Fostering Offshore Wind in the European Union

The role of policy instruments on the cost of capital

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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**

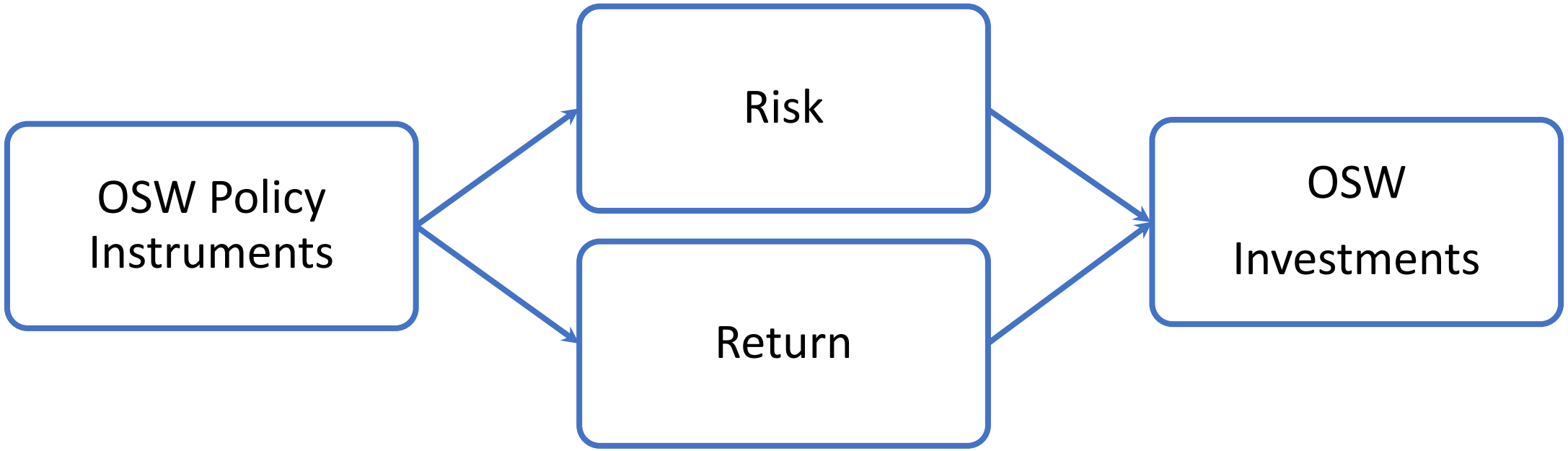
Introduction

- 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:

$$risk\ premium = WACC - \gamma_c$$

γ_c = country-specific risk-free rate

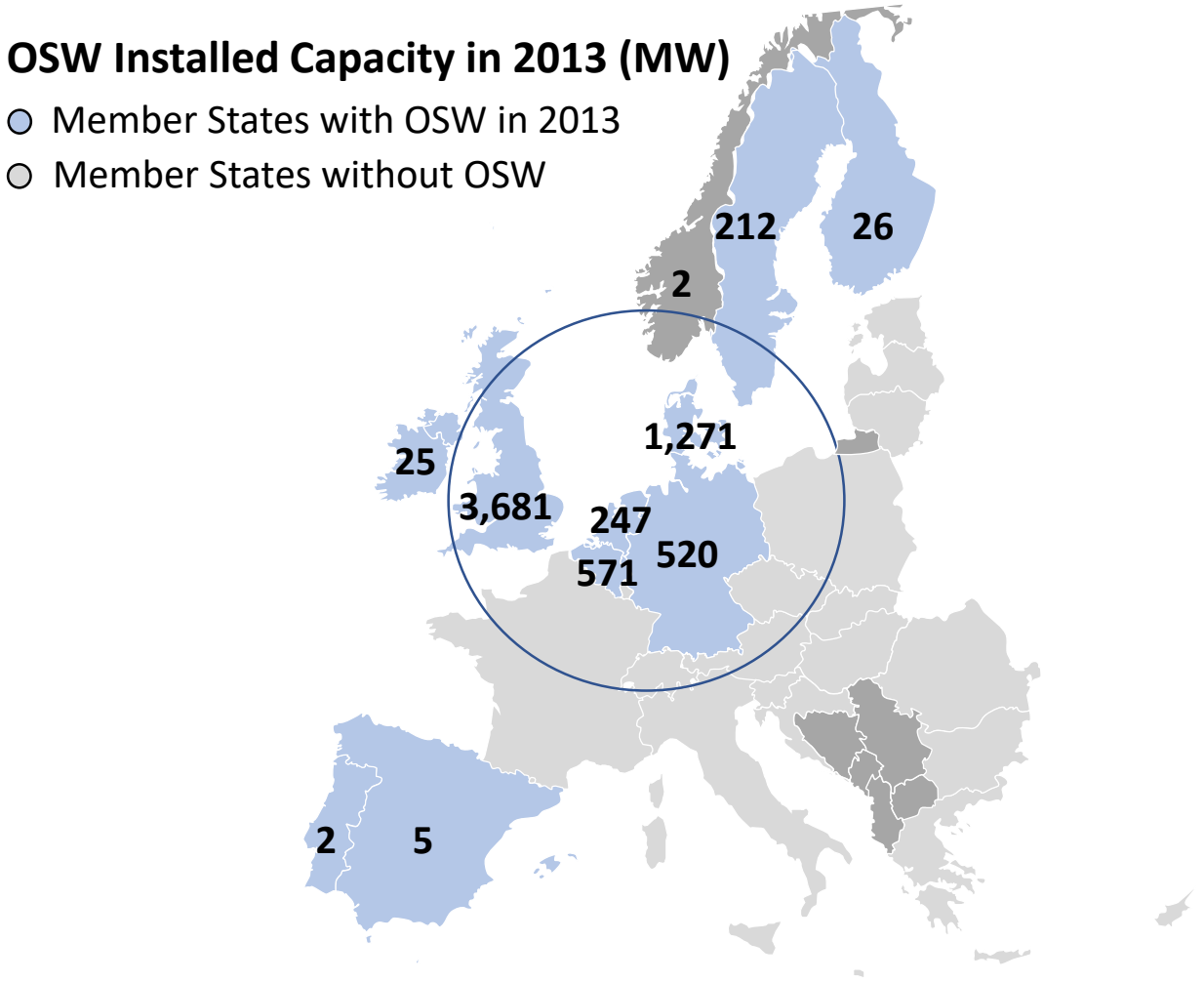
$WACC$ = cost of capital

