IMPACT OF THE RISKINESS OF GENERATING TECHNOLOGIES ON THEIR COST OF CAPITAL AND INVESTMENT DECISIONS

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Overview

Generators' investment decisions depend on the cost of capital but that cost of capital in its turn depends on how the generator's plant mix affects the risk it faces. This paper models that interrelationship, specifically by varying the Debt/Equity ratio that a firm can attain while still meeting its financing covenants. These require a minimum interest cover ratio, both in an average year and in a year with relatively low profits. The greater the risk faced by the generator, the lower the level of debt that it will be able to include in its financing, and hence the higher the Weighted Average Cost of Capital, given that debt generally benefits from a tax shield.

We adapt the electricity market model of Avagyan & Green (2015) to calculate the company's cash flows as electricity demand, renewable outputs and fuel prices vary. These allow us to assess the maximum amount of debt a firm can take, yielding an equity share and consequently a cost of capital that in turn enters into the model and affects investment decisions. This work complements Avagyan & Green (2015) which considers the impact of risk on investment decisions via a mean–variance utility with a constant cost of capital. The aim of this paper is to use numerical simulations to learn how significant the effect of risk on the cost of capital and on investments may be.

Green and Staffell (2013a) used a similar approach to including the impact of cash flow risk on the cost of capital, in evidence to the UK government on whether it was appropriate to have the same per MWh price for all wind farms, irrespective of their expected output. Green and Staffell (2013b), modelling the impact of state aid for nuclear power stations in Great Britain for the European Commission, showed how different costs of capital could affect the evolution of the capacity mix.

Methods

We use a simulation optimisation method based on the model detailed in Avagyan & Green (2015). That model uses a merit order stack to calculate electricity prices and generator outputs over a year with stochastic demand, renewable generation and fuel prices, given a fixed capacity mix. That capacity mix is then adjusted in the light of the risks and returns facing the generators. In that paper, we chose a social optimum in the sense that risk-averse generators had a mean-variance utility equal to zero (equivalent to a zero-profit condition in the absence of risk aversion).

In this paper, once again we explicitly seek a zero-profit equilibrium, but one in which the cost of capital that generators are covering is endogenous. Despite the Modigliani-Miller Theorem, debt offers a tax shield and a high debt-equity ratio will reduce the Weighted Average Cost of Capital (WACC). However, the financiers' typical requirements, that average cash flow is 1.5 times the annual interest payment, and the 10^{th} percentile cash flow is 1.2 times that payment, limit the amount of debt that can be taken on. The riskier the firm, the lower the proportion of debt, and the higher its cost of capital. In turn, this will affect the annualised fixed cost of each generating technology, changing both the overall amount of capacity and the zero-profit capacity mix. That could change the distribution of profits, and we will iterate between capacity, profits (and cash flows), the debt-equity ratio and the cost of capital until we find an equilibrium.

Results

Figure 1 shows the equilibrium distribution of cash-flows for three types of power station. The absolute cash flow risk is the greatest for nuclear stations, in line with Roques et al (2006), since their revenues vary with gas (and hence electricity) prices but their costs do not. CCGT and OCGT stations face revenues and costs that tend to move together with the gas price, and hence a lower absolute risk. Despite this, we find that the proportional variation in cash flows is greater for the fossil fuelled stations than for nuclear plants, since the latter have a much greater average cash-flow – a high proportion of their costs are fixed capital costs.

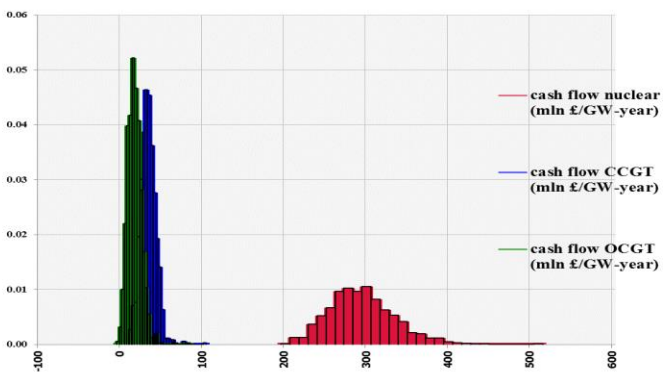

Figure 1

Debt Share	***Nuclear***	**0.60**	
	CCGT	**0.48**	
	OCGT	**0.34**	
	Company		**0.62**
Cost of Capital	***Nuclear***	**0.071**	
	CCGT	**0.076**	
	OCGT	**0.083**	
	Company		**0.066**
Equilibrium Investment (GW)	***Nuclear***	**30.6**	**31.9**
	CCGT	**18.9**	**17.7**
	OCGT	**8.0**	**8.2**
	All	**57.5**	**57.8**

Table 1

This means that the nuclear station can take on a higher share of debt and will therefore have a lower cost of capital, should this be applied at the project level. Moreover, when all stations have the same lower cost of capital (company is less risky than stand-alone projects), the level of nuclear capacity increases (**Table 1**). In further work, we plan to investigate the impact of construction risk on the cost of capital; as with the variations in cash flow, UK government projections of power station costs give a large absolute range for the cost of nuclear stations. The average nuclear construction cost is so high, however, that the proportionate risk may not be out of line with that faced by other technologies.

Conclusions

We showed that cash-flow risks have a noticeable effect on the cost of capital, and that this can have an economically significant impact on investment decisions. However, the average level of cash flows (and hence the proportion of fixed costs) is important as well as their variability, and this can lead to counter-intuitive results. Long-term contracts do insure nervous investors against political risk, and allow governments the possibility of offering above-market prices to favoured generators, but the benefits of insurance against normal cash-flow risks may have been exaggerated.

References

Avagyan V., Green R. (2015). Optimal Portfolios for Risk-Averse Generators. 39th IAEE/USAEE “Dynamic Energy Landscape” conference presentation.

Green, R. and I. Staffell (2013a) *Consultation on the EMR Delivery Plan: Response from Professor Richard Green and Dr Iain Staffell*, mimeo.

Green, R. and I. Staffell (2013b) *The Impact of Government Interventions on Investment in the GB Electricity Market.* Expert Opinion for the European Commission State Aid Decision SA.34947 on UK Electricity Market Reform – Contract for Difference for the Hinkley Point C New Nuclear Power Station.
http://ec.europa.eu/competition/state_aid/studies_reports/green_staffell_en.pdf

Modigliani F. and Miller M. (1958). “The Cost of Capital, Corporation Finance, and the Theory of Investment,” *American Economic Review*.

Roques , F.A., W.J.Nuttall, D.M.Newbery, R. De Neufville and S.Connors (2006) “Nuclear power: A hedge against uncertain gas and carbon prices”, *Energy Journal*, vol. 27, no. 4 pp 1-23