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QUANTIFICATION OF POLITICAL RISK IN ENERGY FORESIGHT

- A METHODS OVERVIEW

by

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1 Introduction

Uncertainty is almost ubiquitous in energy related decision making. It has many sources, multiple facets and numerous implications. From the uncertainties surrounding Global Warming over the incertitude of future technological progress to the volatility of fuel and other energy prices, the uncertainties account for an important part of the current energy strategy puzzle.

One key element of this puzzle is however political risk. Especially when it comes to the supply of oil and gas, where around 70 % of the worldwide resources are concentrated in what is sometimes labelled the "strategic ellipse" (cf. e.g. Rempel et al. 2006), encompassing the region from the Arabian peninsula over the surroundings of the Caspian Sea up to the most important Siberian hydrocarbon reservoirs.

How should political risk be taken into account when aiming at solving the energy strategy puzzle? This is the key issue addressed in this paper, however with a clear focus on the first step of strategic decision making, namely the environment analysis. Thereby environment does not mean only the natural environment but the entire surrounding world which is relevant for the decision making.

Consequently the first point to be discussed in the following is energy related decision making in general and the role of risk herein in particular (cf. Section 2). Then a typology of risks and especially political risks is sketched in Section 3 before approaches to the modelling and quantification of political risk are reviewed in Section 4.

2 Decision making and risk

In decision theory, usually two streams of research are distinguished (cf. e.g. Bamberg, Coenenberg 2006): normative decision theory and descriptive decision theory. Normative decision theory is mostly dealing with the questions how decisions ought to be taken whereas descriptive decision theory aims at describing and explaining empirically observable decision behaviour. Both directions are worth exploring to get some fundamental insights into strategies to deal with political risk in energy decisions.

2.1 Normative decision theory and energy related risk

The standard model of normative decision theory takes the perspective of a single decision maker who wants to identify the decision which is optimal for him- or herself. Thereby determining optimal decisions implies that the decision maker has clear and consistent preferences, i.e. he or she is capable to choose between any two alternatives (complete preferences) and these choices are not contradictory (transient preferences). This starting point is obviously highly simplified, since in most energy problems many stakeholders are involved and the preferences are not always well-defined[1]. Nevertheless this setting allows some interesting insights. Two notably shall be pointed out here.

First normative decision theory makes an important distinction between three decision settings:

- Decisions under certainty,
- Decisions under risk,
- Decisions under incertitude (in the Anglo-Saxon literature often labelled: “Knightian uncertainty”).

The latter two are often grouped under the common denominator “decisions under uncertainty”. Yet there is a fundamental difference between the two: in the second setting of decisions under risk, objective probabilities may be assigned to each of the possible states of the surrounding world. By contrast incertitude means that the decision maker has no possibility to determine the probability of the different possible developments.
For decisions under risk, normative decision theory proposes a rather clear-cut decision rule under uncertainty: the so-called Bernouilli principle, i.e. the maximization of expected utility[2]. For decisions under incertitude (sometimes also called: “deep uncer-

[1] Arrow’s impossibility theorem, building on the earlier Condorcet paradoxon, establishes that even if every single individual has consistent preferences, there is no general rule which allows aggregating these preferences into one consistent set of aggregated preferences fulfilling some basic choice axioms.
[2] Consistent preferences may be represented by a utility function which describes in an aggregated way the benefits associated with any possible decision outcome. This may be (and usually is thought to be) a

tainty"), the rules are less clear-cut. Savage (1954) and others have linked this case back to decision making under risk by introducing the concept of subjective probabilities. Yet beside this line of thinking, also a number of heuristic decision rules have been proposed, among which the maximin rule, the Hurwicz criterion or the minimum-regret rule. It is up to the decision maker(s) to choose among these rules, which introduces already some element of arbitrary in the decision process.

