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Evaluating investments in renewable energy under policy risks

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HIGHLIGHTS

- Quantification of policy risks associated with renewable energy investments.
- Results emphasize that policy risk has a major impact on risk and return.
- Study of the cross-country diversification potential.
- Cross-country diversification can considerably decrease the risk for an investor.

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ABSTRACT

The considerable amount of required infrastructure and renewable energy investments expected in the forthcoming years also implies an increasingly relevant contribution of private and institutional investors. In this context, especially regulatory and policy risks have been shown to play a major role for investors when evaluating investments in renewable energy and should thus also be taken into account in risk assessment and when deriving risk-return profiles. In this paper, we provide a stochastic model framework to quantify policy risks associated with renewable energy investments (e.g. a retrospective reduction of a feed-in tariff), thereby also taking into account energy price risk, resource risk, and inflation risk. The model is illustrated by means of simulations and scenario analyses, and it makes use of expert estimates and fuzzy set theory for quantifying policy risks. Our numerical results for a portfolio of onshore wind farms in Germany and France show that policy risk can strongly impact risk-return profiles, and that cross-country diversification effects can considerably decrease the overall risk for investors.

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1. Introduction

The increasing expansion of renewable energy to reduce greenhouse gas emissions is one main goal of the Europe growth strategy 2020. To provide incentives for private and institutional investors to invest in renewable energy such as wind farms, governments typically grant subsidy payments during the life span of the investment projects (e.g. feed-in tariff (FIT)) (Turner et al., 2013). In this context, policy risks have been identified as one of the most prominent risks as the uncertain future of the policy support schemes for investments in renewable energy projects implies a high degree of uncertainty regarding future cash flows (Micale et al., 2013, Jin et al., 2014, Gatzert and Kosub, 2015, 2016). In Spain, Bulgaria, Greece, and the Czech Republic, for instance, the guaranteed feed-in tariffs have recently been reduced retrospectively[1] for solar farms, thus implying a considerable reduction of investors' returns.

Hence, policy (or political) risks play a major role for investors when evaluating investments in renewable energy projects and should be taken into account when establishing risk models and when deriving risk-return profiles. In this context, especially country diversification effects may help to reduce regulatory and policy risks associated with renewable energy investments in different countries for diversified portfolios. For investors seeking new investment alternatives, especially the stability of long-term

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[1] The term "retroactive" is often used as a synonym for "retrospective" (see, e.g., Gatzert and Kosub (2015)).

cash flows plays a major role along with the question of policy risk as described above. Against this background, the aim of this paper is to develop a model to quantify policy risks based on a qualitative risk assessment by experts using fuzzy numbers, which will be also applied to identify potential country diversification effects that may reduce the overall risk of a portfolio of renewable energy investments. We thereby also take into account energy price risk, resource risk, and inflation risk.

Policy support schemes[2] as one main incentive for renewable energy investments have been studied in various dimensions in the literature, including real (regulatory) option approaches and first insight regarding policy risks for various countries (e.g. Boomsma et al., 2012; Brandstätt et al., 2011; Campoccia et al., 2009; Holburn, 2012; Kitzing, 2014; Monjas-Barroso and Balibrea-Iniesta, 2013; Yang et al., 2010), resource risks resulting from wind volatility (e.g., Liu et al., 2011) or curtailment risk (e.g., Jacobsen and Schröder, 2012). In addition, based on a review of risks and risk management solutions for renewable energy projects with focus on onshore and offshore wind farms, Gatzert and Kosub (2016) show that especially policy and regulatory risks represent major barriers (see also Jin et al. (2014) and Micale et al. (2013)) and that diversification is among the most important tools for risk mitigation and used in various dimensions.

Overall, while previous literature has emphasized that policy and regulatory risks are among the most relevant risks for investments in renewable energy projects, risk mitigation and transfer is highly challenging (see Gatzert and Kosub (2016)). In the literature, the definitions and distinctions between political, policy, and regulatory risks differ. Smith (1997) defines traditional political risks as the risks related to expropriation, currency convertibility and transferability, as well as political violence, and regulatory risks as the risks arising from the application and enforcement of regulatory rules, both at the economy and the industry (or project) level, including rules contained in contracts with governments, in laws, and in other regulatory instruments. With focus on regulatory risks frequently occurring in infrastructure projects, Bond and Carter (1995) distinguish two cases: (1) tariff adjustments not being permitted or made on time (in case of inflation or devaluation, for example), where companies can hedge against this risk by implementing automatic adjustments into contracts, but ultimately complying with these obligations lies with the government or its state owned enterprises; and (2) regulatory changes, which, for instance, include possible changes in environmental regulations that may impact many infrastructure companies and their lenders.

