Efficient Power Generating Portfolios for the United States and Japan

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(1) Overview
In this study, Markowitz mean-variance portfolio theory is applied to power generating technologies in the United States and Japan. A current user view is adopted to determine efficient frontiers of electricity generating technologies in terms of expected return and risk (the standard deviation of expected return) as of 2003. Expected returns are defined as inverted generation costs measured in MWh/US$, which comprise fuel, investment, as well as operations and maintenance costs. In addition, a technology specific externality surcharge for environmental damage caused by power generation is added on top of each cost variable.

(2) Methods
The Kolmogorov-Smirnov procedure is used to determine the distributions of the inverted cost components data, which has been supplied by the OECD. Test results determine the distribution with the best fitting shape for each inverted cost component, whose specifically estimated distributive parameters are then used in a Monte Carlo simulation procedure. Efficient portfolios that are generated based on these optimally shaped cost components distributions are then compared with portfolios of simulated data where the cost components are assumed to be normally distributed. The latter assumption seems common in literature, and therefore deserves testing.

(3) Results
Monte Carlo simulated data with different distributive assumptions are superior in estimating efficient portfolios for power generation technologies in both countries, viz. the United States and Japan. *R*-squared tends to be higher in regression estimations with non-normal distributed data, while at the same time distribution tests also give clear support in favour of non-normality. The consequence of this alteration in distributive assumptions is revealed by assessing the portfolio

composition for each case which clearly shows some significant changes. However, it is so far not possible to draw a general conclusion about the direction of impact originating from the use of non-normal distributive assumptions.

The results based on the non-normality assumptions disclose that an electricity generating technology portfolio holder of the United States, who wishes to keep expected return the same, while lowering risk as compared to the actual portfolio in 2003, would do better by increasing the shares of Coal (from 59 percent up to 73 percent) and Nuclear (from 22 percent to 27 percent), while abandoning Gas generated electricity altogether (from 19 percent down to zero). A user with the same preferences in Japan would favour a more diversified generation portfolio mix, containing 41 percent of Coal (up by 10 percentage points as compared to the actual portfolio), 41 percent Nuclear (up by 5 percentage point as compared to the actual portfolio), and 18 percent Gas (down by 15 percent as compared to the actual portfolio). Current users in the United States and Japan would do better by reducing the share of Gas generated electricity. High generation cost volatility of Gas and a weak diversification effect with other technologies are the key reasons why Gas performs poorly.

(4) Conclusions

In a nutshell, the following main conclusions can be drawn from this study. Different distributive assumptions of input data for the Monte Carlo simulation lead to different efficient generation portfolio mixes. Our results purport the use of non-normally distributed data because econometric regression and test results speak in favour of it. Users in the United States and Japan would do better by reducing the share of Gas in their respective portfolios, and are best advised to use more Coal and Nuclear power instead.

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