Revisiting the Costs Escalation Curse of Nuclear Power: New Lessons from the French Experience

Executive summary (2 August 2015)

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Nuclear power competitiveness depends on its capital costs, inasmuch as they represent, on average, 80% of the levelized cost of electricity. However, from the first wave of nuclear reactors constructed back in the late 60's and 70's, to the on-going construction of Generation III+ reactors in Finland and France, nuclear power seems to be doomed to a cost escalation curse.

If this cost increasing trend goes on, nuclear power will become more expensive while competing technologies will become cheaper. Therefore determining how to escape to this curse is vital for nuclear power to remain a competitive energy source. In this sense, we revisited the French nuclear experience due to the recent publication of the actual construction cost of the nuclear fleet. With this new information, we have identified its main drivers and we found some important lessons to take into account to ease the cost escalation phenomenon.

The nuclear curse has been widely studied in the U.S given that the cost escalation was severe. If we compare the overnight costs of the last nuclear power plant in USD_{2010}/MW with those of the first one, we can find that they were 7 times greater.

For the French case, an independent cost estimation previously done pointed out that the units installed in 1974 were 3.5 times less costly in constant euros than the post 1990 installed reactors. This finding led to think that the cost escalation is inherent to nuclear power, given that even under the best conditions, as prevailing in France (i.e. centralized decision making, high degree of standardization and regulatory stability), the construction costs have also significantly risen.

However, we revisited the French experience thanks to the availability of new data: the actual expenditures for the construction of the 58 commercial reactors published in 2012 in a report by *Cour des Comptes*, the French government audit agency. We found that the escalation was about a factor of 1.5 between the first and the last unit, thus the cost increase was less severe than it was originally believed, and by no means comparable with the U.S case

To identify the main drivers of the increase in costs in France, we have used a principal component linear regression model in which the costs are determined by an index of capacity, experience and safety indicators.

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Regarding capacity, we found that by increasing 1% the size, we might expect a cost increase of 1.31%. This result does not come as a surprise given that is well documented that for the U.S experience the scale-up meant more complex reactors and longer lead-times that resulted in more expensive units per MW installed.

Capacity could be one of the starting points in rethinking nuclear power strategy. In this sense, several authors have outlined the advantages of installing small modular reactors. They argued that since these reactors have shorter construction schedules, they have lower market risk, thus lower cost of capital.

Our results also indicate that as the number of similar reactors built increased, the construction costs decreased. The constructing of similar types of reactors is one of the main elements that prevented a severe cost escalation in France. These learning effects suggest that standardization is a successful strategy to overcome delays and uncertainties during the construction process.

Our last result says that those reactors with better performance in safety indicators were more expensive. Then achieving higher safety levels also helped to explain the cost escalation in the French nuclear fleet. This finding supports what has been often argued by nuclear industry, that is that the newest designs although more expensive, have also embodied better safety features.