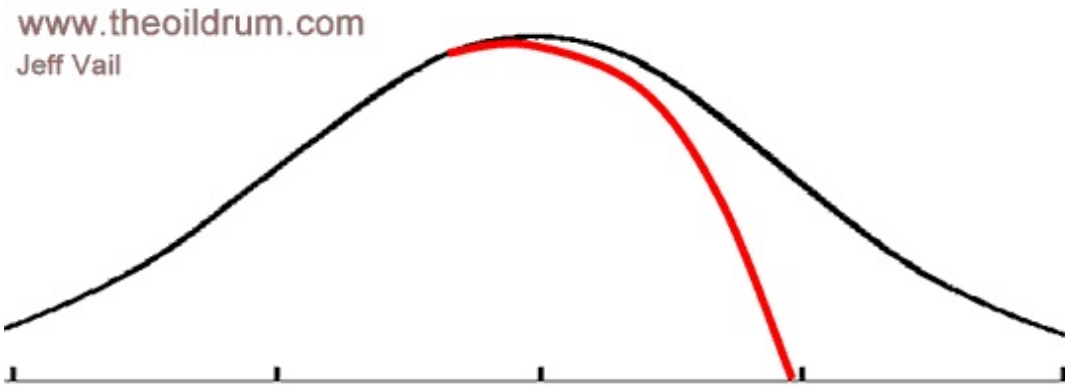
The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Geopolitical Disruptions #1: Theory of Disruptions to Oil & Resource Supply

Posted by jeffvail on August 14, 2008 - 10:17am
Topic: Policy/Politics
Tags: above ground factors, geopolitical feedback loops, geopolitics, gfl, original, supply disruption [list all tags]

The peak and gradual decline in world oil production is beginning to spawn a set of geopolitical positive-feedback-loops that seem likely to exacerbate depletion and accelerate the effective rate of decline of world oil production. Rather than isolated incidents, these geopolitical feedback loops are the direct result of geological peaking in oil production. Unlike geologically driven peaking, however, the effective rate of decline caused by geopolitical feedback loops has the potential to continually accelerate. This post will lay out a theory to better understand the impact of this system of geopolitical phenomena.



While geological peaking of oil supply (black line) presents a significant challenge, it also acts as a catalyst for a system of geopolitical feedback loops (red line) that may catastrophically exacerbate the situation.

I've discussed the impact of various types of geopolitical disruptions to oil production previously at The Oil Drum. One of these geopolitical phenomena, the Export Land Model (ELM), has been well developed by TOD members Westexas and Khebab (see their Iron Triangle post and Wikipedia article). While I think that ELM is already proving to be the most significant of the geopolitical factors--especially in the earlier phases of peak oil--I think that it is important to place ELM into the context of a larger set of geopolitical pheonomena. In part, this is the case because of a similarity between the various geopolitical forces at work. In part, it is because these forces tend to act as alternatives to one another, and their full implications cannot be properly understood in isolation.

In this post, the first part in a series, I hope to lay the framework of a theory for better

understanding these phenomena, for extrapolating trends, and for predicting their future impact. It is also important to place the problem of geopolitical disruptions in context, and to highlight the danger of dismissing these phenomena as isolated and separate "above ground factors." The next post in this series will review and update the set of geopolitical feedback loops currently in action, looking not only at disruptions to oil production, but also at the larger issue of resource production, including gas, coal, fertilizer, metals, etc. The final post will discuss the interrelationship between the various geopolitical forces at work as well as the potential approaches to "solve" this system of problems.

Building a Theory of Geopolitical Disruptions to Resource Supply

Since this theory is still very much in formation, I'll proceed by asking a series of questions, followed by my best answer at present. I hope that readers will help to both refine these answers, as well as propose additional questions that must be addressed:

1. Are Geology and Geopolitics Separate?

When considering peak oil, it is tempting to look at the issue as a purely a matter of depletion due to geology and production economics. While peak oil certainly begins with the study and understanding of geological depletion, it spawns a set of exacerbating geopolitical factors that are critical to understanding the ultimate scope and impact of peak oil.