- 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)

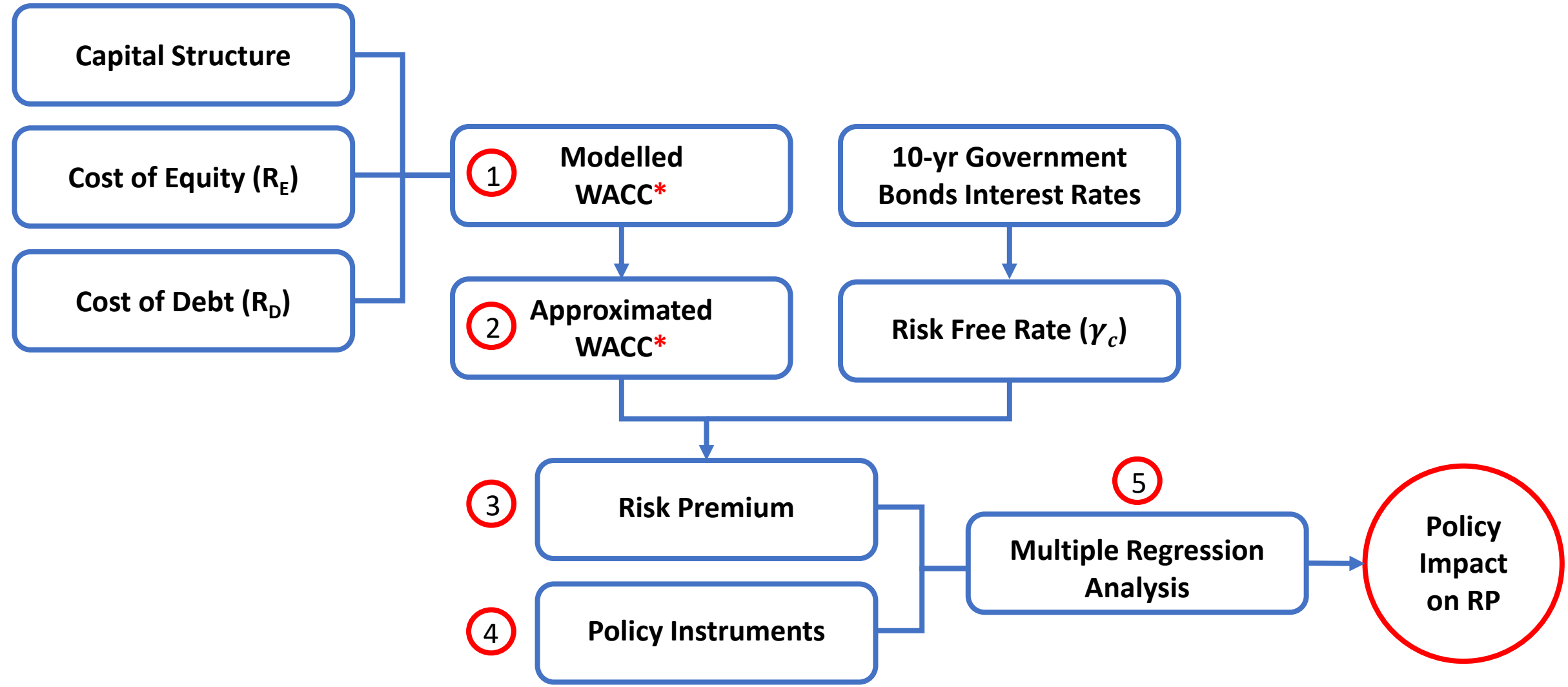
Offshore wind installed capacity in the EU