Further (empirical) analyses of specific aspects of policy and regulatory risks as well as risk drivers are studied in Alesina and Perotti (1996), Barradale (2010), Fagiani and Hakvoort (2014), Holburn (2012), Hitzeroth and Megerle (2013), Lüthi and Prässler (2011) as well as in Lüthi and Wüstenhagen (2012), who conduct an empirical survey on stated preferences among photovoltaic project developers and derive their willingness-to-accept for certain policy risks. In addition, Bürer and Wüstenhagen (2008) study venture capital investments in clean technology and illustrate active and passive risk management strategies to manage regulatory risks. Sachs et al. (2008b) include regulatory risks into their political risk analysis and use a method based on fuzzy numbers to quantify regulatory risks based on qualitative information acquired from experts. Reuter et al. (2012) also study the probability of feed-in tariff reductions as one application of their renewable energy investment approach, but without modeling the underlying risk factors and with focus on investment incentives instead of a risk assessment of existing projects in the operating phase. In general, policy risk can be expected to further increase in the future as pointed out by Turner et al. (2013), who see a trend towards combining regulatory certainty with market-based components, as states change their support schemes to achieve cost reduction and a fairer distribution of risks.

The purpose of this paper is to contribute to the literature by developing a model framework that allows studying policy risks for investments in renewable energy projects. In contrast to previous work, we explicitly take into account risk factors that drive policy risk in the model (e.g., economic stress or governmental budget constraints), apply the fuzzy Delphi probability prediction method to obtain the likelihood and impact of the considered policy risk scenario (i.e., a retrospective reduction of the feed-in tariff), and conduct sensitivity analyses, thereby taking into account several other risk factors (energy price risk, inflation risk, and resource risk). Based on this, we derive risk-return profiles of renewable energy investments for the case of onshore wind farms using Monte Carlo simulation, thereby also taking into account potential country diversification effects that may contribute to reducing policy risks.

The quantification of policy risks is challenging, and relying on expert estimations will typically be necessary as the number of comparable events, which can be used to quantify policy risk and to calibrate the model, is typically not sufficiently large. This is also stated by Brink (2004), for instance, who points out that the measurement and observation of political risk to a great extent depends on subjective human judgment. Therefore, if objective probabilities for policy risk factors cannot be obtained, one needs to revert to experts (see also Sadeghi et al. (2010)). In this paper, we make use of fuzzy set theory, which provides a methodology for 1) handling subjective and linguistically expressed variables and 2) for representing uncertainty in the absence of complete and precise data (see Sadeghi et al. (2010)). The use of expert estimations and fuzzy numbers for quantifying qualitative information on risk (i.e. expert estimates) is also done by, e.g., Sachs et al. (2008a), (2008b), Sachs and Tiong (2009), Sadeghi et al. (2010), and Thomas et al. (2006). Regarding the cash flow model, we extend the approach in Campoccia et al. (2009) and follow Monjas-Barroso and Balibrea-Iniesta (2013) to model energy prices at the exchange using a mean-reverting process, which can also be extended. Inflation risk is modeled using the Vasicek (1977) model. The developed model will be applied to the evaluation of onshore wind farms regarding the risk of a retrospective reduction of a feed-in tariff, but it can also be applied to other renewable energy investments such as solar farms, for instance.

The paper is structured as follows. Section 2 presents an approach for the quantification of policy risk based on expert opinions and fuzzy numbers and Section 3 provides a model for modeling cash flows of renewable energy investments including market risk, resource risk, inflation risk and policy risk. Section 4 presents the calibration of the model to the case of France and Germany as well as the results of the numerical analyses. Section 5 summarizes and discusses policy implications.

2. Modeling and assessing policy risk of renewable energy investments

As described before, the definitions of policy, political and regulatory risks differ. In what follows, we consider developed countries and use the term “policy risks”, thereby focusing on retrospective adjustments of support schemes of investments in renewable energy (e.g., a retrospective FIT reduction) as has been observed in Bulgaria, the Czech Republic, Greece, Italy, and Spain, for instance.

[2] See Meyer (2003) for an overview of different support schemes such as feed-in tariffs, feed-in premiums or the tender system.

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