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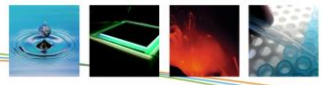


23/12/2012

Coping with recurring uncertainties: how determining is the chosen methodology?

Wouter Nijs

Motivation

- Include a hedging strategy for uncertainty within TIMES
- Some parameters like fuel prices will always be uncertain. It is impossible to fully predict over the time horizon.
- More and more people get suspicious when hearing a model is based on a "perfect foresight" methodology
  - "Nobody can predict costs so why taking costs as to be optimised ?"
  - "How can portfolios be set up if you only predict demand ?"
- Do we have a methodology to offer when expectations matter ?.. Given that computation gets faster and faster
- And if we have such a methodology, is it worth to use ?

The alternative is not using any model about the future (and I am not defending this)

"Okay – it's agreed; we announce – 'to do nothing is not an option!' then we wait and see how things pan out..."
www.private-eye.co.uk.

Objectives

Compare model results of *deterministic/portfolio/operational recourse/full recourse* models by including the ability to change operation or both operation and investment over time.

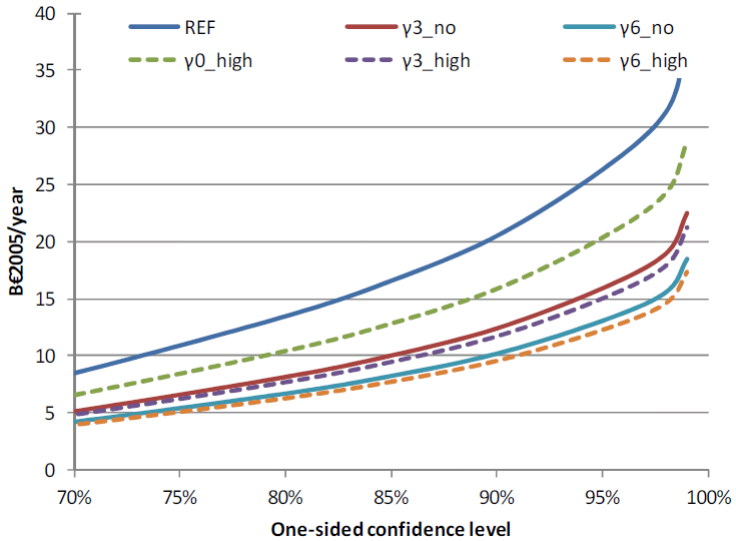
1. *Deterministic vs portfolio*
2. *Detereministic vs "SPINES" = operational recourse vs classical STOCHASTIC = full recourse*

1. Deterministic vs portfolio

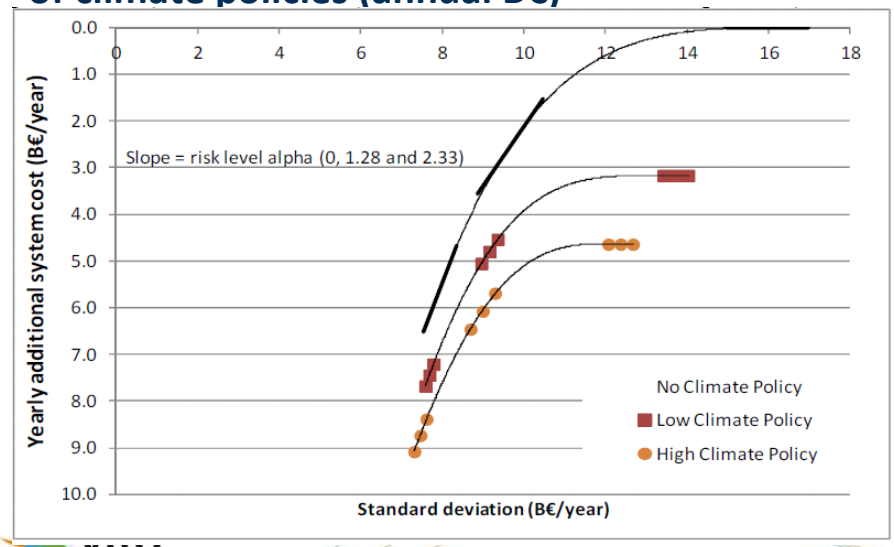
- TIMES model optimizes the energy system under a given set of drivers and boundaries, taking both cost and variation of cost into account.
- Within TIMES by using Excel files, but not in the code
- Enables the modeler to put an extra cost on upward variation of the total fuel costs (not just the separate ones).
- The main advantage is that covariances are taken into account and that a high number of future price paths can be included.

- New conclusions on VaR
  - What is VaR ? Example: the 80%-VaR is the upper estimate of the difference between the actual cost of an energy system and the expected cost which is exceeded with 20% probability.

VaR is high but can be reduced in many ways



Risk (standard deviation) and cost for 3 levels of climate policies (annual B€)



Share of total energy generation by source for a CO_2 reduction target of 58%

	Coal	Gas	Oil	Renewables	Other
γ0_low (REF)	24.2%	19.9%	31.1%	15.2%	9.6%
γ3_low	28.3%	18.1%	24.7%	19.6%	9.3%
γ6_low	31.8%	16.8%	21.4%	20.2%	9.7%

1. Deterministic vs portfolio: conclusions

- CO2 policies can decrease the cost of reducing fuel price risks by up to around 30%. Conversely, for a risk-averse society, reducing CO2 is up to 30% less costly than for a risk-neutral society.