A second important insight of normative decision theory is related to sequences of decisions with intermediate information arrival. This is a typical decision setting in the field of energy problems. Power plants to be put online in 2015 have to be decided upon today, given the long time needed for planning, authorisation procedures and construction. Yet power plants only to be used from 2020 onwards have not to be chosen today. Rather it is preferable to wait and decide on the type of power plant to be built only when further information, e.g. on future CO_2 trading regimes is available. This type of decision problem, of a "wait-and-see" structure is graphically illustrated in Figure 1 (cf. e.g. Birge, Louveaux 1997).

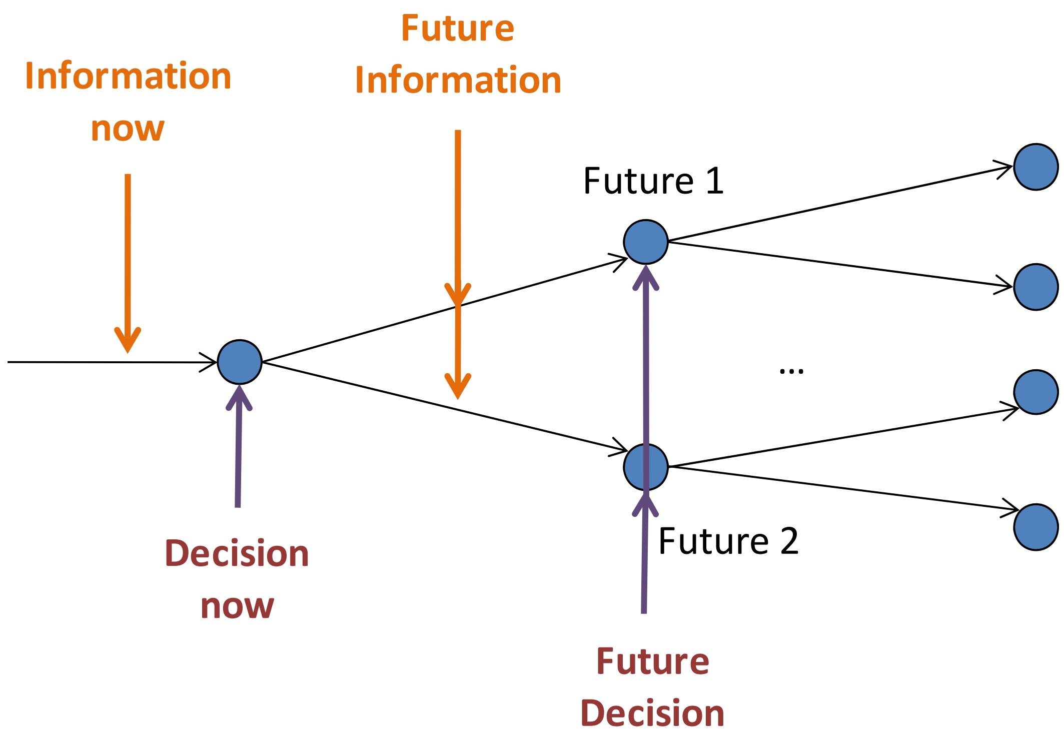

Figure 1: Decision problems with „wait-and-see" decision structure

non-linear function of the decision outcomes (e.g. earnings), and typically is continuously increasing but the incremental gain in utility per unit of earnings is decreasing the higher the level of earnings is, i.e. the function is monotonously increasing and concave in the decision outcomes. This then leads immediately to risk-averse preferences.

As a general rule it can be stated that decisions under uncertainty should only be taken when the costs of waiting exceed the expected value of information available through waiting. Hence the preserved flexibility of not taking a decision is valuable in this setting. And along the same line choices which preserve more flexibility (e.g. by committing less capital) are preferable to choices narrowing strongly future decision alternatives.

But obviously optimal decision making in such a setting would require the knowledge of all probability distributions of all uncertain future events and also all stochastic dependences (correlations or similar) between the different future events. This is clearly not the case and obviously one reason why observable decision behavior, as analysed by descriptive decision theory, is diverging from the normative precepts.

