Boris Krey and Peter Zweifel

EFFICIENT ELECTRICITY PORTFOLIOS FOR SWITZERLAND AND THE UNITED STATES

Socioeconomic Institute, University of Zurich
Hottingerstrasse 10, CH-8032 Zurich, Switzerland
B. Krey: Phone:+41 1 634 06 08, E-mail: boris.krey@soi.unizh.ch
P. Zweifel: Phone: +41 1 634 37 20, E-mail: pzweifel@soi.unizh.ch

Overview

This study applies financial portfolio theory to determine efficient electricity-generating technology mixes for Switzerland and the United States. These efficient allocations satisfy at least two objectives that are enshrined both in the Swiss constitution and mission statement of the US National Energy Policy Development Group, viz. "secure provision" and "low cost to the economy". Expected returns are given by the (negative of the) rate of increase of power generation cost. Volatility of returns relates to the standard deviation of the cost increase associated with the portfolio, which contains technologies such as *Nuclear*, *Run of river*, *Storage hydro*, and *Solar* in the case of Switzerland, and *Coal*, *Nuclear*, *Gas*, *Oil*, and *Wind* in the case of the United States.

Methods

Since shocks in generation costs are fond to be correlated, we use the seemingly unrelated regression estimation (SURE) method for filtering out the systematic components of the covariance matrix of the cost changes.

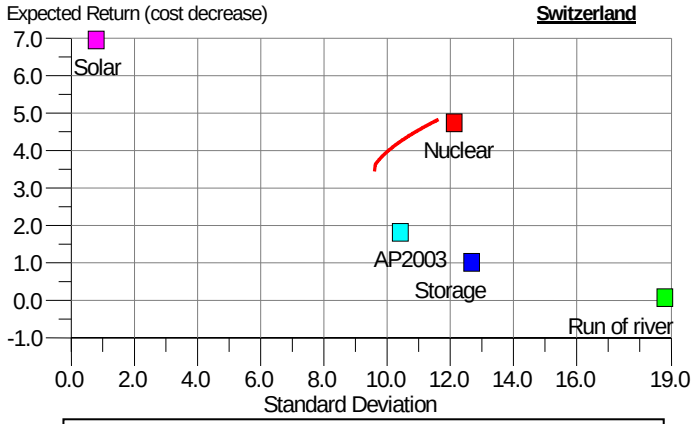
Results

When introducing constraints with regard to the acceptable share of a technology included in the portfolio and taking account of external costs such as those due to global warming and health losses, the results suggest that at observed generation costs in 2003, the maximum expected return (MER) portfolio for Switzerland would call for a shift towards *Nuclear* power and *Solar*, and therefore away from *Run of river* and *Storage hydro* generated electricity (see Figure 1 below). By way of contrast, the minimum variance (MV) portfolio mainly contains *Nuclear* power, *Storage hydro*, *Run of river* and *Solar*. The 2003 MER portfolio for the United States contains *Coal* generated electricity and *Wind*, while the MV alternative combines *Coal*, *Oil*, *Nuclear* and *Wind* (See Figure 2 below). Interestingly, *Gas* does not play any role in the determination of efficient electricity portfolios in the United States.

Conclusions

One could argue that for a population as risk-averse as the Swiss, the minimum variance portfolio is appropriate. Under this standard and with a "realistic" restriction on the shares of *Run of river*, *Storage hydro* and *Solar*, *Nuclear* accounts for 51 percent (neglecting external costs) or 60 percent (high external costs, see Frontier 1) of the 2003 efficient portfolio. If one compares these efficient portfolios with the actual 2003 portfolio, one is led to conclude that the current mix of technologies is clearly inefficient. A move towards *Nuclear* and away from *Run of river* electricity seems to be advisable in terms of reducing risk and maximizing expected returns. For the United States, a similar discrepancy emerges in terms of *Coal* and *Gas* generated electricity. With a "realistic" restriction on the share of *Wind* power, *Coal* accounts for 66 percent in the minimum variance portfolio (neglecting external costs) or 81 percent (high external costs, see Figure 2). Interestingly, *Gas* does not show up in any efficient portfo-

lio. The United States thus may reap an efficiency gain by investing in more *Coal* generated electricity and staying away from *Gas*.



Constraints imposed (maximum shares):

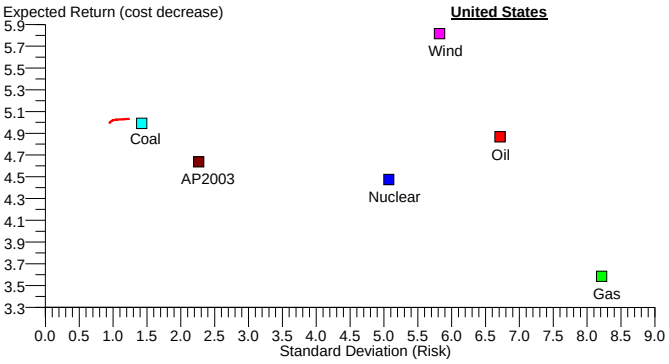
Run of river ≤ 24%, *Storage hydro* ≤ 32% & *Solar* ≤ 4%

Maximum Expected Return Portfolio (MER)
Max. E(Rp) = 4.83, St.D. = 11.63
96% *Nuclear*
4% *Solar*

Minimum Variance Portfolio (MV)
E(Rp) = 3.45, Min St.D. = 9.60
60% *Nuclear*
32% *Storage hydro*
4% *Run of river*
4% *Solar*

Actual Portfolio 2003 (AP2003)
Return = 1.82, St.D. = 10.41
40% *Nuclear*
24% *Run of river*
32% *Storage hydro*
4% *Solar*

Figure 1 Swiss Efficient Electricity Portfolios (2003, SURE-based, with constraint, with high external costs)



Constraints imposed (maximum shares):

Wind ≤ 5%

Maximum Expected Return Portfolio (MER)
Max. E(Rp) = 5.03, St.D. = 1.24
95% *Coal*
5% *Wind*

Minimum Variance Portfolio (MV)
E(Rp) = 4.99, Min St.D. = 0.94
81% *Coal*
7% *Oil*
7% *Nuclear*
5% *Wind*

Actual Portfolio 2003 (AP2003)
Return = 4.64, St.D. = 2.26
56% *Coal*
21% *Nuclear*
18% *Gas*
3% *Oil*
2% *Wind*

Figure 2 U.S. Efficient Electricity Portfolios (2003, SURE-based, with constraint, with high external costs)

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