Behavioral Economics and the Tradeoff between Coal and Renewable Energy Capacity Additions

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See footnotes at end of text.

The introduction and evolution of renewable energy technologies, along with policies intended to support them, have disrupted the traditional electricity generation mix which has historically relied on coal as the primary baseload generating source. Since 1999 renewable energy (RE) generating capacity has grown by 3,303%[1] with a robust 40.2%[2] being added in the last five years despite lapses in one of the main policies that drive RE capacity additions, the Production Tax Credit. The growth in RE capacity can be attributed to an array of Federal, state and local tax credits and subsidies as well as state renewable portfolio requirements. To a lesser extent some states have even passed legislation limiting carbon dioxide emissions which incentivizes RE generation at the margin.[3] Along with these policies, RE technologies have broadly witnessed decreasing average costs that can be attributed to economies of scale and "learning by doing" (among other factors). Indeed, Rhodes, et al. (2017) show that even without carbon pricing wind and natural gas have the lowest LCOE for large swathes of the United States. This, then, leads to a natural question: as the capacity of RE grows nationwide, and as natural gas prices stay low due to an abundance of supply, what will happen to the share of coal as a baseload supplier? The answer may have been decided *much* before the present day discussion of substitutability between renewable energy and fossil-fuel technologies. This brief Dialogue delves into one possible cause for the decline in coal generating facilities that has nothing to do with renewable energy and coal competing to supply baseload demand, but rather internal decision making and lessons from the field of behavioral economics.

One of the main, and most robust, findings from behavioral economics is that humans are more deeply affected by losses than by equivalent gains. In short, we are loss averse. In their seminal work on prospect theory and loss aversion, Kahneman and Tversky (1979), show that losses weigh heavily on decision making and in fact sway consumer choices in such a way that sub-optimal decisions are made. Their findings are consistent even when pairs of options with the exact same risk and reward probabilities are presented in the same questionnaire, but framed differently to reflect a possible gain or loss. Lessons from Kahneman and Tversky's prospect theory have been proven time and time again in a number of contexts, and are a mainstay of the behavioral finance literature.

Applied to the topic at hand, consider a simple example of the tradeoff between choosing to invest in a coal generating facility or a wind farm. Although wind production is intermittent by the hour, to the project facilitator electrical output over a year can be estimated with accuracy because yearly wind speeds and net capacity factors are less stochastic. Further, the vast majority of wind projects sell their electrical output at a fixed PPA[4] price that is agreed upon in advance of construction. Without any marginal fuel costs, wind projects can yield a near constant cash flow to the wind farm developer. Let's assume for this example, then, that the wind project will yield an expected net present value of $50 million dollars with little to no expected volatility. Coal projects on the other hand may appear riskier at the outset given uncertainty in market conditions and future policy decisions. For example, perhaps a coal project is profitable given current coal prices and the lack of a carbon tax or permit system, but if marginal coal prices were to rise, or if a tax on carbon dioxide emissions was passed, or both, then it is possible that the coal facility will become too expensive to be tapped for baseload demand and losses would be equal to the costs of installing the plant. For simplicity, then, let's assume that there is an 80% chance that the coal project will yield a net present value of $100 million, and a 20% chance that the net present value of the project is negative $20 million. What is your gut reaction to this investment decision?

Guaranteed $50 million from wind facility
Coal facility with:
80% chance of $100 million
20% chance of losing $20 million

According to prospect theory we would expect most to choose the 'guaranteed' $50 million from a new wind farm rather than take the risk of losing $20 million on a new coal plant. This is despite the fact that (at least in this example) the coal plant has a higher expected profitability of $76 million; $26 million more than the expected profit from the wind farm.

80% • \$100M + 20% • -\$20M = \$76M

Although this is certainly a simplification, this tradeoff decision making may already be seen in the growing age of existing coal plants and the dearth of new coal plant facilities that have been brought online. According to the EIA the capacity-weighted average age of existing coal facilities is 39 with 88% of the existing coal fleet having been installed between 1950 and 1990 (EIA, 2017) Figure 1, below, shows this downward trend in coal capacity additions by showing the amount of new coal plants by year since 1930. It is clear that new additions have been in a broad decline since at least 1978, eight years after the first "Earth Day". Further, since 1992 there has not been a single year in which there were 10 new coal fired plants installed. Figure 1 also includes any combined cycle gasification plant installations. Even when including combined cycle gasification plants it is clear that the amount of new coal facilities is waning.

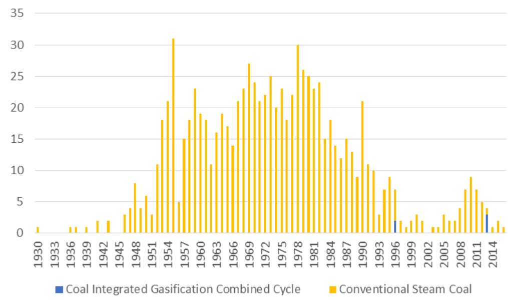

Figure 1

Of course project profitability and cost benefit decisions are much more complex than the simple example presented here. However, the mounting evidence (and acceptance) of global climate change due to the burning of fossil fuels should not be discounted in effecting large-scale capital decisions. That is to say, to the decision maker the probability that a new carbon tax or permit system is instantiated is most likely non-zero. If a new coal project is to have a 50-year life span, and this decision maker assigns any non-zero probability to future climate action that would inhibit profitability, then it is entirely possible that loss aversion may impact the decision making process. Returning to Kahneman and Tversky (1979), the authors show that even when there is only a 1% risk of earning \$0, respondents tend to pick the option with a guaranteed payout of \$2400 instead of an option with a higher expected payout.[5] Thus, even an incredibly low amount of risk could affect capital decision making and shift investment away from coal and toward RE and natural gas facilities.

As baseload capacity markets continue to evolve and adapt to the presence of cheap natural gas and a continually declining LCOE for wind and solar, it is interesting to note that tradeoff decisions between coal and renewable energy have already taken place, and that these decisions may have been unduly influenced by cognitive biases. Lessons from prospect theory and loss aversion in particular, suggest that investors may have hedged uncertainty with potentially lower profit RE projects in the past, and may continue to do so in the future.

Footnotes

[1] 1999 capacity = 2,472 MW; 2017 Q1 capacity = 84,143 MW

[2] 2012 capacity = 60,005 MW

[3] States in the Regional Greenhouse Gas Initiative, and California which has a carbon trading program.

[4] Power Purchase Agreement

[5] They choose \$2400 rather than 33% chance of \$2500, 66% chance of 2400 and 1% chance of \$0.

References

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