Some commentators consider "above ground factors" to be separate, stand-alone phenomena that are neither related to nor driven by the geological peaking of oil production. This is a critical mistake. Rather than being merely isolated phenomena, these geopolitical forces are best viewed as phenomena that would not exist but for geological constraints. Without geological constraints on oil production--specifically without geographical constraints on where remaining viable oil reserves are located--oil producers would produce sufficient oil from geopolitically stable locations. In reality, resources are almost always subject to uneven geographical distribution.

For economic and political reasons, consuming nations *tend* to produce domestic supplies first. When consuming nations produce oil in foreign nations, regions with geopolitical stability and stable legal systems to protect property interests are favored, so oil from these countries *tends* to be produced first. As a result, when the world has produced roughly half of its reserves, and when world production approaches peaking, the majority of remaining reserves (especially the majority of economically viable reserves) tend to be located outside consuming countries in the least geopolitically and legally stable regions.

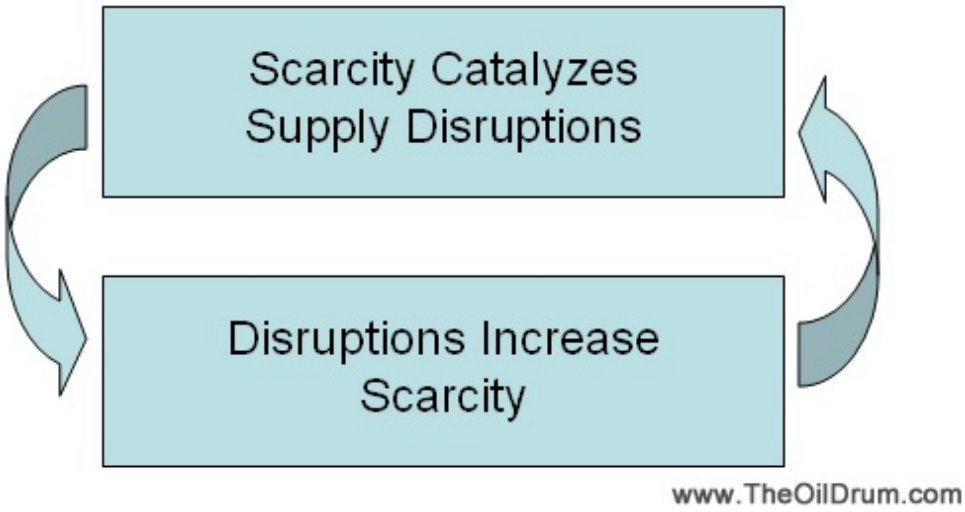
This, roughly, is why "our oil" is increasingly likely to be located "under their sand." As a result, today's increasing geopolitical problems in oil and resource production are a direct result of geological factors combined with picking the low hanging fruit first. If it had made more sense to produce oil from offshore Nigeria, Azerbaijan, or the Arctic first, and save Texas and Alaska oil for later, we would have done that. But because that wasn't what made sense, today's geopolitical problems are a direct result of geography when viewed from a macro perspective. Additionally, this process of explaining why geopolitical problems exist today also demonstrates that it is useful to view geopolitical problems as a global system of phenomena, not as isolated events.

2. Are Geopolitical Disruptions Feedback Loops?

It seems that geopolitical forces act as positive feedback loops. I'll detail the feedback inside and between various geopolitical forces in my next post, but for now I'll outline the general concept: 1) global scarcity of oil, energy, or other resources increases the likelihood of disruption to the supply

of that resource (for various reasons that I've discussed before and will outline in more detail in the next post in this series); 2) when these disruptions occur, they further increase the global scarcity of the resource, increasing the effect noted in #1 and creating a positive feedback loop.* For that reason, I call this set of exacerbating factors "geopolitical feedback loops" as they are subject to positive feedback both from their own operation and from the rate of geologically-driven depletion. I think that term is appropriate, but admittedly a bit cumbersome--I'll shorten it to "GFL" for now.

*Some GFLs may not be positive feedback loops--the Export Land Model, for example, is probably a positive feedback loop to the extent that the drop in net exports from one exporter causes global prices to rise enough to make that exporter's export revenues increase despite the decline in net export volume. However, it would be a negative feedback loop if the rise in domestic consumption due to high export revenues (the system's output) has the result of decreasing export revenues (feeding the system's output back into the system in an inverted manner) and thereby causing a decrease in domestic consumption (acting to re-establish equilibrium).



