Frackonomics: Economic Observations on Hydraulic Fracturing

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Overview of Tonight’s Talk

• Fracking Risks – Real or Hype?
  – Pathways to Dialogue

• The Problem of Externalities

• Property Rights and Ground Water Contamination

• Market Benefits from Natural Gas Production
Fracking Risks – Real or Hype?

• Pathways to Dialogue: What Experts Say about the Environmental Risks of Shale Gas Development
  – Resources for the Future
  – Authors: Alan Krupnick, Hal Gordon, Sheila Olmstead
Pathways to Dialogue

• Survey of 215 shale gas experts from NGOs, academia, industry, and government.

• Respondent Tasks:
  – Identify routine risks related to shale gas development that government regulations and/or voluntary industry practices are inadequate to protect the public or the environment.
    • Select from from 264 risk pathways.
  – Identify priorities for reducing potential accidents.
  – Answer who should have primary authority to ensure that risks are mitigated—government (via regulation), industry (via voluntary action), or a combination?
Degree of Agreement among Each Expert Groups’ 20 Priority Risk Pathways
12 Consensus Routine Risk Pathways

**Activities**

- **Site Preparation**
  - Land clearing and infrastructure construction
  - Stormwater flows
  - Habitat fragmentation

- **Drilling**
  - Venting of methane
  - Methane
  - Air quality

- **Fracturing and Completion**
  - Use of surface water and groundwater
  - Freshwater withdrawals
  - Groundwater

- **Storage/disposal of Fracturing Fluids and Flowback**
  - On-site pit/pond storage
  - Treatment by municipal wastewater treatment plants
  - Treatment by industrial wastewater treatment plants
  - Flowback and produced water

**Environmental Burdens**

- Stormwater flows
- Habitat fragmentation
- Methane
- Freshwater withdrawals
- Groundwater
- Surface water
- Flowback and produced water
Complete Disagreement

- Industry respondents uniquely identified 6 risk pathways associated with community impacts (e.g. traffic, congestion).
- NGO respondents uniquely identified 5 risk pathways associated with convention air pollutants.
Complete Disagreement

– Government respondents uniquely identified 5 risk pathways involving groundwater.
– Academic respondents uniquely identified 2 risk pathways. One involved impact of industrial development on communities and the other was the risk of surface water diversion on groundwater.
Notable Agreement
But Lacking Consensus

• Impact on surface water from using wastewater for road deicing or dust suppression (all groups but industry).
• Impact on ground water from hydraulic fracturing flowback (NGO and academic respondents).
• Seismic vibrations caused by deep underground injection of flowback (industry and academic respondents).
Risk of Accidents

• Respondents were asked to identify high priority accidents.
• All groups identified cement failure and casing failure in their top three.
• NGO, academic, and government experts identified impoundment failure of wastewater pits and ponds as the other high priority accident in their top three.
• Industry experts cited truck accidents.
Risk Mitigation Authority

• Academic and NGO experts chose government for risk mitigation more frequently than industry experts.
• Industry experts were evenly split between industry and government.
• When shared authority became and option, all groups chose this option with industry experts more frequently choosing industry as the lead.
The Problem of Externalities

• Pathways suggests two classes of externalities:
  – Routine risk pathways, those we anticipate to normally be part of the process.
    • Air pollution from methane venting.
    • Surface water pollution from stormwater flows off drilling sites, freshwater withdrawals, normal use storage treatment disposal of fracturing fluids and flowback.
    • Groundwater pollution from freshwater withdrawals and onsite storage of fracturing fluids.
  – High Priority Accidents
    • Cement failure
    • Drill casing failure
    • Impoundment failure of wastewater
    • Truck accidents
Correcting Externalities of Routine Risks

• Economic Principles
  – When left unaddressed, externalities are readily identifiable sources of economic inefficiency.
  – Economic tonic is to make firms internalize the economic costs they impose on others at the margin. Ideally this would be accomplished by unit charges on emissions or water withdrawals that come with external costs.

• If firms pay the damages they inflict at the margin, the incentive to curtail damages is just right.
Reality Check: Correcting Externalities of Routine Risks – Air Quality

• The science and engineering of methane emissions from well sites is inadequate to formulate concrete policy. More information needed.