	2013	2017
Total OSW installed capacity in the EU	6,562 MW	15,780 MW
Relative shares	UK: 56% DK: 19% BE: 8.7% DE: 8% NL: 3.8%	UK: 43% DE: 34% DK: 8% NL: 7% BE: 6%
Number of connected turbines	2,080	4,149
Grid connected OSW farms	69	92
Location		
North Sea	66%	71%
Irish Sea	-	16%
Baltic Sea	17%	12%
Atlantic Ocean	16%	1.2%



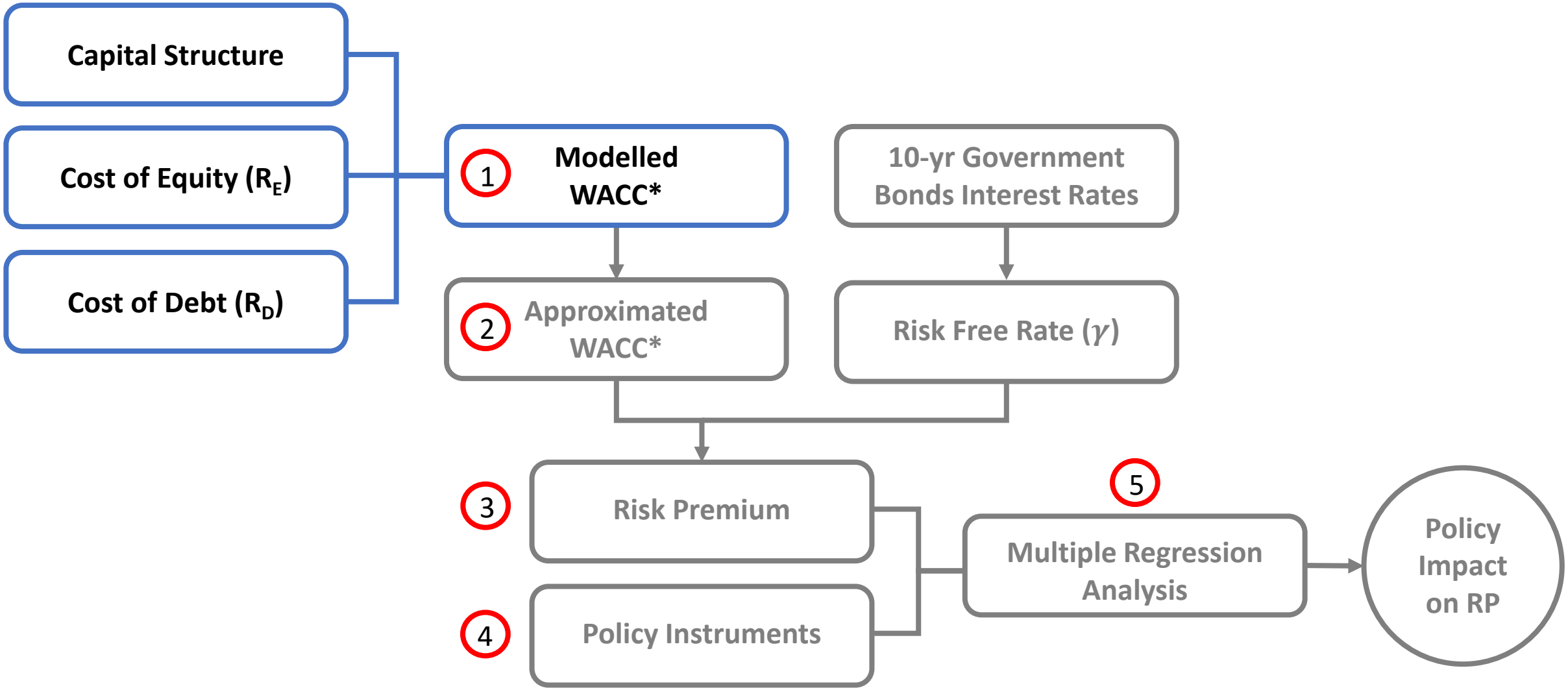
Source: EWEA (2014); WindEurope (2018)

5-Steps Approach: Estimating the impact of policy instruments on OSW risk premiums



Source: May and Neuhoff (2017); Noothout et al. (2016)