3. How Does the "Rate" of Disruption from Geopolitics and Geology Compare?

There are also critical differences between the rate of geological depletion and the potential rate at which geopolitical disruptions cumulatively impact oil supply rates. Unlike depletion, whereby oil production from a given field or set of fields decreases rapidly after peaking before beginning to "tail off" and decrease more slowly (the black line in the graphic above), geopolitical forces may disrupt production catastrophically, or may disrupt production at a rapidly accelerating rate (the red line in the graphic above).

This is not to say that GFLs will have a greater impact than geology--while it is certainly possible that a single geopolitical disruption will dramatically outpace geological depletion over a short time period, geological factors will likely be the main determinant of oil production declines during the initial phases of peak oil. However, depending on our society's ability to mitigate Peak Oil with substitute energy sources and to adapt to a lower energy world, it also seems likely that geopolitical disruptions will eventually overtake depletion as the most significant problem. Because geopolitical disruptions will have a disproportionately greater impact in an environment of increasing oil scarcity, as well as due to factors involved in secondary and tertiary recovery methods, the right half of the global oil production curve will not look like the left--when the impact of GFLs are added to the rate of geological decline, the drop in global oil production may be much faster than generally expected.

4. Along What Timeline Will Geopolitical Disruptions Unfold?

Geological forces do not require an actual peak in global oil or energy production to begin to form positive feedback loops--rather, the catalyst for positive feedback is the onset of diminishing marginal returns in investment in energy, where energy begins to become more expensive in relative terms. While global oil and energy supplies may not have peaked, we have almost certainly crossed the threshold of more expensive energy. Also unlike depletion, geopolitical feedback loops may disrupt production in a region that is still far from geological peaking. For this reason, it is reasonable to expect GFLs to increasingly disrupt global oil production alongside an increase in the scarcity of oil, and before an actual peak in global production. Annecdotal evidence supports this view of the the timing of geopolitical disruptions: while some degree of scarcity of oil has coincided with geopolitical disruptions in the past, increasing scarcity over the past decade has coincided with easily observable increases in geopolitical disruptions. While I think the general issue of timing is obvious, one critical unanswered question remains: how fast will geopolitical disruptions impact overall production rates?

5 . Will the Aggregate Effect of Geopolitical Disruptions be Smooth or Unpredictably "Bumpy"?

Unlike geological depletion, geopolitical disruption is uniquely susceptible to "black swan" events--things that simply cannot be predicted. This is problematic because, unlike geological depletion which can be understood as a slow but compounding process, geopolitical disruptions may appear non-existent, but then suddenly exert a huge toll on global production. This makes predictions of future oil production levels even more uncertain than predictions that account for only geological factors, and increased uncertainty in estimating future oil production makes selecting and mobilizing the necessary political will for various mitigation options more difficult.

Some GFLs, such as the Export Land Model, will likely produce fairly smooth and predictable effects. Others, like the increased motivation to target oil production infrastructure, will likely produce relatively smooth aggregate effects, but will be subject to significant and sudden disruptions--for example, if al-Qa'ida successfully destroys the export terminal at Ras Tanura, or if Iran blockaded the Strait of Hormuz. The critical unanswered question here is whether, in aggregate, the impact of GFLs will be predictably smooth (as assumed in the graphic at the top of this post) or unpredictably volatile.

6. Is the System of Geopolitical Feedback Loops Solvable?

Because individual geopolitical disruptions can be "solved", there is a tendency to think of them as separate from geological challenges (and thereby a convenient alternate explanation for those who don't like the implications of geological depletion). Additionally, there is a tendency to think that because individual problems are solvable, the system of geopolitical forces can also be solved as a whole (specifically, solved by the same tool-set of security, military force, etc.). In reality, while the occurrence of individual events and geopolitical disruption in individual regions is highly uncertain (and too complex to predict mathematically), the increasing scarcity of oil and other resources caused by geological factors creates an ever increasing catalyst to geopolitical disruption.

In the face of geological depletion, geopolitical disruption is not a question of if, but a question of where and how fast. If a single geopolitical disruption--say, a militant group attacking a pipeline--can be solved, why can't the larger system also be solved? In theory, it can, but there are systemic problems to solving the larger system. In general, this is because the "solutions" to the individual problems are actually to overwhelm and repress the root cause locally--something

which will become increasingly difficult globally.