• U.S. air quality regulation to date only targets local/regional pollution and does not regulate greenhouse gases.

• Air quality policy generally calls for technology standards as opposed to paying for emissions at the margin. Lack of incentives to innovate.

• Take away points:
  – Air quality emissions from fracking, a consensus risk path, will impose real and economically inefficient external costs on others.
  – Compliance costs for meeting Clean Air Act requirements will fall on everyone.
  – Methane as a potent greenhouse gas is completely ignored under current regulation.
Reality Check: Correcting Externalities of Routine Risks – Surface Water Quality

- **Surface Water Quality Regulation**
  - The Clean Water Act (CWA) relies on State/Federal partnership to designate waterbody uses and articulate discharge standards to meet designated uses. Standards are generally technology-based and industry specific.
  - CWA has a system of fines when water quality does not support designated uses.
  - Fines are frequently avoided when states/municipalities/counties undertake restoration/mitigation activities.

- **Track Record from EPA Summary of Assessed Waters**
  - Impaired water body: stream reaches, lakes, waterbody segments with chronic or recurring monitored violations of the applicable numeric and/or narrative water quality criteria.
    - 53% of assessed streams and rivers are impaired.
    - 67% of lakes, reservoirs, and ponds are impaired.
    - 99% of Great Lakes open water is impaired.

- **Take away:**
  - The CWA track record of regulating criteria pollutants indicates administration falls short of the legislative goals.
  - A continued technology-based standards approach to regulation for fracking operations should be expected to contribute to the nation’s surface water quality problems.
Reality Check: Correcting Externalities of Routine Risks – Ground Water

• Federal ground water regulatory programs
  – Underground injection control program is responsible for regulating the construction, operation, permitting, and closure of injection wells that place fluids underground for storage or disposal.
  – Ground water rule provides for increased protection against microbial pathogens in public water systems that use ground water sources.
  – Wellhead Protection Program is a pollution prevention and management program used to protect underground sources of drinking water.
  – Private ground water drinking wells are not regulated by the Federal government.

• Take away:
  – In principle there is regulatory oversight of by the US EPA or states that request primacy for regulation.
Correcting Externalities from Accidents

• High priority accidents:
  – Cement failure
  – Drill casing failure
  – Impoundment failure
  – Truck accidents

• Economically efficient accident management
  – Liability for economic and ecological costs from accidents are covered entirely by the firms.
    • Marginal expenditures on precaution equal the expected marginal reduction in accident costs.
Ground Water Accidents

• Cement failure and drill casing failure are consensus accidents and one of the greatest sources of public fear of fracking.

• In a National Bureau of Economic Research Working paper, Duke University researchers estimated the impact of adjacent drilling on property values in Washington County, Pennsylvania.
  – They estimated that Properties within 2000 meters of drilling sites experienced a 10% increase in property values.
  – They also estimated that properties within 2000 meters that rely on groundwater experienced a 23% decrease in value.

• These results suggest risk perception of well contamination is capitalized in home values.
Ground Water Property Rights Regimes

• **Source:** National Agricultural Law Center
  
  – Absolute Dominion
    • A landowner may use as much ground water as possible.
  
  – Correlative Rights
    • Distributes water on an equitable basis among landowners and allows off-tract uses, although these uses are subordinate to on-tract uses.
  
  – Prior Appropriation
    • The first landowner to beneficially use or divert water from a groundwater source is given a priority over later users.
  
  – Reasonable Use
    • Water must be put to a reasonable use on the overlying tract of land and does not permit water to be taken to another tract.
Ground Water
Property Rights Regimes

• Source: National Agricultural Law Center
  – Restatement (Second) of Torts Rule
    • A proprietor of land or his grantee who withdraws groundwater from the land and uses it for a beneficial purpose is not subject to liability for interference with the use of water by another, unless
      – the withdrawal of groundwater unreasonably causes harm to a proprietor of neighboring land through lowering the water table or reducing artesian pressure,
      – the withdrawal of groundwater exceeds the proprietor’s reasonable share of the annual supply or total store of groundwater, or
      – the withdrawal of the groundwater has a direct and substantial effect upon a watercourse or lake and unreasonably causes harm to a person entitled to the use of its water.
Ground Water Property Rights

• Dominant property rights regimes in the U.S. emphasize getting as much water as you need/desire.
  – Without restrictions under Absolute Dominion.
  – With seniority restrictions under Prior Appropriation.
  – With reasonable use and no adverse effects on others under Reasonable Use and Restatement (Second) of torts.

