

Hussam said I could play the devil's advocate. The main message I want to convey is to challenge conventional thinking and particularly fuzzy feel-good thinking.

Here are five sorts of things that can go wrong with unexamined fuzzy thinking, and I'll try to give an example of each.

Black Swans

Many of you may have read *The Black Swan* by Nassim Nicholas Taleb. His big idea is that much of the world (although not all of it) behaves more according to power laws than bell curves and that extremes happen more often than we're prepared for, by both nature and nurture.

My example is the IAEA's 1975-77 Regional Fuel Cycle Centre study.

The main result was as expected. A regional fuel cycle center would be profitable using all the cost estimates, interest rates and so forth developed in the study. The calculations also showed substantial economies of scale to be had in reprocessing facilities and operations. The investment in a regional center could be 40-60% lower than for national facilities for countries with fairly large nuclear power programs. For countries with small programs, the regional cost could be a third or even less of the cost for a national facility. The time it takes to recover capital costs and start making money could be shortened by 10 years.

The study also concluded a regional center would have important non-proliferation advantages and would offer safety, health and environmental advantages. The study concluded a regional centre would have "considerable advantages" and "no major disadvantages".

So what happened? Basically, the concept was stillborn. It never went anywhere.

I would argue the major explanation is that the economics changed. Here's the uranium price through 1975 in 1975 dollars. Here are the two years until the study was published in 1977. And here's what's happened since. The study used a uranium price of \$40 per pound, which certainly looked reasonable at the time. And they did a number of sensitivity analyses, including varying the uranium price from \$(1975)30 per pound to \$60 per pound. To their credit, they concluded that, given the other economic parameters they assumed, even the regional reprocessing center would be uneconomic if uranium prices were to drop as low as \$30 per pound. By 1980, prices were below \$20 per pound, and that's where they stayed for decades.

A second issue is that the US had consent rights over a significant portion of the nuclear fuel that a regional center would be intended to reprocess, and there appeared to be a significant chance the US wouldn't allow reprocessing.

So neither the politics nor the economics – both Black Swan type systems – followed the smooth trajectories, bell curves, and rationality that underlay all the positive conclusions of the study, and the concept was stillborn.

Perverse incentives

The second item on my list of things that can go wrong is perverse incentives. In June 2006 six countries circulated a proposal for an international reserve of low enriched uranium. It drew heavy criticism from countries concerned about an erosion of Art. IV Non-proliferation Treaty rights and the entrenchment of the divide between nuclear technology haves and have-nots. That summer there were three announcements about new enrichment interest in Argentina, Australia and South Africa. Some of my colleagues described these announcements as 'predictable'. Now if there was a cause-and-effect relationship, then a proposal designed, according to its authors, to reduce incentives for getting into the enrichment business was, empirically, having the opposite effect. And, logically, if you have a strategy to take you in one direction, and you find it taking you in the opposite direction, you should change your strategy. But that has never been

discussed out loud at any of the Board discussions on this issue or at other major events. I think it deserves more attention.

Confidence eroding rather than confidence building

I was a big supporter of the Russian low-enriched uranium reserve that was approved by the Board of Governors in a divided vote last November. I'm much more sceptical about the IAEA reserve that's still being pushed now. Here's the argument.

This started in 2003 with the former DG, Mohamed ElBaradei calling for international control of all enrichment and reprocessing. That would be necessary in a world of zero nuclear weapons. By 2006 the initiative had morphed into efforts to create low-enriched uranium reserves. I would argue that a low enriched uranium reserve is not really a step towards international control of all enrichment and reprocessing. It's not a step away either. It's more orthogonal. But one way we justified the effort was to say that it would be a confidence building step.

Well it turned out we couldn't get all parties to agree. It was a divided vote, and it left for some a bitter taste. And if you believed before the vote that this could be a confidence building measure, then you should seriously consider that continuing to advocate and champion something that left a bitter taste might erode confidence rather than build it.