For example, the Nigerian rebels can, theoretically, be defeated by overwhelming government force, but this does not solve their grievance--that their ethnic group is being oppressed and resources that are rightfully theirs are being appropriated. Rather, it relies on overwhelming military force and expenditure to repress it (and, it should be noted, this "solutions" is being discussed theoretically, as the massive military force and expenditure by Nigeria's government at present is failing miserably to repress rebel attacks on oil infrastructure). It seems, at least to me, far more likely that the world can concentrate resources to temporarily repress geopolitical flare-ups regionally, especially in the earlier phases of peak oil. However, if global resources are spread thin, it is impossible to address every trouble spot simultaneously. Because of this, it seems unlikely that there would be enough pressure at individual points to repress disruptions across the entire system.

Finally, while many geopolitical problems can be repressed by favoring one side in a dispute as leverage against the other (the Exploitation Model), it is often not fundamentally possible to actually resolve the issue by making all parties happy (thereby eliminating the root cause of the geopolitical disturbance) because the minimum demands of opposing groups are often mutually exclusive. I've written about this problem of Mutually Exclusive Overlap before, and I think that it makes the global system of geopolitical feedback loops an inevitability. However, while I think that the broader system is not "solvable," I do think that it is possible to buffer their effect, a topic I will discuss in a later post.

7. Is Price the Sole Catalyst of Geopolitical Disruptions?

While demand destruction and economic troubles may grant a temporary reprieve from increasing geopolitical tensions (because they may temporarily reduce the underlying catalyst of scarcity), the steady march of resource depletion will eventually catch up and cause geopolitical tensions to escalate again unless a truly economical, scalable substitute for fossil fuels is built out sufficient to negate depletion and accommodate continued economic and population growth. In that sense, if peak oil is not a problem for humanity, neither will we suffer the exacerbating effects of geopolitical feedback loops. However, to the extent that peak oil presents a serious problem, it will be increasingly exacerbated by geopolitics.

Additionally, demand destruction is particularly inefficient at buffering these geopolitical feedback loops because the lowest value consumption tends to be "destroyed" first. In a demand destruction scenario, when consumers are forced to reduce consumption out of economic necessity, they will choose to first eliminate the consumption that is least necessary to the maintenance of their quality of life. As a result, as demand destruction gradually decreases consumption, the consumption that remains is, by process of elimination, increasingly inelastic. For this reason, demand destruction actually exacerbates the positive-feedback nature of these geopolitical phenomena.

A pipeline bombing, cartel action, or rise in domestic consumption that removes 500,000 barrels of oil per day from the international market exerts far more leverage on a future United States that consumes only 10 million barrels (due to demand destruction) per day of oil than it does on today's United States that consumes roughly 20 million barrels per day. However, if this same future United States only consumes 10 million barrels per day of oil due to the development of economically viable substitutes and voluntary efficiency measures, then this would not be the case. I'll address this point in more detail in my discussion on buffering GFLs in a later post. In general, if scarcity is the underlying catalyst to geopolitical disruptions, I think that price is not the best indicator of that scarcity--rather, price of a barrel of oil as a percentage of purchasing

power parity may be more appropriate.

8. Are Geopolitical Feedback Loops "Scale Free"?

A scale free system (aka a fractal) is one that exhibits the same behavior at all levels. Do GFLs operate as a scale free system? Assuming that, at a point in the future where total oil production is rapidly declining, there would be a world wide catalyst for geopolitical disruption to oil supplies, would it also be true that a region where oil production is rapidly declining will see a regional catalyst before world supply begins to decline? The answer is still unclear. Mexico, for example, is already well beyond its peak in oil production--ahead of the global process of peaking. Does this mean that internal pressures in Mexico are greater than elsewhere, that the driving forces behind geopolitical feedback loops are greater than elsewhere, or that the attacks on Mexico's gas pipelines can be attributed to GFLs being more advanced in Mexico than elsewhere? We don't know.