Steps 1: Estimation of the cost of capital



Step 1: Estimation of the cost of capital

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

! DiaCore

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

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

Capital Structure

Cost of Equity (R_E)

Cost of Debt (R_D)

1 **Modelled WACC ($WACC_{model}$)**

$$WACC = \frac{E}{D+E} \times R_E + \left(\frac{D}{D+E} \times R_D \times (1 - Tax)\right)$$

WACC: Weighted Average Cost of Capital
D: Share of Debt
E: Share of Equity

Source: Noothout et al. (2016)

Results: Estimated cost of capital

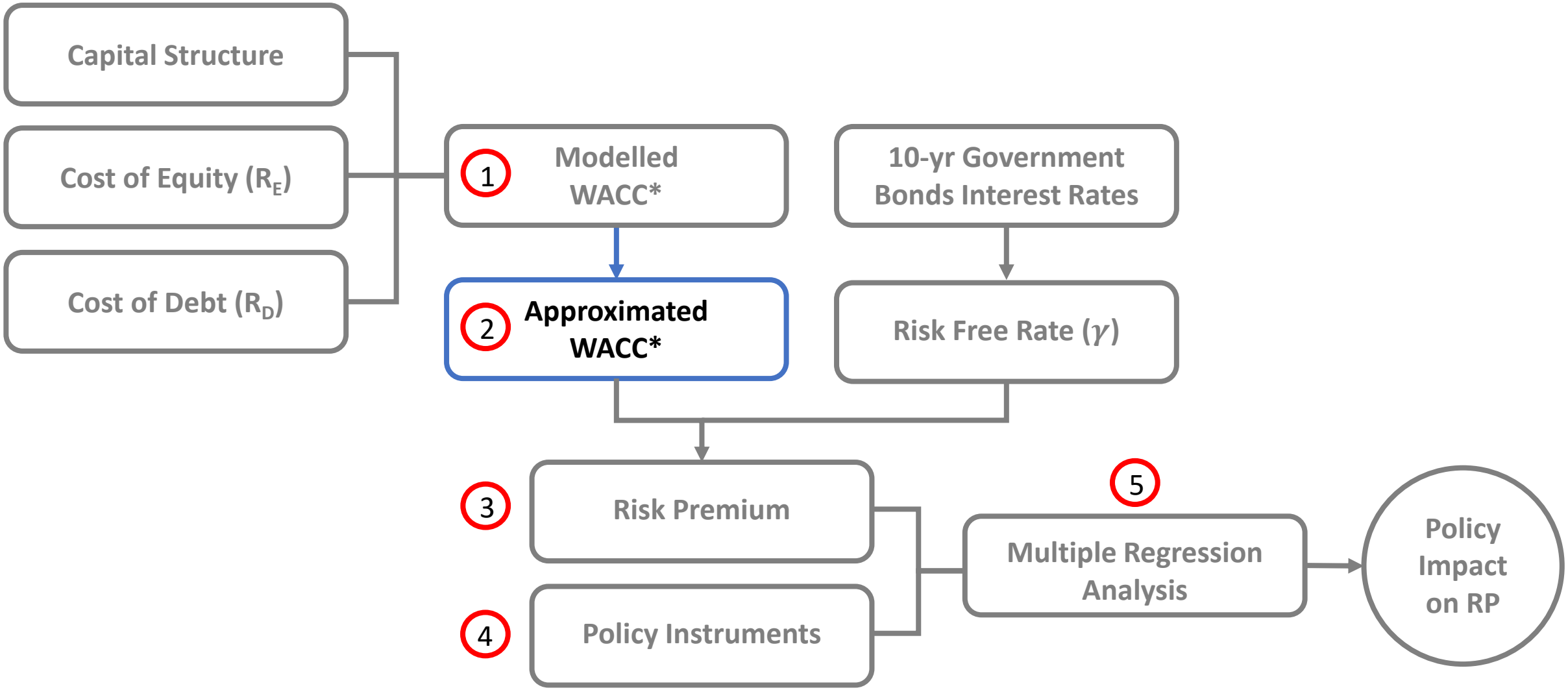
Member States with OSW in 2013	R_E* (%)	R_D (%)	$WACC_{model}$ (%)
Belgium	10.8	7.1	6.52
Denmark	11.2	6.9	6.98
Finland	11	7	7
Germany	9.3	6.7	6.09
Ireland	13.8	8.9	9.59
Netherlands	10.8	7.1	6.97
Portugal	15.4	11.4	10.61
Spain	13	9.7	8.65
Sweden	11.1	7.2	7.26
United Kingdom	10.4	7.1	6.95

