals of society and the firm. Risks that consumers would pay to avert will not be undertaken because they negatively impact the firm's bottom line and share price. Risks that are worthwhile, again from the standpoint of consumers, will be undertaken. In the words of the mainstream textbook on the economics of regulation:

> Strict liability [minimizes social costs] almost by definition. Since strict liability requires that the company bear all the product-related costs associate with accidents, in effect what this doctrine does is force the company to internalize all

> accident costs. The social objective function and the company's profit function consequently become one and the same.[7]

The straightforward solution to the risks involved with fracking is to charge the firm the costs of its harms and to fully compensate the victims. This is exactly what the strict liability standard does.[8]

There is still a lingering issue associated with strict liability standard. What if the disaster caused by fracking is so great that the company goes bankrupt and is unable to make its victims whole? The solution we propose is to force any firm engaging in fracking to be underwritten by a firm so large that it can make the victims whole again, no matter how significant the damage is. This requires the firm to go to Wall Street, and in exchange for what amounts to an insurance payment, to get blanket coverage on any huge environmental disaster the firm might cause.[9]

The firm would still be responsible for smaller, more typical torts from noise nuisances to spillages onto others' property. But the legal onus for the enormous disasters would be on Wall Street. The financial firms, as part of the condition of agreeing to insure them, would be allowed to "regulate" the types of fracking that the energy firm uses. One may ask what the point is of shifting the choice of regulation from the accountability of democracy to the short-sightedness of modern capitalism. One needs to look no further than the financial crisis once again. Bureaucrats who would inevitably be charged with regulating would be rapidly captured by the industries they intend to regulate. But who will capture the "regulators" when any failure of Wall Street to efficiently regulate the firms engaging in fracking will fall on themselves? To the extent that the firms engaging in fracking convince Wall Street to allow them to partake in risky practices, Wall Street itself must pay for it. What we are doing is harnessing the pervasive greed of Wall Street to defend the environment.

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[7] Viscusi, W. Kip, Joseph E. Harrington, Jr., and John M. Vernon. 2005. *Economics of Regulation and Antitrust*. Fourth Edition. Cambridge, MA: The MIT Press, 813.

[8] The only reason we do not advocate a strict liability standard for all environmental issues relating to fracking is the likelihood of nuisance lawsuits and moral hazard issues given how strictly liability must be enforced. For instance, it provides the incentive to move next to fracking sites just to give legal standing to sue. For more on this, see Garvin, James R. 2005. "Moral Hazard, Adverse Selection, and Strict Liability." *Journal of Insurance Issues* 28 (1): 1-13.

[9] There are limits of even large financial firms for coping with such risks; a single firm is unlikely to be able to cover a two trillion dollar disaster. However, reinsurance, whereby in practice consortiums of firms would cover such an extreme event, means this will not be an issue either.

The strict liability standard is a remarkably robust method of protecting victims, and when paired with an insurance requirement, guarantees that neither communities nor tax payers will shoulder the burdens of possible disasters caused by fracking. There is one exception to this issue that environmentalists have been correct to emphasize. This is the exception to which we will now turn.

Trade Secrets: A Problematic Area for Courts

Firms engaging in fracking use different chemical recipes for the procedure. These recipes, while lacking formal legal protection, are trade secrets firms have no interest in disclosing. If they disclose, they lose any competitive edge they may today hold, and if they lose the competitive edge, they lose the incentive to develop better chemical recipes in the future. This presents a significant difficulty for the strict liability standard since it is difficult to trace pollutants to firms if it is unknown what pollutants they are using in the first place.

Several states have responded by passing laws requiring disclosure to doctors (who are then required to non-disclosure agreements).[10] This appears to solve much of the issue with a relatively light regulatory burden. As such, we do not oppose other states wishing to enact similar measures that would both aid diagnosis and allow the legal system to perform its function. In general, chemicals with unknown properties should follow the same framework as chemicals in other industrial processes. No special loophole should be given to fracking, but some of the special scrutiny regarding fracking may be unfounded if legal institutions are already in place to alleviate the externalities associated with fracking.

At the same time, we should not preclude alternative legal standards to be suggested with even lighter regulatory burdens. Regulations are all too easy to subvert and are used to suppress competition instead of protecting communities.[11] If evidence is produced showing that courts can provide their own standards to access the information needed to enforce the strict liability standard, this regulation may ultimately be unnecessary. We should also be

[10] Detrow, Scott. 2012. "Fracking Disclosure: Colorado's Compromise is Pennsylvania's Controversy." *State Impact*. June 7th, 2012. http://stateimpact.npr.org/pennsylvania/2012/06/07/fracking-disclosure-colorados-compromise-is-pennsylvanias-controversy/ (Accessed July 16th, 2012).
[11] Stigler, George. 1971. "The Theory of Economic Regulation." *The Bell Journal of Economics and Management* 2 (1): 3-21.

open-minded as to how communities, without the need of top-down regulation, may discover rules that effectively govern the use of various chemicals in cooperation with firms engaging in fracking.