In theory, it seems reasonable to suggest that a country experiencing the problems with its own early peak may experience greater geopolitical pressures than others, but it is far from clear that this is the case in Mexico where oil export revenues are still rising, and where there are ample alternative explanations for the gas pipeline attacks. Additionally, other countries where production peaked well before global production (e.g. the US, Norway, UK, though arguably not Indonesia) haven't experienced a localized rise in geopolitical tensions. There are many complicating factors (especially when viewing the US and UK and their position on the world stage), but this is a possibility to keep track of as some regions progress past peak before others.

9. How Should Quantitative Data be Integrated in this Model?

One criticism of this model of geopolitical feedback loops is, quite understandably, its lack of hard, quantitative data at its base. In one sense, the subject matter is fundamentally less suitable to quantitative, data-driven analysis than the core issue of geological depletion. Some exceptions stand out--the Export Land Model, mentioned above, is a prime example of a geopolitical feedback loop that is well suited to data-driven analysis.

Even ELM, however, presents problems for data-driven analysis. For example, when an exporting state that currently subsidizes domestic fuel prices decides to cut that subsidy when export revenues begin to decline, or if a state decides to buy domestic political support by using some of its export revenues to boost subsidies, how do we integrate the impact of this fundamentally political maneuver with the more pure analysis of net export declines? Similarly, it is quite challenging to gather accurate data of nationalist sentiment (and the degree to which this sentiment may lead to violence), the ability to mobilize political will to conserve resources for future generations, the degree to which resources motivated a military "adventure"--all of these demonstrate the challenge of bringing data-driven analysis to inherently "fuzzy" topics.

Perhaps the most important question is the degree of importance of data-driven analysis to this topic. Will the quest for mathematical analysis of these topics provide more predictive power for a given amount of effort, or will it create a misleading appearance of accuracy and predictive ability while actually creating faulty conclusions? If quantitative analysis is appropriate here, how, specifically, should it be carried out? This question, in particular, is one where I hope the many TOD readers with experience in this area will weigh in.

I plan to begin to introduce some quantitative data in the next post in this series by attempting to tally the amount of production currently shut-in or otherwise disrupted due to the various categories of GFLs around the world. I expect it will be difficult to accurately track this data over

time (at least when compared with our ability to track actual oil production), but it seems like the best place to start with quantitative analysis, and may provide some insight into the rate and timing of geopolitical impacts on oil production.

10. Is the Potential for Financial Crash a Geopolitical Feedback Loop?

It's purely artificial to separate the financial impact of peak oil from the geopolitical impact--in fact, there are broad areas of overlap between the realm of finance or macroeconomics with geopolitics. How should these issues be integrated into this model, if at all? It is unclear to me whether financial markets are an exacerbating or mitigating factor in the context of broader geopolitical disruptions.

In one sense, the financial turmoil caused by high oil prices makes it more difficult to raise capital necessary to exploit new technologies, develop substitutes for oil, and to produce more economically challenging oil reserves. Likewise, price volatility and peak oil combine to exacerbate both financial and geopolitical issues. However, it can also be argued that financial turmoil mitigates the geopolitical problems of peak oil by destroying demand and reducing scarcity (though, as mentioned above, this is a double edged sword because it may increase inelasticity of the remaining demand).

I hope that readers can propose the best way to integrate models and predictions of financial turmoil (such as Gail the Actuary's recent financial market predictions) with this model of geopolitical feedback loops.

Conclusion

I've recently finished the book "We Think" by Charles Leadbeater. This book is an outstanding discussion of the advantages and pitfalls of collaborative innovation. I'm not proposing that the theoretical framework I'm setting forth in this and later posts is in any way gospel truth--it is an initial effort to tackle a very complex system of problems, and certainly needs further development. The Oil Drum is, in many ways, an ideal example of a "we-think" collaborative environment, and I hope that the amazing breadth and depth of knowledge of TOD readers will help to further develop this theory. Developing a better understanding of the impact of a system of geopolitical feedback loops in resource production is a critical first step in both improving our ability to predict future energy and resource supplies, and in understanding how to best act to mitigate resulting problems. Hopefully my answers to the above questions begin to lay out a foundation for a broad theory of geopolitical disruption to resource supply. In the next post I will look at several discrete geopolitical phenomena within this analytical framework, but for now my hope is to start a discussion of the overarching issues raised in this post.