* R_E taken from DiaCore, shown as indicative

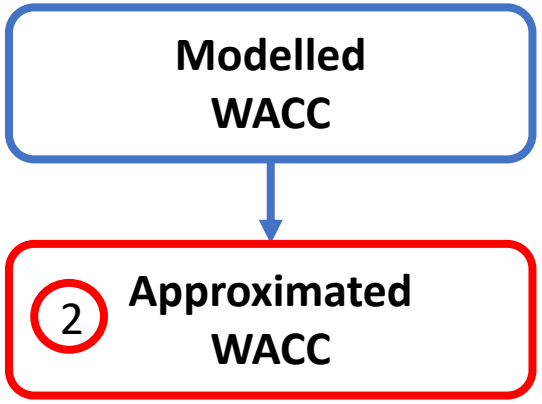
- Timeframe **2013**
- Assumed average capital structure of 70/30 and R_E derived from DiaCore
- DE shows the lowest OSW cost of capital, whereas PT the largest

Source: Noothout et al. (2016)

Steps 2: Testing the cost of capital



Step 2: Testing the cost of capital

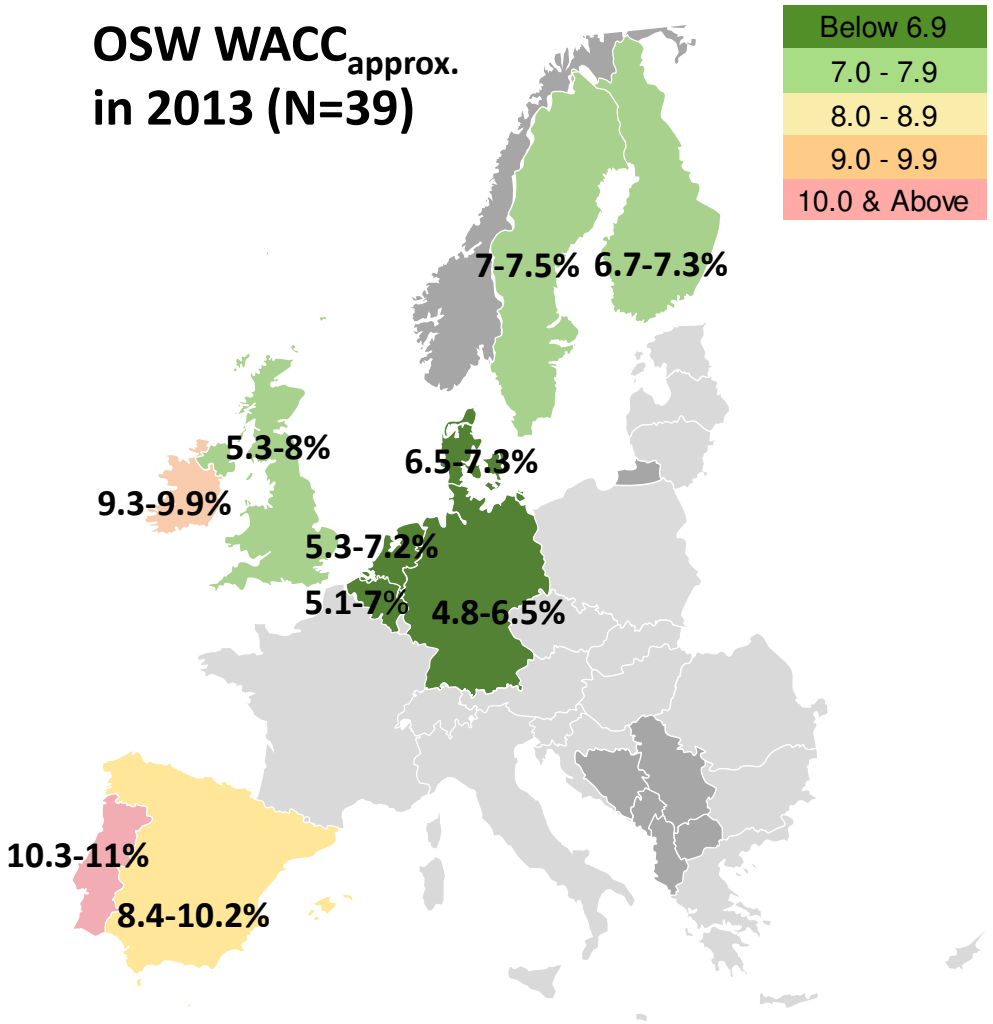


- Results tested through **semi-structured interviews**
  - 4 Respondent types:
    - Consultants & Academics
    - Equity providers
    - Debt providers
    - Developers or OSW farms owners
  - Variables tested:
    - Assumptions: Capital structure & R_E
    - Estimations: R_D & $WACC_{model}$
    - **Additional co-variates**: policy or retroactive changes & tenders
- Relative responses → point estimates
- Respondents can give multiple interview-observations
- 4 OSW interview-observations derived from **DiaCore**

Source: May and Neuhoff (2017)