In order to conform with the nomenclature frequently used outside decision theory (e.g. in the context of corporate risk management, e.g. Johanning, Rudolph 2002), we will subsequently use the term of "political risk" without the connotation of objective probabilities but rather in the general sense of "political uncertainty".

Two further semantic precisions should be made here: firstly, the concept of risk in decision theory, as previously referred to, is basically a symmetric concept – risk includes both possibilities for positive and negative deviations from an expected value. In risk management, more frequently an asymmetric concept of risk is employed. Risk comprises then uniquely the possibilities of adverse developments (downside). This meaning of risk is also referred to in the context of this study, unless otherwise mentioned.

Secondly, the distinction is important between the potential risk of an adverse event and the actual occurrence of this adverse event, i.e. the materialization of the risk.

2.2 Descriptive decision theory and energy related risk

Energy related decisions are taken by policy makers (notably on energy legislation), by companies (e.g. on power plant investments) and by households (e.g. on car or appliance purchases). These decisions obviously are intertwined, with the political decisions setting the frame for decisions of individuals. So in the following the focus is on these decisions.

Even casual empirical investigations of energy-related political decisions indicate that these decisions involve multiple persons (ministers, members of parliament, administrative staff etc.) so that the standard configuration of normative decision theory is not met.

In this context, scenarios are an important tool for decision support (cf. e.g. Shoemaker 1996). Energy scenarios thereby serve multiple purposes such as increasing transparency, illustrating the potential alternatives, indicating pathways to desirable futures etc. An important distinction in scenario analysis is again a decision between descriptive and normative scenarios.

Descriptive scenarios aim at depicting the world as it could be. They may be viewed as a way of representing complex distributions of future uncertainties in a limited number of alternative worlds. The regularly published Shell scenarios are a typical example of such scenarios. In their latest version (Shell 2008), the Shell scenarios depict two alternative visions of the world of tomorrow, one labelled SCRAMBLE, the other one BLUEPRINTS. Both describe possible worlds with the developers not expressing any clear preference for one or the other.
By contrast, the IEA World Energy Outlook (IEA 2008) generally adopts a different philosophy to scenario construction[3]. It contains one descriptive scenario, labelled "Reference" or "Global Energy Trends". But in addition also normative scenarios are included, in the 2008 edition a "550 ppm policy scenario" and a "450 ppm policy scenario" referring both to targets of climate change mitigation. These normative scenarios, as indicated by their title, do not aim at describing likely or possible scenarios occurring independently of the decision maker's will. Rather they fix a policy objective (in occurrence a CO_2 concentration target) and then explore the possible (or optimal) pathways to achieve these targets. Hence normative scenarios do not depict likely futures but desired ones.

In as far as the treatment of risk or uncertainty is concerned, normative scenarios do not contribute to making risk explicit. Rather they tend to provide an idea (or an illusion) of feasibility of certain policy objectives. For descriptive scenarios, this is different. Well-constructed descriptive scenarios will highlight key elements of uncertainty in the future states of the world. They reduce the immense complexity of possible real world developments to a limited number of alternative visions of the future (typically two to five), yet by doing so they enable decision makers to grasp the complexity.
Hence basically two objections can be made to the use of descriptive scenarios for decision support on energy problems: the first one is the potential danger of oversimplification of real-world complexity by describing only a few scenarios. The second one is that the wait-and-see structure of most decision problems (cf. Figure 1) is not fully reflected. In fact, typical scenario trees as the one depicted in Figure 2 do not contain the possibility of further bifurcations in the future – they divide into different branches from now onwards, but further ramifications are not foreseen. Hence within each scenario the future seems to be deterministic, leading to an undervaluation of flexibility.

[3] Note that a new World Energy Outlook is published every year. Detailed, entirely remodeled scenario projections are however only performed in the even years. Therefore the reference chosen here is the 2008 World Energy Outlook.

