**_Black Swans_ Fly in Face of Network Optimizations**
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By Deep Parekh

I recently read the eye-opening book *Black Swans*, by Nassim Nicholas Taleb, which talks about real world 'unpredictable' events that occur that throw life completely off course – events such as petroleum prices, exchange rates, regional trade wars, global economic crises, short supply of logistics capacity, and other such significant events that impact all companies, their operations, and their demand and supply balances. It dawned on me how naïve our traditional network or sourcing optimization studies are, and how we significantly underutilize (and often misuse) the power of mathematical modeling and optimization. We put all our efforts into finding the 'least-cost' solution or the 'max-profit' solution, but completely delegate the risk and uncertainty that underlies all models to a font size 6 on the last page of disclaimers around the model. This has got to change - and we are determined to lead the charge with changing the practices around this topic, how we treat it, and how we represent it, in our firm.

**The Traditional Approach**

We have typically been engaged by companies to perform 'network optimizations' or 'sourcing studies' for them, with the sole purpose to figure out how we can reduce cost or maximize profit. We belabor our consultants to gather all the right transportation costs (often arguing about lane rates), warehousing costs, conversion costs, material costs, and so forth, and using these, develop the perfect mathematical models with the stereotypical 'all things being constant' (which they never are) disclaimer, somewhere with an asterisk somewhere below the executive summary of results, with the risks highlighted in font size 6, and the potential savings highlighted in font size 24.

Then, we develop about a hundred different scenarios; what if the DC was in Dallas instead of Kansas City, how much would that be, and what if we close down the DC in Henderson, and put it in Sacramento instead, since there's so much west coast demand, and suppose we split the demand between Seattle and Los Angeles, will that be a lower cost approach than the current network? We get mired in choices between different options, but never consider the risks associated with all of these – we strive to find the best and most elegant arrangement of the deck-chairs on the Titanic, so to speak - you get the idea!

Now mind you, not that there's anything wrong with this – there's a lot of value in being able to demonstrate what the optimal sourcing network is for a company. However, we may be missing the true value of these mathematical models. While they're solving these complex problems, they also spit out a valuable 'by-product' – what we refer to as 'Shadow Prices', which essentially represent the 'range' for which the particular solution is valid. This range is critical in understanding the true boundaries of the solution. The solution itself is of some interest, but what's more important to know is *under what situations is it feasible and valid.*

**Shall We Go North of South (or East or West)?**

One client hired us to re-do a sourcing network study which they had done about 5 years before on their own. When we enquired as to what the problem was and why they had to re-do it, the response we got was interesting. They had moved production from the US to Canada, based on currency exchange rates between the US Dollar and the Canadian Dollar, and it made sense at the time. However, no one bothered to check the boundaries of the currency play at the time of the project, and when the Canadian Dollar rose during the oil crisis during the last 2 years, no one knew how long that would last (or not last), and so they wanted to make a decision to bring production back home. Now, it could have very well been the case if they had sent the production to Mexico or even China. What are the future labor rates, and what is the potential of a political / economic crisis such that rates may dramatically change?

No one knows the answer to these uncertainties, as Taleb writes in *Black Swans*, but at least we can be aware and educated about the relevant risks that occur, and what our exposure is, and put these boundaries and ranges at the front and center of the problem.

### How Shadow Prices & Cost Coefficients Can Help Us Establish Ranges

In order to fully utilize the power of mathematical modeling and optimization we have to be prepared to look beyond the final "optimal" solution and realize under what type of scenarios that solution remains valid. Any mathematical model gives us all the necessary information to calculate these ranges as long as we ask the right questions.

The first of these questions should be under what circumstances our current Min-Cost or Max-Profit solutions remain valid. Using cost coefficients we can determine how "airtight" our business decisions are to variations in our cost / profit objective calculations. In our previous clients case most of their profits projections were based on the fact that the Canadian Dollar was to maintain a specific exchange rate when compared to the U.S. Dollar, but when the currency failed to follow that pattern then suddenly all their decisions were no longer valid.

On the other hand we might not be at all interested in keeping our decisions constant and maybe more interested in seeing how small changes in our constraints affect our bottom line. Using shadow prices we can show how modifying our constraints impact our objective function value.

By using just two out of multiple components from the insides of our mathematical models we can determine ranges that will set the playing field for all possible feasible solutions to our problem. These types of sensitivity analysis are very simple to make and very powerful if used properly and it would be unwise to ignore the valuable information they can give us.

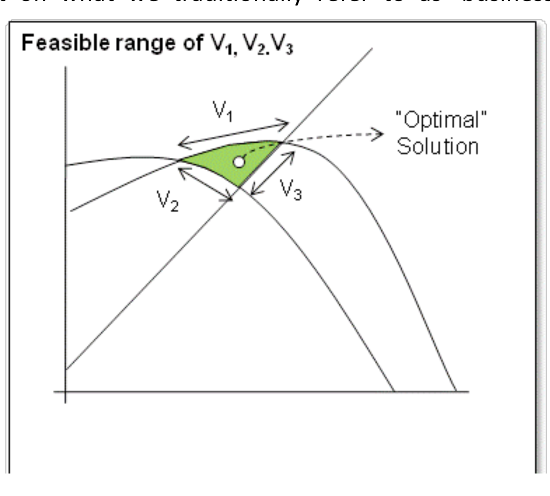
### Ranges are all the Rage

Remember the professor in college who used to give points for how you thought through a problem, and not just on the final answer? Well, it's just like that in real life. We need to think more about what the environment of the problem's solution is, rather than just the answer. Take a typical network optimization problem – there are typically 3 elements to the problem:

- Demand Requirements (market demand / DC demand / retail demand / consumer demand)
- Capacity / Lane Constraints (supply / production / warehousing / transportation)
- Costs (materials / conversion / distribution / transportation)

During the process of solving an optimization problem, the mathematics, while figuring out the best (optimal) combination of these, already figures out all the possible ranges of each element that the solution is valid for, and generates these ranges as part of the solution. All one needs to do is understand these ranges, and use them in our planning.

This is really nothing new; it's just a different slant on what we traditionally refer to as 'business continuity planning'. We are just trying to demonstrate a mathematical logic and method in order to develop better range planning using optimization as a tool.




### So How Does This Actually Work Practically?

Consider a graphical representation of a problem with 3 variables; let's say cost, capacity, and demand. Whereas trying to obtain only the optimial 'point' solution, we take a greater interest in the ranges of all three variables, to understand where this solution is valid. We may find that from a demand perspective, the range is too small, because we might sell a lot more than this, and if we do, then the optimal solution may no longer be valid. Similarly, along the capacity line, we may find that the optimal solution implies that our capacity will never grow beyond a certain point. However, if there are manufacturing efficiency improvements going on, the capacity may exceed what the optimal solution demands, and the total solution may no longer be valid.

**Ranges Trump Point Solutions**

Hence, this becomes an easy way to disregard solutions that superficially may look appealing financially. Be sure to look closely at your next optimization problem that you either request (shippers) or perform (LSPs) because what you're recommending or accepting may not work as well as you think it should.

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