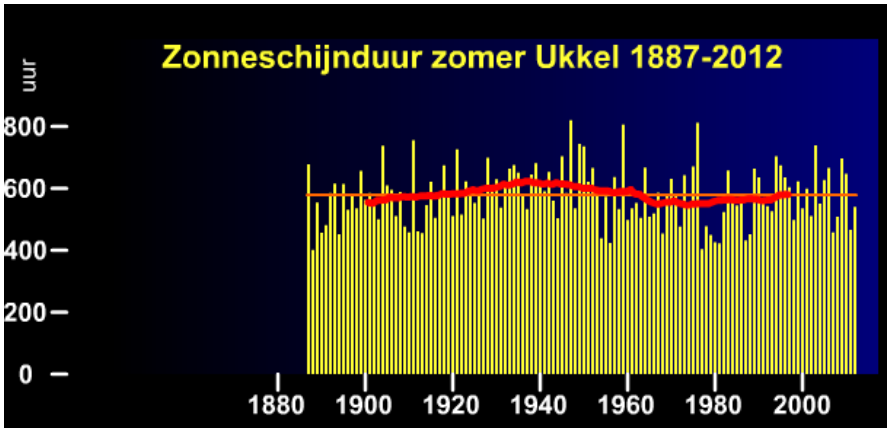
Remarks:

- Much uncertainty has yet to be introduced: for example, no variation is assumed on the prices of biomass or technology parameters.
- The portfolio approach assumes a single decision pathway with fixed outcomes without the ability to change over time:
  - No revelation points in time
  - Therefore, the changes may be an overestimation, as consumers are able to adapt their behavior on a much shorter timeframe.

2. Deterministic vs SPINES vs STOCHASTIC

- WHY a variant on classical stochastic ?
  - Not a single decision pathway (not in portfolio)
  - A “continuous” hedging period (not in classical stochastic)
  - Technical explanation: presentation Pernille, IFE
- HOW: already in the TIMES code: SPINES as a variant of STOCHASTIC
  (An explanation of the implementation is written in the User Control Switches)
- MODEL RUNS: Belgian TIMES model with stochastic AF for PV and Wind as from 2010 (startyear 2005)
  - two stages, 4 States Of the World (variation during the year and somewhat lower PV available ~ 20%)
  - Target of 100% renewable in 2050

Sun is variable during a year, but also over the years (in Belgium…).



Input file for both classical stochastic and SPINES

~TFM_INS							
TimeSlice	LimType	Attribute	STAGE	SOW	Year	Pset_PN	AllRegion
		SW_START	1				2005
		SW_START	2				2010
		SW_SUBS	1	1			4
01_Jan_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.1
03_Jan_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.133333
05_Feb_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.1
07_Feb_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.1
09_Ma_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.183333
11_Ma_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.346667
13_Apr_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.1
15_Apr_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.32
17_Apr_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.1
19_May_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.24
21_May_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.633333
23_Jun_D	FX	S_NCAP_AFS	2	1,2		EUPVSOLR*	0.333333

How long does it take to run ?

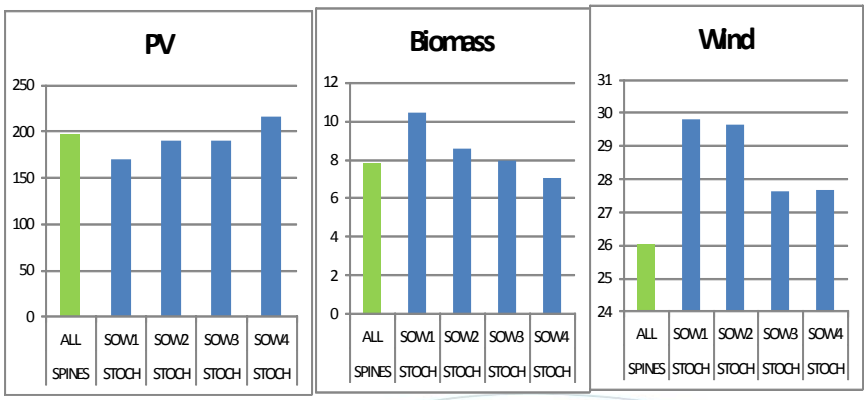
With unchanged CPLEX options, two stages, 4 States Of the World

- Detereministic: 0 hours 8 minutes
- Stochastic: 3 hours 51 minutes
- SPINES: 4 hours 19 minutes

- SPINES size of the model is lower than the classical stochastic approach, cfr some variables non SOW specific, but more bound…
- I have the impression that SPINES is faster for models with many options (it runs much faster if time horizon is set to 2030 rather than 2050).

2. Deterministic vs stochastic/spines: conclusions

- Example: investment in PV, Biomass power plants and Wind (GW in 2050).



2. Deterministic vs stochastic/spines: conclusions

- SPINES has a higher expected cost than classical STOCHASTIC
- Capacities differ and go in the direction of more robust
- A more robust *deterministic* model (via increasing timeslices, including bounds for reserve,…) gives smaller differences when *stochastic approaches* are included
- …but it guarantees the solution is “variation-proof”.

General conclusions

- Using stochastic approaches is easy within TIMES when one starts from an example (building a good model takes much longer)
- The methodology matters. Approaches that cover uncertainty
  - can quantify the impact of the uncertainty
  - have an impact on choices, although often within the ranges of the deterministic runs
  - guarantee that the system can cover all situations
  - SPINES gives a result that differs from running worst case
- Other domains:
  - Bigger challenge is how to capture micro risk (company level) rather than macro risk
  - Strong link with TIMES GIS and grid aspects (cfr peaking power production from renewable)