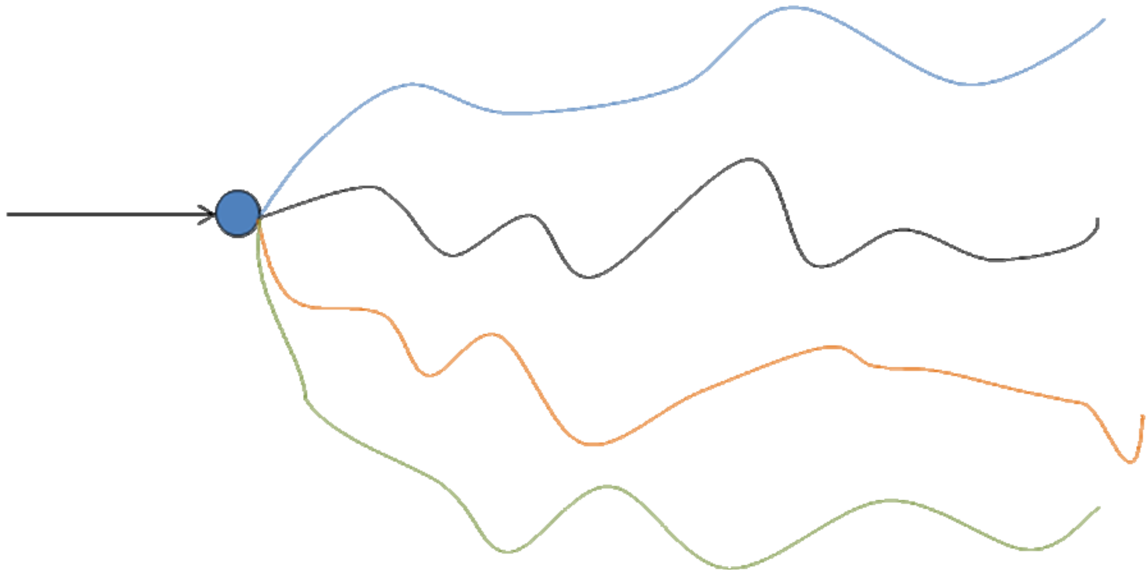

Figure 2: Scenario tree

3 Political Risk – typology

Although the concept of political risk seems to be taken as granted for most stakeholders in the energy field, a precise definition is far from evident. This may be even a consequence of the widespread use of the term in varying contexts. In economics and management science, the term is most frequently used in the context of foreign direct investment. E. g. PWC and Eurasia (2006, p. 5) define political risk as: "Any political change that alters the expected outcome and value of a given economic action by changing the probability of achieving business objectives". But obviously this definition is too strongly centred on a company view to be directly usable here. Since a general definition is difficult, we instead follow here the route of identifying political risk by providing a typology of political risks. In order to derive this typology, first a look at general typologies of risk, as used in the context of corporate risk management, is useful. Moreover, the impact of political risk on different stakeholders will be summarized in the last subsection of this section.

3.1 Typologies of risk

Several typologies of risk have been developed and applied to company-wide risk management in major energy companies (cf. e.g. Weber 2005). Mostly they make a fundamental distinction between:

- External risks and
- Internal risks.

External risks are those which emanate in the environment of the company, being it markets, society or politics. Internal risks are those stemming from inside the company itself, including project, IT or human resource risks.

Similarly, it seems adequate to distinguish external and internal sources of risk when it comes to political risks in energy foresight. The perspective taken here is obviously a national or perhaps supranational (European) one, which distinguishes between political risks inside and outside its own borders.

3.2 External political risk

Geopolitical risks are probably the category of risk mostly thought of when political risks are evoked. Yet besides these dangers emanating from (at least temporarily) hostile countries also the uncertainties related to international negotiations and treaties should not be neglected.

