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AN EFFICIENT INVESTMENT PORTFOLIO FOR THE SWISS ELECTRICITY SUPPLY SECTOR

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Overview

This paper investigates the combination of existing and possible future power generation capacities in Switzerland from a risk-return perspective. We start from the efficiency frontier of the current Swiss power generation technologies and assess the impact of different demand-driven investment options for achieving a risk-return optimized future production portfolio. The study covers the currently operating power generation technologies, such as nuclear power, storage as well as run-of-river hydro power plants, and two new renewable energy technologies (PV and wind). Additionally, a so far unused (but in the political arena heavily debated) technology in Switzerland, the natural gas combined cycle (NGCC) turbine, is assessed. As the outcome of the NPV calculations depends heavily on the risks involved, we concentrate on their identification and configure them in a way that is most plausible for each investment option. In particular, the technology-specific risks incorporated include electricity spot market prices, production capacity and reliability, fuel costs, funding liabilities, and operation and maintenance outlays.

Methods

The research reported in this paper builds upon the Mean-Variance Portfolio Theory (Markowitz, 1952). We focus on a mean-variance optimization of the net present values (NPV) of electricity generation investments. The optimization is undertaken from the point of view of an electricity producer who is trying to attain either a power generation portfolio with the highest or the most stable yield.

In a first step the risk parameters for each investment had to be identified and defined in an appropriate way. This was mainly done by relying on time series data, which was then used to estimate the underlying risk distribution parameters. The factors had to be modeled with the best fitting distribution, which in our case mainly consisted of the standard normal, or the max extreme distribution. For other factors such as gas, uranium or electricity prices past data was insufficient to credibly picture the future development, forcing us revert to prediction methods such as the single moving average and the single exponential smoothing method.

In a first step, using the Monte Carlo simulation method, we assessed the NPV model for every investment alternative with 100’000 draws. The average return was then adjusted by the appropriate, investment-specific discount rate. This adjusted average return, together with the return-specific variance, was the foundation for the portfolio optimization conducted in the second step of the analysis. The minimum variance (or maximum return) optimization was performed for portfolios containing either base load or peak load technologies. By defining different scenarios for the upper and lower bound for each technology’s share, we simulated different situations, enabling us both to explain the risk-return profile of the current mix of technologies and to make predictions for future portfolio comparisons.

Results

The portfolio optimization left us with two still unrestrained efficient frontiers. Figure 1 shows the efficient frontier over all considered base load technologies, providing a first hint that we are confronted with some technologies that exhibit a high yield/high volatility profile, while others have a negative yield but still contain a quite large return variation. Figure 2 depicts the minimum variance base load portfolio allocation for a scenario describing how the rising demand in electricity until 2020 should be met, given that the current output can be maintained. The variance of this portfolio can be kept at a very low level of 0.6%, provided that a negative return value of -5.48% is accepted.

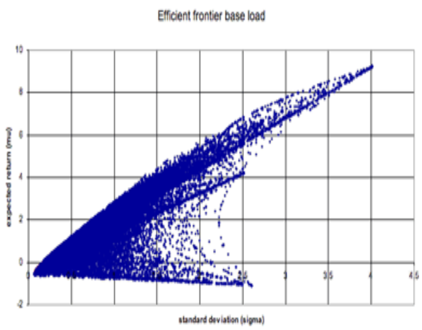

Figure 1: Efficient Frontier Base Load

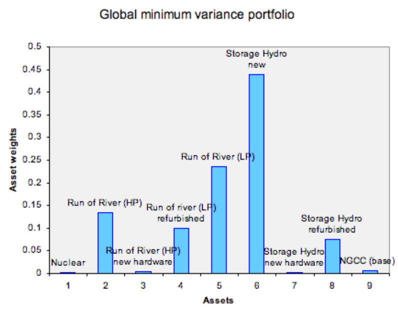

Figure 2: Minimum Variance Base Load

While some of the scenarios investigated were actually able to explain the development of the Swiss energy portfolio quite nicely, others can serve as useful predictors on where to go in the near future. By assessing the current and the planned production resource portfolio of the AXPO Group, one of Switzerland's largest energy suppliers, we can observe the changes in priorities (supply security vs. return), thus allowing us to form expectations on the aggregate change in the portfolio composition.

Conclusions

The outcomes of the NPV calculations seem to be in line with currently observed returns; at least this seems to be the case where real data for comparison is available. By applying the scenario restrictions to the portfolio optimization problem, the model did quite well in explaining the past portfolio compositions. The performance of the model in assessments of future changes remains to be seen. So far it can only be said that the proposed options on how to enlarge production in Switzerland, either by AXPO or the government, are quite congruent with our predicted outcome.

References

Markowitz, H., 1952. Portfolio selection. Journal of Finance 1 (7) 77-91.