A Cost Benefit Analysis for Fracking

Primarily, the potential social costs of fracking lie in enormous environmental disasters, especially the increase of likelihood of earthquakes and contaminations of aquifers. We agree that there is a great deal of uncertainty associated with unknown industrial processes. However, the consumer benefits of cheaper natural gas are so great that they likely outweigh these risks.

A reasonable estimate of the consumer surplus of fracking is approximately $100 billion per year.[12] This means that the benefits for whoever buys the natural gas are worth $100 billion each year; we are actually excluding profits of extracting natural gas from the analysis. We are also momentarily throwing aside the fact that our policy proposal forces businesses and Wall Street to bear the risks associated with fracking for it to take place. Even under these conditions, the risks are so minimal in comparison that fracking is clearly desirable.

We use the Pareto distribution, which is designed to account for extremely unlikely events. Pareto distributions allow for there to be "black swans." These are events so extreme that a traditional distribution predicts they will happen once in the lifetime of the universe, but such events instead happen much more frequently. Such distributions are often used in financial modeling, but can be helpful for gauging instances of genuine uncertainty,[13] which certainly describes fracking. In order to parameterize the Pareto distribution, we need an estimate of the costs of a "black swan" for both earthquakes and the pollution of aquifers. An example of a sufficiently large magnitude is an earthquake as severe as the one that took place in Christchurch, New Zealand in 2011.[14] That earthquake caused approximately $15 billion in

[12] Ames, Robert M., Anthony Corridore, Joel Nathan Ephross, Edward Hirs, Paul W. MacAvoy, and Richard Tavelli. 2012. "The Arithmetic of Shale Gas." Working Paper. Available at SSRN: http://ssrn.com/abstract=2085027 or http://dx.doi.org/10.2139/ssrn.2085027

[13] Taleb, Nassim. 2007. *The Black Swan: The Impact of the Highly Improbable*. New York: Random House.

[14] The earthquake and tsunami that hit Japan is more of an extreme event than we are looking for here. A "garden-variety" natural disaster caused by fracking would already be a black swan; an earthquake that hits a nuclear power plant is a black

damage[15] and the deaths of 185 individuals. At the median estimate of the statistical value of a human life at $7 million,[16] that comes to an economic cost of $16.295 billion. For aquifers, we suggest using estimates of the economic costs of disruptions to the Ko'olau forested watershed in recharging the Pearl Harbor aquifer as the correct magnitude. The cost of such a disruption has been estimated to be between $4.57 billion and $8.52 billion.[17] We assume the high estimate of $8.52 billion.

The next question to answer is: what amount of risk constitutes a black swan? Arguing over definitions rarely breeds wisdom, so instead we offer different cost estimates for if such an event would be 4 sigma, 4.5 sigma, 5 sigma, 5.5 sigma, and 6 sigma. "Sigma" is merely a conventional way to communicate how unlikely an event is. If an event is 4 sigma, it will happen one out of 15,787 times. If it is 4.5 sigma, it will happen one out of 147,160 times. We can derive the entire distribution of outcomes for earthquakes by assuming $16.295 billion in damage happens one out of 15,787 times (that is, we are assuming it is a 4 sigma event). Doing that gives a single parameter[18] alpha, which in that case equals 0.412. For another example, if the cost of disrupting an aquifer costs $8.52 billion and that is a 4.5 sigma (one out of 147,160) event, the parameter alpha equals 0.520. Table one provides a summary of all such distributions derived and used.

swan on top of a black swan. At any rate, we are implicitly considering even that outcome in the analysis because we are using the Pareto distribution.

[15] This figure comes from the IMF. See Craymer, Lucy. 2011. "IMF Lowers New Zealand Growth Forecast." *The Wall Street Journal Online*. Posted March 22nd, 2011. http://online.wsj.com/article/SB10001424052748704139004576215691545270886.html (Accessed July 24th, 2012).

[16] c.f. Viscusi, W. Kip, Joseph E. Harrington, Jr., and John M. Vernon. 2005. *Economics of Regulation and Antitrust*. Fourth Edition. Cambridge, MA: The MIT Press, 717-742. This figure is obtained using economists' estimates of how much individuals are willing-to-pay to eliminate risk. Federal agencies, such as the EPA, the USDA, and the FDA regularly use such estimates of the value of a statistical life when performing their own analyses.