3.2.1 Geopolitical risks

The risks associated with geopolitical constellations may prima facie be classified in quantity and price risks, i.e. risks of supply interruptions (or reduced deliveries) and risks of excessive pricing. But at second sight these are effects which in turn may have multiple causes ranging from strikes over cartelization among supply countries to international warfare or terrorist attacks. In fact geopolitical risks as viewed from our home country may again be categorized into internal or external risk from the perspective of the country or region considered. Only part of the risk perceived from a European perspective can be attributed to deliberate actions of supply countries such as cartel formation.

3.2.2 Risks of international treaties

Energy supply and usage may not only be affected by political turmoil in foreign countries or by their political strategies, yet another source of uncertainty is the evolution of international negotiations like the Climate Change summits or the Doha round on trade liberalization. In this case obviously not only external political risk may be invoked but are also different own political choices which may influence the emergence or the disappearance of such external risk. Also the previously discussed geopolitical risk may partly be affected by own actions, yet other parts are clearly outside own control.

3.3 Internal political risk

Besides external political risk, one should not neglect the uncertainties emanating for any decision maker from internal political decisions in his own country or in the supranational entity called EU. A classification of these risks may be done according to the principal actors responsible for these risks. These are:

- Parliaments and other rule-making instances such as regulators,
- People itself having the right to elect parliaments or even to decide directly via referendums or similar instruments on certain political issues,
- (Governmental) administrations and courts in charge of applying the existing rules.

3.3.1 Legislative (and regulatory) risk

Legislation as rule setting may profoundly influence energy policies and energy strategies, as may e.g. currently be observed in Germany in the debate on nuclear phase-out. But also policies on promotion of renewables or (non-)promulgation of laws on CO_2 storage are political risks from the perspective of other stakeholders like companies.

From the perspective of policy makers pursuing actively some policy goals these are by contrast important decision variables.

3.3.2 Democratic and plebiscitary risk

In a democratic country, obviously the power of rule making itself is not permanent. Rather governments and parliamentary majorities may be overthrown through elections and this may lead to a revision of previously established laws and rules – as can again be observed in the case of German nuclear phase-out. The fundamental right to vote, which in some countries may also directly be exerted through plebiscites (e.g. in Switzerland), constitutes hence from the perspective of all stakeholders also a source of uncertainty.
In a broader sense, one may also subsume the risk of population upheavals or protests and the risk of media campaigns under the term of democratic risk. Such events do not directly impact the legislation in one country, yet the public pressure accompanying them will in democratic societies also influence the opinions and actions of policy makers.

3.3.3 Juridical and administrative risk

Besides the rule making also the application of rules is a source of risk from the perspective of companies and citizens. One might think of the delivery of building permits which may seriously delay or even stop large energy investment projects.

3.4 Relevance of political risks for different stakeholders

The previous discussion may be summarized as done in Table 1 to indicate which stakeholders are particularly affected by which type of political risks. Obviously most political risks affect all stakeholders, although the degree and the type of impacts may vary. For example geopolitical risks may modify the investment opportunities and profitabilities for companies, yet for households the main impact may be price increases. And for policy makers the impact may primarily be the necessity to enter into diplomatic negotiations.

Table 1: Overview of stakeholders affected by different types of political risks

Stakeholders	External political risks		Internal political risks		
	Geopolitical risk	Risk of interna-tional treaties	Legislative and regulatory risk	Democratic and plebiscitary risk	Juridical and ad-ministrative risk
Households	X	X	X	(X)	(X)
Companies	X	X	X	X	X
Policy makers	X	X		X	X

4 Modelling political risk in energy foresight

The preceding categorization of political risks has highlighted the broad range of potentially relevant issues. Also the cursory overview of some relevant elements of decision theory has highlighted the width of the subject. Before hence proceeding to specific proposals for the inclusion of political risks in quantitative energy foresight studies, a few general recommendations on the process for quantifying political risk are highlighted, which are emerging from the previous discussion. This is preceded by some terminological clarifications needed to discuss properly risk quantification.

