Fostering Offshore Wind in the European Union

The role of policy instruments on the cost of capital
Presentation outline

- **Introduction: role of policy instruments on the cost of capital**
  - Need for renewable energy investments
  - Case of offshore wind

- **Simple investment model**
  - Offshore wind policy instruments → risk and return

- **Estimating the impact of policy instruments on risk premiums**
  - 5-steps approach

- **Discussion**

- **Lessons learned**
Introduction

❖ Paris Agreement: the “well below 2°C” limit
  • Zero global carbon emissions from energy use by 2060
❖ “Clean Energy for All Europeans” Package
  • Renewable energy sources target of 27% by 2030... or 34%?!
❖ Need significant renewable energy investments
  • Sometimes associated with high risk and low return → high cost of capital
  • Case of offshore wind (OSW) energy → capital-intensive asset
  • Policy instruments can help to mitigate risks and reduce financing costs

Research Question: How far can offshore wind energy policy instruments in the EU be associated with perceived risk premiums?

Source: IREA (2018)
Simple offshore wind investment model

Source: Model adapted from Wüstenhagen and Menichetti (2012)
Offshore wind policy instruments

- **Revenue stability** plays a key role in evaluating policy instruments

  - *Feed-in-Tariffs (FIT)* represent fixed and guaranteed prices eligible renewable energy producers receive in exchange for power fed to the grid
    - Producers are not subject to tariff related risks
  
  - *Sliding Feed-in-Premiums (FIP)* guaranty a premium in addition to market price
    - Producers have an incentive to adjust their production according to energy demand and price signals, increasing overall market efficiency
    - Producers exact revenues can vary creating uncertainty

- **Quota Obligations** with * Tradable Green Certificates (TGC)* create a market for renewable electricity property through governmental imposition to source a percentage electricity from renewable sources
  - Producers typically receive a green certificate for each unit of electricity produced
  - Uncertainty about the future price of electricity and the future value of certificates

Source: Paul Noothout et al., 2016, pp. 34, 38, 74
Estimation strategy

**Objective:** estimate the effect of policy instruments on the risk premium

- The **Weighted Average Cost of Capital (WACC)** is a measure of the **cost of capital**
- We assume that the risk premium can be calculated as follow:

\[
\text{risk premium} = WACC - \gamma_c
\]

\[
\gamma_c = \text{country-specific risk-free rate}
\]
\[
WACC = \text{cost of capital}
\]

- WACC estimation is based on the theoretical model and assumptions of the **DiaCore** project, with **2013 as timeframe**
- The effect of policy instruments on the offshore wind risk premium can be estimated with a **multiple regression analysis**

Source: May and Neuhoff (2017)
### Offshore wind installed capacity in the EU

<table>
<thead>
<tr>
<th>Total OSW installed capacity in the EU</th>
<th>2013</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total OSW installed capacity (MW)</td>
<td>6,562</td>
<td>15,780</td>
</tr>
</tbody>
</table>

#### Relative shares

- **UK**: 56% (2013) → 43% (2017)
- **DK**: 19% (2013) → 8% (2017)
- **BE**: 8.7% (2013) → 7% (2017)
- **DE**: 8% (2013) → 7% (2017)
- **NL**: 3.8% (2013) → 6% (2017)

<table>
<thead>
<tr>
<th>Number of connected turbines</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
</tr>
</tbody>
</table>

#### Grid connected OSW farms

- **North Sea**: 66% (2013) → 71% (2017)
- **Irish Sea**: - (2013) → 16% (2017)
- **Baltic Sea**: 17% (2013) → 12% (2017)
- **Atlantic Ocean**: 16% (2013) → 1.2% (2017)

**OSW Installed Capacity in 2013 (MW)**

- Member States with OSW in 2013
- Member States without OSW

Source: EWEA (2014); WindEurope (2018)
5-Steps Approach: Estimating the impact of policy instruments on OSW risk premiums

- Capital Structure
- Cost of Equity ($R_E$)
- Cost of Debt ($R_D$)

1. Modelled WACC*
2. Approximated WACC*
3. Risk Premium
4. Policy Instruments
5. Multiple Regression Analysis

Source: May and Neuhoff (2017); Noothout et al. (2016)
**Steps 1: Estimation of the cost of capital**