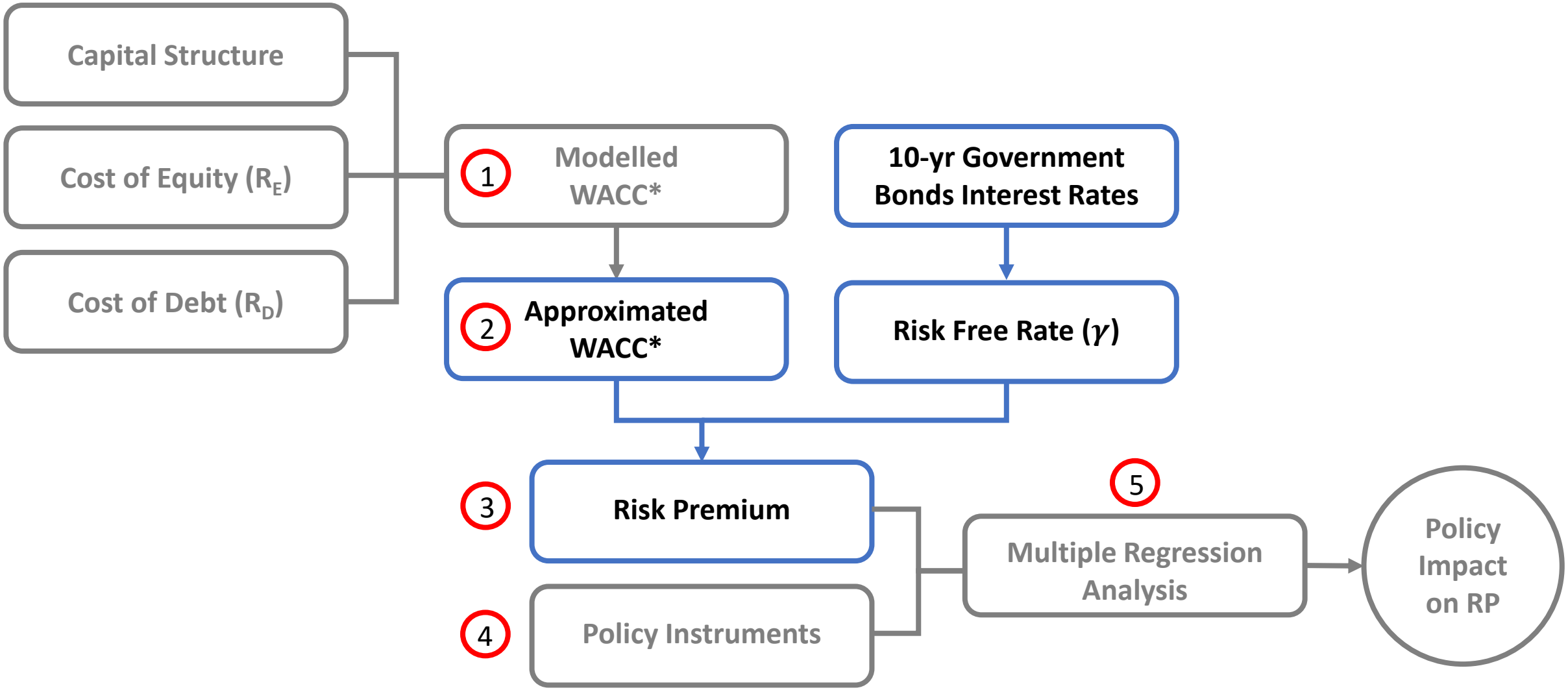
Results: Tested cost of capital

- 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



* Including 4 interview-observations from DiaCore and 13 flagged values

Steps 3: Estimating risk premiums



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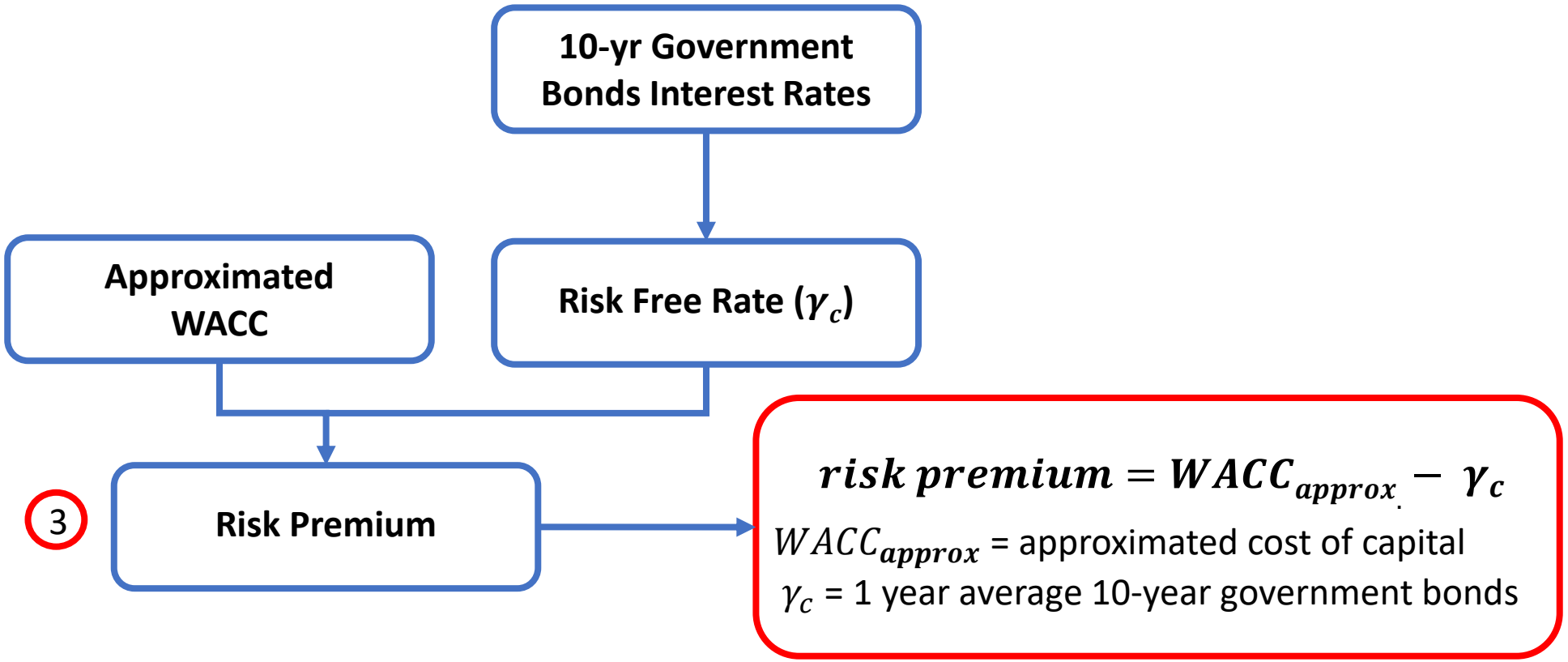


Source: May and Neuhoff (2017)

