Analyzing Transport Options for Crude Oil

Project Description: On 6 July, 2013, a freight train derailed in the Quebec town of Lac-Mégantic, killing 47 people, spilling over one million gallons of crude oil, and causing widespread destruction. Estimated damages exceeded $100,000,000. Horrific as this event was, it was not singular, nor was 2013 a unique year: statistics compiled by the U.S. Department of transportation point to a steady stream of train derailments in the U.S. over the past 5 years, with corresponding damages rising monotonically from slightly less than $4.7 million in 2010 to just less than $30.5 million in 2013. These patterns are particularly noteworthy in light of recent trends in U.S. tight oil production, particularly from the Bakken play (which was the source of the crude on the train that derailed in Quebec).

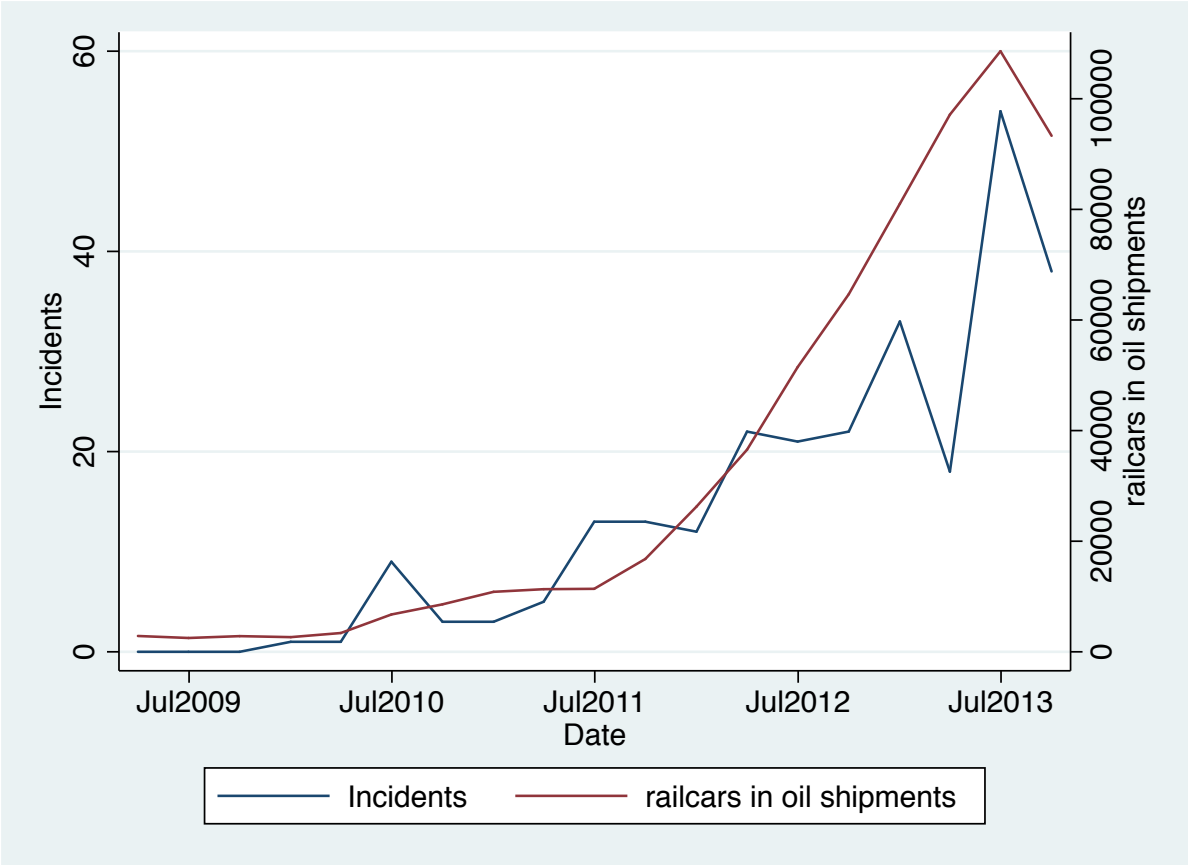
This important trend, combined with the relative lack of pipeline capacity to ship oil from the Bakken play, strongly suggest an expanding role for rail in transporting American crude oil going forward. Indeed, the number of carloads of crude oil shipped by rail has roughly doubled in each of the past 4 years; correspondingly, the volume of oil shipped by rail increased by more than an order of magnitude between 2010 and 2014. These observations point to the importance of understanding the risks associated with rail shipments, as well as alternative pathways (such as pipelines). The research I propose to conduct would consist of a careful empirical assessment of the risks associated with shipping a given amount of crude by rail and by pipeline. These estimates will allow analysis of the benefits and costs associated with each transportation option. It will also facilitate an appraisal of probable future patterns of tight oil production. In this regard, an important concern is the impact of spot price uncertainty upon the incentives to expand pipeline infrastructure. Evaluating this aspect requires building and parameterizing a model of investment under uncertainty (in the presence of partially irreversible up-front investments).