- **Capital Structure**
- **Cost of Equity ($R_E$)**
- **Cost of Debt ($R_D$)**

1. **Modelled WACC*:**
   - **Approximated WACC***
   - **10-yr Government Bonds Interest Rates**
   - **Risk Free Rate ($\gamma$)**

2. **Risk Premium**
   - **Policy Instruments**
   - **Multiple Regression Analysis**

3. **Policy Impact on RP**
Step 1: Estimation of the cost of capital

Avg. D/E Ratio: 70/30
D: Share of Debt
E: Share of Equity

\[ R_D = TS + CR + PS \]
\( R_D \): Cost of debt
\( TS \): Term Swap Interest Rate (2.68%)
\( CR \): Country Risk
\( PS \): OSW project spread (4%)

\[ R_E = R_f + \beta(MRP) \]
\( R_E \): Cost of equity
\( R_f \): Risk-free rate
\( \beta \): Beta
\( MRP \): Market risk premium

Source: Noothout et al. (2016)
### Results: Estimated cost of capital

<table>
<thead>
<tr>
<th>Member States with OSW in 2013</th>
<th>$R_E^*$ (%)</th>
<th>$R_D$ (%)</th>
<th>WACC$_{\text{model}}$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>10.8</td>
<td>7.1</td>
<td>6.52</td>
</tr>
<tr>
<td>Denmark</td>
<td>11.2</td>
<td>6.9</td>
<td>6.98</td>
</tr>
<tr>
<td>Finland</td>
<td>11</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Germany</td>
<td>9.3</td>
<td>6.7</td>
<td>6.09</td>
</tr>
<tr>
<td>Ireland</td>
<td>13.8</td>
<td>8.9</td>
<td>9.59</td>
</tr>
<tr>
<td>Netherlands</td>
<td>10.8</td>
<td>7.1</td>
<td>6.97</td>
</tr>
<tr>
<td>Portugal</td>
<td>15.4</td>
<td>11.4</td>
<td>10.61</td>
</tr>
<tr>
<td>Spain</td>
<td>13</td>
<td>9.7</td>
<td>8.65</td>
</tr>
<tr>
<td>Sweden</td>
<td>11.1</td>
<td>7.2</td>
<td>7.26</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>10.4</td>
<td>7.1</td>
<td>6.95</td>
</tr>
</tbody>
</table>

* $R_E$ taken from DiaCore, shown as indicative

- **Timeframe 2013**
- Assumed average capital structure of 70/30 and $R_E$ derived from DiaCore
- DE shows the lowest OSW cost of capital, whereas PT the largest

Source: Noothout et al. (2016)
Steps 2: Testing the cost of capital

- Capital Structure
- Cost of Equity ($R_E$)
- Cost of Debt ($R_D$)

1. Modelled WACC*
2. Approximated WACC*
3. Risk Premium
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- 10-yr Government Bonds Interest Rates
- Risk Free Rate ($\gamma$)

Policy Impact on RP
Step 2: Testing the cost of capital

- Results tested through **semi-structured interviews**
  - 4 Respondent types:
    - Consultants & Academics
    - Equity providers
    - Debt providers
    - Developers or OSW farms owners
  - Variables tested:
    - Assumptions: Capital structure & $R_E$
    - Estimations: $R_D$ & $WACC_{model}$
    - **Additional co-variates**: policy or retroactive changes & tenders

- Relative responses $\rightarrow$ point estimates
- Respondents can give multiple interview-observations
- 4 OSW interview-observations derived from **DiaCore**

Source: May and Neuhoff (2017)
Results: Tested cost of capital

- Total of 52 approximated WACC*
  - with 13 flagged values, in 13 interviews

- Lowest cost of capital
  - DE < BE < NL < DK
  - 2nd to 4th largest OSW installed capacity

- Highest cost of capital
  - PT > IE > SP
  - Marginal OSW installed capacity

- Exceptional U.K.
  - Relatively high cost of capital
  - Largest OSW installed capacity

OSW WACC$_{\text{approx.}}$ in 2013 (N=39)

* Including 4 interview-observations from DiaCore and 13 flagged values
Steps 3: Estimating risk premiums