So if people frame multilateral approaches as confidence building if everything goes right, the corollary is that if something goes wrong, you may be actively eroding confidence.

Fair division rules

Next are fair division rules. If anything's going to be multilateral, the partners will have to agree on how to divide gains and share burdens. There is no single fair division rule that's theoretically and practically perfect in all settings. There are three basic principles that people appeal to. None trumps the others. Practical agreements often involve

layering the principles. The three are parity, proportionality and priority. Parity means everyone gets an equal amount of the costs or benefits. Proportionality means your share is proportional to something – your GDP, your population, your investment in a company or joint project, whatever. Priority is when someone gets all the cost or benefits based on some selection rule, or at least gets to go first. “First come, first served”, for example, in bank queues around the world.

Yucca Mt. was an example of priority. It was the site that did best against the decision criteria so it gets all the waste. If it's most cost-effective to put the waste at Yucca Mt., then put all of it there. But politically Yucca Mt. did worse than how the waste is distributed now. It's stored largely at the reactor sites where it was generated. This is more an example of proportionality, and proportionality seems more politically acceptable in this instance.

Another example is the first major agreement to restrict the sulphur emissions that cause acid rain. It was called the 30% club. Countries agreed to cut emissions or trans-border fluxes by 30%. Any introductory economics student could tell you that wasn't cost-effective, but again proportionality was more politically acceptable. Later, as trust was built and independent analyses showed the joint gains that could be captured by asymmetric limits and cross-border payments, these things got layered in.

The punch line is that there's no single fair division rule that's theoretically and practically perfect in all settings. The pure pursuit of cost-effectiveness probably won't get you political support. And being satisfied with what's politically easiest will leave a lot of joint gains on the table. And what's politically possible will change with time and the skill of the available politicians.

Grand designs vs. incremental incentives

My last bullet is grand designs vs. incremental incentives. I was part of a seminar in the mid-1980s on global warming. The conventional wisdom was that it was a text-book

commons problem. Collectively all countries would be better off if we limited greenhouse gas emissions, but everyone's individual incentives were to not limit their emissions. Nothing would happen until we all got a huge agreement. I'll make three observations.

First, empirically this conventional wisdom was wrong. Even in the mid-1980s some European countries were already unilaterally imposing on themselves carbon taxes and GHG limits. Even now, although many countries have not agreed to limits, we still have others who have imposed limits on themselves (some with more success than others).

The second observation is from a colleague who constructed a group negotiation simulation in which different participants played key countries. Each had an explicit score sheet that quantified the value of different outcomes in a way that mirrored a commons problem. I asked my colleague about his results. He said sometimes the groups cooperated and got jointly beneficial cooperative outcomes. Sometimes they fell apart and everybody defected and suffered. He had a hypothesis. If someone emerged as a rhetorical and substantive leader, there was more likelihood the group would come up with a successful collective solution. You needed someone who made the noble speeches about all being in the same boat and having to cooperate. And you needed someone to put the first money on the table unconditionally.

My third observation is about the ozone hole. Initially the US was against limiting the CFCs that were causing the ozone hole. But one of the big US CFC producers was developing non-CFC alternatives as a hedging strategy. This investment was successful, at which point the company's political incentives switched. If it was the market leader in non-CFC alternatives, it had an interest in limiting CFCs so everyone would need non-CFC alternatives. The US became an advocate and leader for limiting CFCs. The full story is more complicated, but what's important is that the interplay of technological developments and political possibilities, and the interplay between grand collective designs and individual incremental incentives, can be complicated and surprising – more like Black Swans than normal distributions.

Punch line

My two messages are:

1. Challenge fuzzy thinking.
2. Prepare to never waste a crisis. Taleb's successful investment strategy (that's the author of *The Black Swan*) is to position himself to make a lot of money when there's a crisis. Crises have created opportunities for the Agency. Chernobyl enabled progress on safety agreements. The first Iraq war enabled the Additional Protocol. There will be a next crisis. The best strategy may be to figure out how best to use it.