To produce a satisfactory analysis requires procurement of a substantial database; refining this database to facilitate careful econometric analysis; and then producing thoughtful policy recommendations based on the econometric results. To get a qualitative feel for the problem at hand, I have collected a small dataset. This data includes quarterly observations on carloads of crude oil shipped from January 1, 2009 through September 30, 2013, drawn from a report issued by the Association of American Railroads (AAR) in December 2013 ("Moving Crude Oil by Rail", page 4). I then matched these data with information on the number of incidents, drawn from The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration. In particular, the data is from The Incidents Reports Database from The Office of Hazardous Materials Safety. All reports pertaining to incidents occurring between January 1, 2009 and September 30, 2013 were downloaded. Quarterly totals of number of incidents were calculated from these incident reports.

In Figure 1 below, I plot these variables over the sample period; there is a clear correlation between the two, pointing to the potential for a more detailed analysis to produce meaningful results. Figure 2, using very aggregate data, shows how rail accidents and associated damage costs have risen over time.

The primary focus of the econometric analysis would be identification of an empirically defensible model of the probabilities of significant accidents, along with an appraisal of the associated damages, the risk of fatalities and expected volumes of oil spilled. To

FIGURE 1. Rail Incidents and Number of Railcars Shipping Oil, 2009-2013



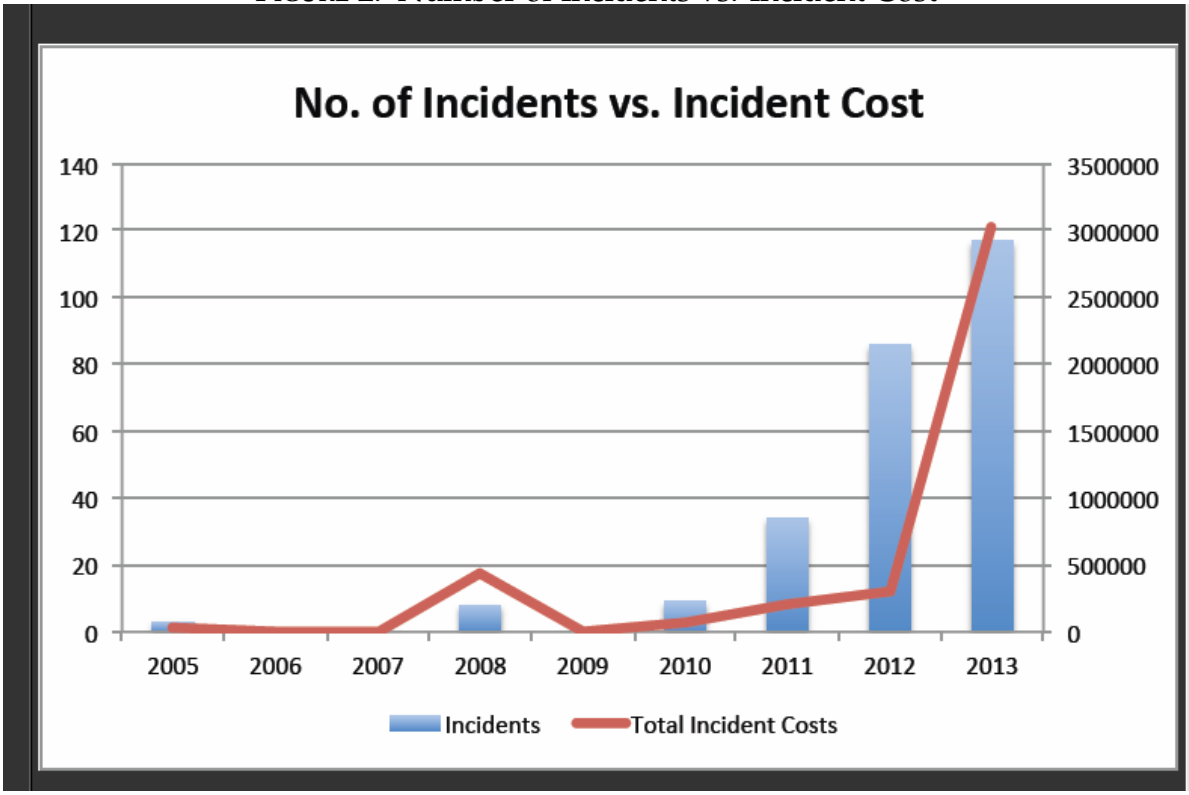
this end, I plan to collect data from the AAR's *Weekly Rail Traffic Reports*, along with the total dollar amount of damages associated with those incidents. The AAR sells these data at a modest price ($625).