4.1 Terminology for risk quantification

When it comes to the quantification of risk, several aspects have to be distinguished:

- The probability of occurrence of an event, i.e. the probability of materialization of the risk.
- An adverse event, which may occur, is a potential risk. An adverse event, which already has occurred, is a materialized risk or a realized risk.
- The direct impacts of the event, in terms of changes in quantities or prices.
- The indirect impacts of the event which may include repercussions on other markets or further countries.
- The monetary impact of the event, which quantifies the loss in welfare or the increase in cost due to the event (potential damage).
- The expected value of the monetary impact, which corresponds to the product of the probability of occurrence with the monetary impact of an event (expected damage).

One might note that in insurance mathematics and business, risk is frequently taken as synonymous to the last concept, i.e. the expected (monetarized) damage. By contrast the term of "political risk" points rather at the possible negative event itself.

Also in the conceptualization of probabilities, the approach taken here deviates from the insurance perspective. In insurance, probabilities are mostly derived from past observations, i.e. a frequentist concept of probabilities is used. For political risks, probabilities may hardly be derived from historical observations (cf. also section 4.3.1). One may even question, whether probabilities "exist" for such possible future events. Yet this philosophical, more specifically ontological question is rather misleading. Undoubtedly, probabilities may be *assigned* to such events. Such assignments may reflect degrees of beliefs of decision makers or experts, and hence the underpinning concept of probabilities is close to a Bayesian view. But the assignment of probabilities may also be viewed as a constructive act in the larger construction of a decision support model as a simplified

map of the complex real world problem. By using the mathematically well-defined (or perhaps rather "well-constructed"[4]) concept of probabilities, a mapping of the real world problem is obtained, which allows the application of a multitude of well-established methods, e.g. the computation of expected values.
Finally one may note that a quantification of the different aforementioned aspects may lead in the case of political risks to rather diverging results depending on which preventive or/and recourse actions of the decision maker are taken into account. Hence any attempt for quantification of political risk should clearly state under which assumption on preventive or/and recourse actions it has been made.

4.2 Procedural recommendations for the quantification of political risk in energy foresight

1. Clearly state what the perspective taken in the energy foresight study is. I.e., what elements are part of the decision variables and what is part of the environment, which may not (or only partly) be influenced by the decision makers. Political risks emerge in the environment, they are not under control of the decision maker.
2. Be aware that probabilities for political risks are hardly available, at best some subjective probabilities may be used.
3. Any energy foresight study, like every model for decision support, requires simplifications. Hence carefully reflect which political risks need to be included in the study.
4. The need for simplification while having to cope with uncertainties should lead in most energy foresight studies to the use of (descriptive) scenarios.
5. Political risks to be taken into account in the scenarios are those who have a relevant monetary impact on decisions and their consequences. To investigate a separate scenario (or sensitivity analysis) for a particular political risk is only justified if this scenario is not too unlikely and its impact is severe.
6. Given these considerations, mainly three types of political risks are candidates for inclusion in national or international energy foresight studies[5]:
    a. Political risks in the supply of energy carriers (notably oil and gas)
    b. Political risks about future climate protection regimes
    c. Risks of lack of acceptance for some energy technologies (e.g. nuclear, CCS, coal, but possibly also large-scale renewables)

[4] These formulations refer, at least loosely, to the epistemological school of "mathematical constructivism".
[5] In energy foresight studies for companies, other political risks may be very relevant as well.

7. Quantifying probabilities for a lack of acceptance is hardly feasible, at least for new technologies. At the same time, the ultimate consequence of such a lack of acceptance is rather clear: the technology has to be excluded from the set of envisagable energy technologies. Therefore such political risks are best quantified by considering one (or several) scenarios with non-acceptance.

Under these circumstances, the focus of the following investigations is on the first two types of political risks.