1. Modelled WACC*
2. Approximated WACC*
3. Risk Premium
4. Policy Instruments
5. Multiple Regression Analysis

Policy Impact on RP

- Capital Structure
- Cost of Equity ($R_E$)
- Cost of Debt ($R_D$)

Risk Free Rate ($\gamma$)
10-yr Government Bonds Interest Rates
Risk Premium
Step 3: Estimating risk premiums

\[\text{Risk premium} = \text{WACC}_{\text{approx}} - \gamma_c\]

\(\text{WACC}_{\text{approx}} = \text{approximated cost of capital}\)

\(\gamma_c = 1\text{ year average 10-year government bonds}\)

Source: May and Neuhoff (2017)
Results: Estimated risk premiums

The approximated risk premium mean is larger than what was observed by May and Neuhoff (2017) for the case of onshore wind ($\text{RP}_{\text{approx.}} = 4.57\%$).

The difference is however not so significant which may be explained by their larger sample size ($N=53$), consideration of more countries ($N=23$), or the challenge of ‘recalling’ values for respondents.

Source: May and Neuhoff (2017)
Steps 4: Identifying OSW policy instruments

1. Modelled WACC*
2. Approximated WACC*
3. Risk Premium
4. Policy Instruments
5. Multiple Regression Analysis

- Capital Structure
- Cost of Equity ($R_E$)
- Cost of Debt ($R_D$)
- 10-yr Government Bonds Interest Rates
- Risk Free Rate ($\gamma$)
Step 4: Identifying OSW policy instruments

- Multi-instruments systems (e.g. DE)
- Design variations
  - e.g. terms, caps, floor price, etc.
- Tenders in DK & NL*
- Floor price in BE → FIP effect
- Stop of FIT in PT (2012)
- No OSW policy scheme in IE
- Hostile investment climate in SP

* Tenders were technology specific in DK, and generic in NL

Source: IEA; European Commission
### Descriptive statistics: OSW policy instruments

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories</th>
<th>Frequency [N=39]</th>
<th>Frequency [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy Instruments</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIT</td>
<td>5</td>
<td>5</td>
<td>12.8</td>
</tr>
<tr>
<td>Sliding FIP</td>
<td>15</td>
<td>15</td>
<td>38.5</td>
</tr>
<tr>
<td>TGC with floor price</td>
<td>6</td>
<td>6</td>
<td>15.4</td>
</tr>
<tr>
<td>TGC without floor price</td>
<td>9</td>
<td>9</td>
<td>23.1</td>
</tr>
<tr>
<td>No policy in place</td>
<td>4</td>
<td>4</td>
<td>10.3</td>
</tr>
<tr>
<td><strong>Additional Factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenders</td>
<td>10</td>
<td>10</td>
<td>25.6</td>
</tr>
<tr>
<td>Retroactive changes</td>
<td>3</td>
<td>3</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>Types of respondent</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultants &amp; Academics</td>
<td>21</td>
<td>21</td>
<td>53.9</td>
</tr>
<tr>
<td>Depth providers</td>
<td>14</td>
<td>14</td>
<td>35.9</td>
</tr>
<tr>
<td>Equity providers</td>
<td>4</td>
<td>4</td>
<td>10.3</td>
</tr>
<tr>
<td>Developers or OSW farm owners</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Steps 5: Multiple regression analysis

Capital Structure

Cost of Equity ($R_E$)

Cost of Debt ($R_D$)

1. Modelled WACC*
2. Approximated WACC*
3. Risk Premium
4. Policy Instruments
5. Multiple Regression Analysis

10-yr Government Bonds Interest Rates
Risk Free Rate ($\gamma$)

Impact on RP
Step 5: Multiple regression analysis

- Multiple regression analysis in **SAS**
- **3-Steps** multiple regression analysis:
  1. Model building
  2. Model adequacy
  3. Model assumptions