• Ground water property rights regimes are geared toward quantity issues and do not directly address quality problems that result from contamination by other parties.
Recovering Ground Water Contamination Losses in Court

• Proving groundwater contamination in court has historically been difficult.
  – In Federal court, expert witnesses face scrutiny under Federal Rule of Evidence 702 (Daubert).
  – A qualified expert may testify in the form of an opinion or otherwise if
    • (a) the experts scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
    • (b) the testimony is based on sufficient facts or data;
    • (c) the testimony is the product of reliable principles and methods; and
    • (d) the expert has reliably applied the principles and methods to the facts of the case.

• Plaintiffs’ expert testimonies are often ruled inadmissible by Daubert challenge.

• As of February 2013, there were no court decisions on pending groundwater contamination cases related to fracking.
Recovering Ground Water Contamination Losses in Court

• There are few credible documented cases of shale gas development leading to significant releases of methane into groundwater, fires in houses when faucets are turned on, etc., though the necessary "before and after" data to perform good studies is lacking (Alan Krupnick, Lucija Muehlenbachs, and Karlis Muehlenbachs, 2011).
Recovering Ground Water Contamination Losses in Court

• As in most natural resource injury cases, groundwater contamination cases hinge on information.
• Drilling always occurs in areas with natural gas reserves and in these areas methane is naturally present.
• Baseline information is often lacking.
• If information is lacking or asymmetric, compensation through the courts will be highly inefficient.
Improving Economic Efficiency in Groundwater Contamination Disputes

• Large-scale and scientifically credible groundwater monitoring before, during and after drilling.
  – Third-party monitoring.
  – Peer reviewed.
  – Model calibration and testing.
  – Industry cooperation and collaboration.

• Potential Funding
  – Funding through fees levied on shale gas developers.
  – Funding through royalties.
  – Funding through fees on well owners.
Summary Points on Externalities

• In order to achieve maximum gain to our nation, the costs of environmental externalities must be incorporated into the development and extraction costs along side direct costs.
• Failing to internalize environmental costs will result in too much extraction.
• Banning or too severely restricting shale gas development will result in too little extraction.
• Current regulatory regimes fall far short of this ideal.
Natural Gas Market Facts

• In 2003 and 2004 the Energy Information Agency did not recognize shale gas production as a major contributor to the natural gas market.

• Proven reserves and production of shale natural gas in the U.S. increased by a factor of four between 2007 and 2010.

• For 2012 shale gas production was forecast to contribute almost 50% of the natural gas market and 70% for 2035.

• Forecasts early in this century did not recognize the technological advances that would come:
  – advances in vertical drilling
  – down-hole telemetry
  – horizontal drilling
  – monitoring and control of deep drilling equipment, and
  – hydraulic fracturing
Natural Gas Market Facts

U.S. Natural Gas Wellhead Price (Dollars per Thousand Cubic Feet)

Source: U.S. Energy Information Administration
Market Benefits from Increased Natural Gas Production

• A matter of perspective:
  – Energy production from natural gas produces approximately half of the CO₂ emissions as coal.
  – Relatively inexpensive natural gas will propel the economy.
  – Relatively inexpensive natural gas reduces the incentive to develop renewable energy.
Natural Gas Market Facts

• With increased production the U.S. energy future looks bright indeed. The most recently reported wellhead price for natural gas reported by the EIA was $3.35/mcf.

• Landed prices of LNG
  – Japan in past 15 months $15-$17/mcf
  – Many places in Europe over $9/mcf

• Mean estimates to convert NG to LNG, ship, and regasification: $2.15/mcf.
  – $1.10 liquification
  – $0.70 shipping
  – $0.35 regasification
Natural Gas Market Facts

• Natural gas producers such as Exxon Mobile are pushing for more LNG exports.
  – DOE reported 1.6 tcf of LNG exports in 2012.
  – Current applications to DOE for export approval at 17 facilities: 21.3 tcf per year.
  – Total natural gas production in 2012 was 24 tcf.

• With increased LNG export capacity, the price of U.S. shale natural gas will be the world price of natural gas.