4.3 Alternative possibilities for quantifying political risk in energy foresight

If there is a substantial and relevant political risk to be considered, this may be done in several ways, depending on which aspect of political risk is to be quantified. Notably expected damage may only be assessed, if a priori the probabilities for the materialisation of the event in question have been estimated. Hence first possibilities for the quantification of these probabilities are discussed. Then possibilities for quantifying the impact of certain political risks are discussed.

4.3.1 Assigning probabilities to political risks

Given the limited number of observations on the materialization of political risk, **historical statistics** will generally not provide robust estimates on the probabilities of realization of political risks. E.g. there are three observations on major oil price jumps (+50% or more within one year) among the 50 last years, yet deriving from this statistic a probability of 6 % for an upward oil price jump per year is rather hazardous. And this possibility entirely breaks down, if there are structural changes.

An alternative to such objective probabilities are **subjective guesses** – these may be partly objectivised by using **survey methods** to compile average estimated probabilities for the occurrence of one risk or another. A sophisticated technique for such surveys is the so-called Delphi method (e.g. Sackman 1974, Häder 2002), where two rounds of questions are asked and the interviewees are confronted in the second round with the expectations of their colleagues out of the first round. This methodology has been repeatedly and rather successfully used to investigate scenarios of technical change, yet its applicability to issues of political risk is still to be proven.

Economists will favour observable **market prices** as indicators of probabilities of political risk. E.g. the price spread between the Certified Emission Reductions (CERs) provided by CDM projects in developing countries and the value of an Emission certificate (EUA) within the European Trading Scheme may serve as an indicator on the perceived risk that the political process allowing to exchange CERs against EUAs may break down. In fact, the price difference does not directly correspond to the probability of break-down, rather it is a measure of the expected damage related to this political risk. Nevertheless measuring the economic risk through market values seems attractive given that the direct economic impact of these prices minimizes effects of social desirability or other response biases common in survey-based methods.

On the other hand market values are only available for a limited number of political risks and mostly only for political risks relevant in the near future (up to five years ahead). For longer term risks, few markets exist. Hence one possibility may be to create artificial markets, allowing selected groups (e.g. staff members) or the general public to put bets on the occurrence of certain events. Adequately organised, such **artificial forecast markets** could be a useful tool also for assessing political risk, as they have proven to be for predicting election outcomes or future consumer trends. Yet again these markets show weaknesses when it comes to assessing events in the far future. The pay-offs of the participants have to be linked directly to the actual outcome on the event in order to provide adequate incentives- yet if the event is only observable decades later, the bettors may have forgotten the bet or may have deceased etc.

4.3.2 Exogenous Parameter settings

If the main objective is not to estimate the probability of realization of some political risk but to quantify the implications related to it, the most straight forward approach is to **modify some parameter**(s) describing the direct impact of a materialization of this political risk in a model used for quantitative energy foresight. For political risk related to oil and gas supply, direct impact may be described by increased import prices or/and reduced import quantities. Using appropriate models then the more indirect impacts such as welfare losses or price increases for electricity may be quantified. Obviously the weakness of this approach is that already some knowledge on the quantitative impact of the materialized risk is needed on beforehand and then only the more indirect impacts, possibly taking into account also some recourse actions, may be quantified.

Nevertheless this approach is useful and also in corporate risk management similar approaches may be found. Notably the so-called **stress tests** performed for bank or energy trading portfolios aim at quantifying the impact of some extreme (market) events on the company performance.

An issue to be carefully reflected for long-term energy foresight studies is whether political risks of temporary supply interruptions or temporary price increases are adequately represented by a specific scenario where these political risks materialize and are modelled through corresponding parameter choices. This seems **hardly adequate for supply interruptions** which so far in history have only occurred over limited periods. Here an adequate representation might not be through a specific scenario but through explicit restrictions or prescriptions on strategy choices as discussed next.