General Information:
- **Baseline**: FIT
- **Dependant variable**: \( y = \text{risk premium (RP)} \)
- **Independent variables**:
  - \( x = \text{feed-in-premium (FIP), tradable green certificates (TGC) with and without floor price (TGC}_w \ & \ TGC\_w/o) \) and a merged TGC (TGC\_merged)
- **Co-variates** (4): Tenders (TD), No policy in place (NOPD), Type of respondent (TYPD), Retroactive changes (RCD)
- **Sample size**: 39 interview-observations (N=39)
1. Model building

The following variable screening methods were used to select the most important variables that contribute to the risk premium:

• Stepwise regression [REG Procedure]: which determines the independent variable(s) added to the model at each step using t-tests
• All-possible-regressions [RSQUARE Procedure]: gives all possible models at each step, with suggested independent variable(s) that are associated with different criteria

TD and RCD were found insignificant to explain the risk premium

Preliminary equation:

\[ \text{risk premium}_i = \alpha + \beta_1 \text{FIP} + \beta_2 \text{TGC} + X\delta + u_i \]

*i*: interview-observations
\(\alpha\): y-intercept; \(Y\), when \(X=0\)
\(\beta_1\) & \(\beta_2\): slope of the regression line; change in \(Y\) for 1-unit change of \(X\)
\(X\delta\): control matrix containing [NOPD, TYPD]
\(u_i\): error term
2. Model adequacy

- Check the utility of the model with the [GLM Procedure] which uses the method of least square to fit general linear models.

- The Global F test (P-value < .0001) indicated that the model is significant for predicting risk premiums based on the group of selected variables.

- The value of R-square is 0.603870, meaning approximately 60% of the variation of risk premiums can be explained by the independent variables.

- The t-test, based on a significance level of 10% ($\alpha=0.1$), indicates:
  - The risk premium tends to increase by an estimate of 0.03 to 1.51% for every 1-No policy in place increase, when all the other x’s are held fixed. This could be explained by additional uncertainty associated with revenue and administrative processes.
  - The risk premium tends to decrease with FIT and TGC, where all other x’s are held fixed. This could be explained by the fact that fixed tariffs and the introduction of a floor price reduces price risk, and thus reduces revenue uncertainty.
  - The risk premium tends to increase with FIP, where all other x’s are held fixed. This could be explained by the increased exposure to market risk which decreases revenue certainty.
3. Check model assumptions

- The residuals plotted against the predicted values show no trends or patterns, which indicates that the model is fit.
- The Q-Q plot shows a linear trend with a slight deviation at the tail, which suggests the normality assumption is satisfied.
- The histogram shows the distribution is mound-shaped.
- Studentized Residual vs. Leverage graph shows however some potential outliers and influential observations outside of the reference lines.
Potential modeling problems

- The Fit diagnostic graphs show potential outliers and influential observations outside of the reference lines.

- Potential **multicollinearity**, where the results from t-test and $F$ test may contradict each other and the parameter estimates may have opposite signs from what is expected due to highly correlated independent variables.
  - Opposite signs in effect of FIP than what was expected

- Small sample size

→ the model still needs work!
Assume an **average capital structure** but in reality it changes through project lifetime → hard to estimate

One respondent revealed that $R_E$, taken from DiaCore, were tested with technology providers rather than with equity providers or developers

Tested cost of capital ($WACC_{\text{approx.}}$)

- Overall, **OSW cost of capital is higher** than onshore wind (DiaCore results)
- **Effect of recall or retrieval**: DiaCore $WACC_{\text{approx.}}$ > Interviews $WACC_{\text{approx.}}$
- The case of the **UK**: may be explained by the presence of a **banding multiplier** or other support mechanisms

Design-specificity in instruments may yield to different risk perceptions (e.g. capacity caps, term, etc), which makes support instruments hard to compare

Polarized type of respondent results may be explained by the fact that the OSW industry is highly competitive → need better distribution for better results
Lessons learned

- Different policy instruments lead to different risk premiums
- **Design-specificity** of policy instruments and **high competition** makes the estimation of the effect of individual schemes difficult
- The model preliminary results showed that:
  - Risk premium tends to **decrease** when FIT and TGC\(_w\) are in place
  - Risk premium tends to **increase** when FIP, which can be explained by the increased exposure to **market risk**
- Other factors such as technological innovations, experience, and policies that address the OSW supply chain also have an effect on the cost of capital; and those should probably be addressed in future research work