[*REVISITING THE COST ESCALATION CURSE OF NUCLEAR POWER. NEW LESSONS FROM THE FRENCH EXPERIENCE*]

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Overview

Since the completion of the first wave of nuclear reactors in 1970, to the ongoing construction of Generation III+ reactors in Finland and France, nuclear power seems to be doomed to a cost escalation curse. For the U.S, this phenomena has been widely studied and it has been argued that the heterogeneity in the nuclear fleet did not allow to achieve learning effects. In turn, the French nuclear power program followed a standardization strategy and it was developed within a centralized institutional setting. However, previous cost assessments also found for France a substantial increase in the capital costs. This finding led to conclude that even with the best economic conditions, the cost escalation is inherent to nuclear power.

In this paper we reexamine the main drivers of cost escalation for France, using the actual construction costs from the Cour des Comptes report. By using this new information, we found that the cost escalation of previous studies (based on estimations), was less than it was argued. Our results indicate the existence of a learning curve within the same size and type of reactors. This finding demostrates that the standardization strategy adopted in the French nuclear power program allowed to achieve significant cost reductions.

Methods

In this paper we reexamine the main drivers of cost escalation for France, using the actual construction costs from the Cour des Comptes report. We assume a logarithmic cost function in which the explanatory variables are: capacity, input prices, experience, safety performance indicators and finally a random error.

Within the linear regression framework it is not possible to figure out the main drivers because a severe multicollineariry among the explanatory. By using a principal component regression, we overcame this limitation. With this method we can obtain relevant information from our data set, reducing it to a lower dimension and making it possible to reveal simplified underlying correlations between the costs and the explanatory variables.

Results

Our estimates comfirm that as in the U.S case, the scaling-up of the French nuclear program did not translate in costs reductions. However, we can not discard the existence of pure economies of scale given that we can not distinguish the size from the technological changes embodied in bigger reactors.

Regarding overall learning effects, we also found that cumulated experience had not induced a reduction in costs. This result is often seen as a consequence of the intrinsic characteristics of nuclear power, i.e. lumpy investments and site-specific design. Nevertheless, when we take into account the experience within the same palier and type, we find a positive learning effect. This result means that some cost reductions were achieved due to the standardization strategy adopted in the French nuclear power program.

Finally, we fount that the units with better safety indicators (UCL and US7) are related with higher costs. Therefore, we have some evidence that the latest reactors, although more expensive, have also embodied safety improvements.

Conclusions

It was originally believed that the cost escalation was about a factor of 3.5, when comparing the unit costs from the units built in 1974 and those finished after 1990 (Grubler (2010)). Using the new data, we found that the escalation was about a factor of 1.5 between the first and the last unit. Therefore, important lessons can be drawn from this program in order to identify the elements that should be taken into account to mitigate the cost escalation phenomenon.

On the basis of the analysis using the Cour des Comptes data, there is every reason to believe that the construction

cost escalation is mainly due to the scaling-up strategy and the increasing cost of labor. The scale-up induced greater complexity and leadtimes which in turn meant an increase in costs perMW. Hence, capacity could be one of the starting points in rethinking nuclear power strategy. In this sense, several authors as Kessides (2012) and Rosner and Goldberg (2011b) have outlined the advantages of installing small modular reactors. They argued that these reactors have shorter construction schedules, lower market risk and other cost savings can be achieved through off-site modules fabrication, as well as the learning by doing after the production of multiple modules.

This goes in line with our results about learning effects. We found that overall experience did not traduce in lower costs but some gains were achieved due to the construction of same types of reactors. Given the nature of this result, it would appear that standardization is a successful strategy to overcome delays and uncertainties during the construction process and thus reduce the cost of the following reactors of the same series.

The results regarding the safety indicators show that reducing the risk of a serious accident has also played its role in the French cost escalation, as it was found by Cooper (2010) for the U.S case. Our estimates suggest that in the conception of new nuclear reactors, safety improvements are undertaken (reflected in better safety indicators). In consequence when safety concerns are partly internalized in the construction costs, safer reactors are inherently more expensive.

Taking into account the lessons from French nuclear program, a good strategy would be to limit the types of reactors to be installed in order to obtain learning effects not only in construction costs but also in operation. It should also be considered that new technologies, as the small modular reactors, bring the possibility of reducing the scale of the units as well as off-site module fabrication, thereby reducing the complexity and leadtimes that have been consistently found to be the main drivers of the cost escalation phenomenon.

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