For the political risk of **price increases** for gas and oil, the situation is rather different. Here the **exogenous parameter settings** frequently used in energy system models like PRIMES or TIMES typically reflect also the impact of political risk emanating e.g. from OPEC. In fact most observers agree that current oil and gas prices may only partly be explained by production costs. Correspondingly already current prices already include some mark-up reflecting (materialized) political risk.
Also **political risk** surrounding negotiations on **Climate Change** mitigation may be depicted by different scenarios on CO_2 prices or bounds.

4.3.3 Prescribing or restraining strategy choices

If political risk only materializes temporarily and its impact may be minimized through appropriate preventive or/and recourse actions, then the best way for modelling this kind of political risk might be to **prescribe the corresponding preventive actions** as part of the choice set. **Supply interruptions** for gas or oil are an appropriate example: their impact may be minimized by building up **strategic reserves** or by prescribing some kind of **N-1 security criterion**. Not only the impact on consumers will be minimized if a supply interruption materializes, but also such a measure has a deterring effect on the supplier, who then knows that he won't be capable to exert easily (political) pressure on his customers.
This modelling approach again **requires** considerable **prior knowledge** – not only on the political risks to be considered but also on possible reaction strategies. Yet this approach then allows accounting for the political risk in a broader context of energy strategy choices.

4.3.4 Endogenous strategy choice in models of rational choice

If a quantification of political risk based on first principles is looked for, then models of rational choice with strategic interaction among players are of great interest. Obviously, not all empirically observable behaviour may be adequately described as rational behaviour. Yet more often than suspected at first sight, a rationale may be found to some seemingly strange behaviour[6]. And moreover attributing rational behaviour to other players seems a logical choice if one presumes to behave rationally himself.
Such strategic interactions of rational agents are the domain of **economic game theory** and multiple concepts and configurations have been studied in this field. Yet the by far most popular concept in applied energy modelling is the so-called **Cournot-Nash equilibrium.** Thereby a limited number of suppliers are choosing their supply quantities in

[6] Cf. notably the work of Gary Becker in the field of private households or in the field of politics, the concepts of an "economic theory of politics" (or positive political economy).

order to maximise their own profit but taking into account the impact they have on the market price. Both supply by a monopolist and perfect competition may be viewed as special (extreme) cases of Cournot-Nash equilibria. In practice[7], the various models differ by their geographical and temporal scope, the number of players considered, the level of technological detail implemented and other details. The quantitative results obtained particularly on **price risks** are however especially **dependent on** the assumed **price elasticity of demand**. If good substitution possibilities exist and correspondingly price elasticity is high, then also the potential risk of price increases beyond competitive levels vanishes. And conversely, low price elasticities imply high mark-ups. Consequently the use of such models for the quantification of political risk manifesting through increased energy prices is only recommendable to the extent that the price elasticities used in the models are empirically well-founded.

In principle game theoretical approaches could also be used to investigate the political risk of supply interruptions, yet so far hardly any application exists in this field. One reason probably is that such temporary interruptions most likely correspond to equilibria in mixed strategies in the game theoretical model. Such equilibria in mixed strategies are however considerably more difficult to identify than pure strategy equilibria.

[7] Cf. e.g. Egging, Gabriel (2008), von Hirschhausen, Holz, Kemfert (2009).

5 Final remarks

The preceding investigations have shown that a quantification of policy risk in energy foresight requires a detailed consideration of both the role of energy foresight and the relevance and conceptualization of policy risks in this context. An important step towards quantification is certainly achieved by clearly posing the problem to be analysed and the context factors to be considered. Then a qualitative investigation of causal relationships and strategic interactions will probably reveal that in most energy foresight studies only a very limited number of political risks need to be quantified.

When it comes to quantification, again the first step is to define what is in the focus of quantification– are these occurrence probabilities, selected impacts or the expected value of damages. In any case, quantification is facing serious challenges and even a quantitative result has always to be interpreted as one building block in an improved understanding of the interdependencies of choices and environmental states. In the case of political risk the interdependence of own choices and those of others is crucial, and what-if scenarios are certainly an important tool to analyse these interdependencies.

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