[17] Kaiser, Brooks, Nancy Krause, and James Roumasset. 1999. *Environmental Valuation and the Hawaiian Economy*. Online publication at UHERO. www.uhero.hawaii.edu/assets/HawaiiEnviroEvaluation.pdf

[18] The minimum value of these Pareto distributions is assumed to be $1.

Table 1: Pareto Distribution Summaries

Sigma	Odds of Black Swan	Parameter alpha for cost of earthquakes	Parameter alpha for cost of aquifer contamination
4	1/15,787	0.4117795	0.4234022
4.5	1/147,160	0.5060480	0.5203990
5	1/1,744,278	0.6112008	0.6285337
5.5	1/26,330,254	0.7266375	0.7472440
6	1/506,797,346	0.8524232	0.8765930

For each assumption about how unlikely the black swan is, we ran a simulation of 100,000 different trials. In some trials, the equivalent of an earthquake the magnitude of Christchurch hit. In others, the aquifers were poisoned and caused significant damage. But in many, there was virtually no damage caused by fracking. Such is the nature of the Pareto distribution; it recognizes that there *could* be an unexpectedly massive earthquake, not that there *will* be. But it is only negative for society if the damage caused by earthquakes or poisoned aquifers is greater than the estimated $100 billion consumer surplus.

Table 2 summarizes the results of these simulations. Only under the assumption of sigma equal to 4 do we observe some trials where the costs outweigh the benefits. The worst case observed involves earthquake and aquifer damages totaling over $2 trillion dollars.[19] However, even if sigma equals 4, the mean (average) outcome is still very nearly equal to the full $100 billion, with the median (middle) outcome still closer to $100 billion. After incorporating the possibility of the types of uncertainties environmentalists raise, we still find there to be little case for stopping fracking, considering how great the benefits for consumers are. Such concretizing of these risks should ease the concerns of environmentalists.

[19] This hopefully justifies to environmentalists that we are paying sufficient heed to their warnings, as we are considering in our calculations that fracking may actually cause damages over 7% of United States GDP! With a sigma much lower than four, the simulations allow the possibility of fracking directly leading to the economic equivalent to the end of all life on the planet. Such extreme concerns are not within the realm of discourse.

Table 2: Simulation Results

Sigma	4	4.5	5	5.5	6
Odds of Black Swan	1/15,787	1/147,160	1/1,744,278	1/26,330,254	1/506,797,346
Parameter alpha for cost of earthquakes	0.4117795	0.5060480	0.6112008	0.7266375	0.8524232
Parameter alpha for cost of aquifer contamination	0.4234022	0.5203990	0.6285337	0.7472440	0.8765930
Mean Outcome	$99,953,351,686	$99,999,838,180	$99,999,914,846	$99,999,999,623	$99,999,999,884
Median Outcome	$99,999,999,977	$99,999,999,986	$99,999,999,990	$99,999,999,993	$99,999,999,994
Standard Deviation of Results	$8,584,409,728	$38,657,516	$22,655,990	$28,554	$9,568
Best Case Scenario	$99,999,999,998	$99,999,999,998	$99,999,999,998	$99,999,999,998	$99,999,999,998
Worst Case Scenario	-$2,443,113,333,085	$87,824,798,167	$92,894,719,782	$99,994,276,047	$99,998,070,575

But the beauty of the strict liability solution is that consumers and communities will only reap the benefits of fracking. The social costs are all pushed onto the shoulders of businesses – as they should be. Even in the extremely unlikely event that the costs of fracking outweigh the consumer surplus, it comes out of the pockets of those who took the risk. Our solution clips the tail off the negative side of the distribution of outcomes for the rest of society. We only get the benefits. More than anything, the cost-benefit analysis demonstrates the urgency of moving forward with fracking.

Conclusion

Given the correct legal structure, fracking has the potential to yield tremendous benefits for society. But capitalism does not function well when firms privatize gains and socialize losses. So long as we wish to live in the system of free enterprise, we must allow businesses to experiment with new methods of serving consumer needs. Among those methods potentially is fracking. The question then is how to privatize both gains and losses. The answer is a strict liability standard for potential disasters in conjunction with an insurance requirement. We admit to one specific weakness in our proposal, trade secrets, and relent to moderate regulations to ensure courts will be able to function effectively. Regardless, the potential gain from fracking is so great that they swamp the risks even if those risks fall on the shoulders of society. We urge environmentalists to seriously consider improving institutional structures and to realize the magnitude of social gains from fracking when providing future policy prescriptions.

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The Beacon Hill Institute at Suffolk University in Boston focuses on federal, state and local economic policies as they affect citizens and businesses. The institute conducts research and educational programs to provide timely, concise and readable analyses that help voters, policymakers and opinion leaders understand today's leading public policy issues.

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