My plan is to disaggregate these data over time and space. The data should permit determination of route-specific shipments, given knowledge of where the shipment was picked up and dropped off. One can then match incidents to specific routes. A natural hypothesis is that the congestion and bottlenecks caused by the rapid ramp up in oil shipments has led to the use of routes that are not in as good repair or are not as safe as those normally used, which would account for the big increase in accidents. In any event, explaining why accidents are increasing, specifically, can help determine the appropriate policy response.

I also plan to produce similar estimates for pipeline shipments. To this end, I will make use of data on pipeline incidents available from the Pipelines and Hazardous Materials Safety Administration, which is part of the Department of Transportation.[1] This will allow comparisons of risks and costs between the two shipment modes. On the one hand, accidents leading to oil spills per ton-mile are almost three times fewer for rail. On the other hand, rail is more costly per barrel than pipelines, and the damages from

[1] Data at the PHMSA website indicates that over the ten year period from 2004 - 2013, there were on average 36 incidents involving pipelines each year, with an average dollar cost of slightly less than $1.5 million (http://www.phmsa.dot.gov/).

FIGURE 2. Number of Incidents vs. Incident Cost



incidents tend to be larger. At the same time, rail affords the operators more flexibility in getting the oil to refineries.

A secondary focus is to assess the likely future stream of oil shipments, by estimating the likely future path of tight oil production; with this estimate I will be in a position to estimate the number of "draws" associated with the random variables describing the probabilities of rail accidents or pipeline accidents. Combining all these elements will then allow estimation of the expected damages associated with each transport pathway; then combining with information on costs of increasing pipeline capacity, or building more robust rail cars, will facilitate an assessment of the benefits and costs of various expansions of delivery infrastructure. In turn, this leads naturally to an evaluation of incentives to build out pipeline infrastructure. Such an inquiry is most naturally placed in the context of modern analysis of investment under uncertainty.[2]

Ideally, this work will allow evaluation of recent policy proposals for rail shipments; for example, retirement of all non-bottom-reinforced DOT-111 tank cars and the phasing out all DOT-111s in a few years. Here, an obvious question is: do these cars have a higher probability of a high damage spill? In addition, there are important questions price signals are a problem through issues with tariffs. Is the congestion pricing system adequate? The bonding system? The liability system? For the latter, it is clear that determining liability is a major problem and thus may lead to moral hazard. Basically, operators own or lease the tankers but the railroads determine their route and are responsible for limiting accidents

[2] As popularized by Dixit and Pindyck in their 1994 Princeton University Press book Investment Under Uncertainty.

but not for limiting the damage that would occur given an accident. This system makes liability very hard to determine.

In anticipation of pursuing this research agenda, I have had discussions with Sauleh Siddiqui, an Assistant Professor in the Department of Civil Engineering at Johns Hopkins University. Dr. Siddiqui has studied similar logistic questions. I anticipate collaborating with him on the specific numerical model used to evaluate incentives to invest in additional pipeline capacity.

Conflict of Interest Statement: I have no additional funding, nor do I have any financial or other interests in this research. In particular, I have no ties to the oil and gas industry.