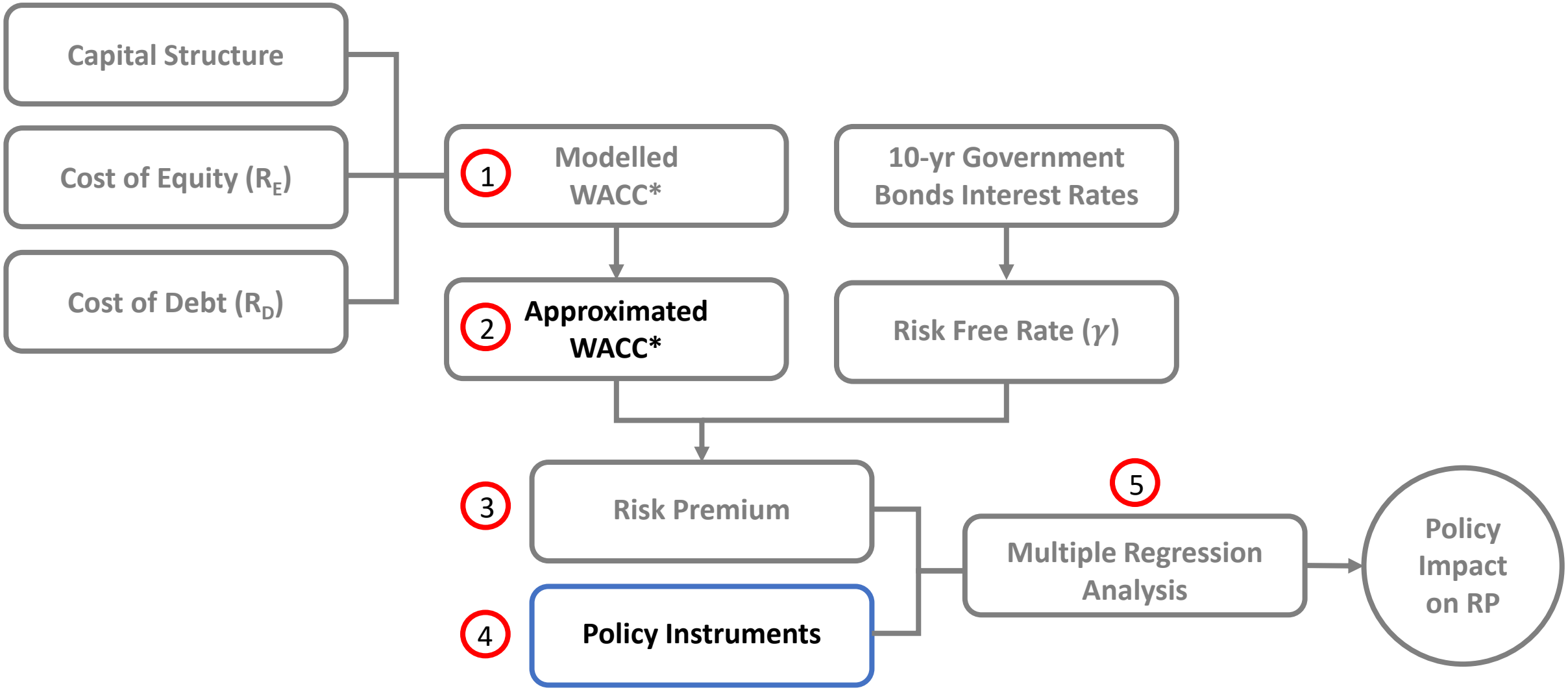
Results: Estimated risk premiums

Descriptive Statistics (%) [N=39]	Variables	Mean	Std. dev.	Min	Max
	$WACC_{model}$	7.25	1.16	6.09	10.61
	$WACC_{approx.}$	7.16	1.43	4.76	10.95
	10-year gvt. bonds yields	2.43	0.91	1.61	5.37
	Risk Premium Approximated	**4.72**	0.84	2.72	6.54

- The approximated risk premium mean is larger than what was observed by May and Neuhoff (2017) for the case of onshore wind ($RP_{approx.}$ = 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



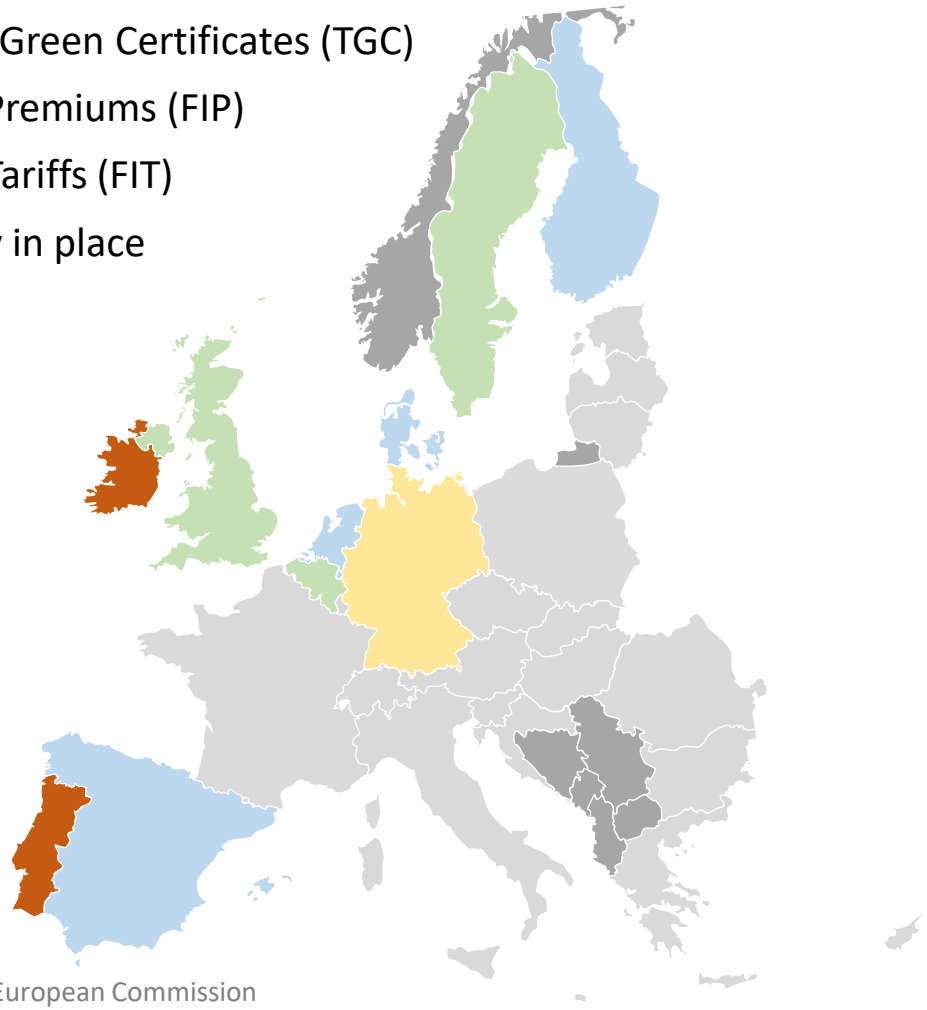
Step 4: Identifying OSW policy instruments

4 **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

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

Main OSW Instrument per Member States (2013)

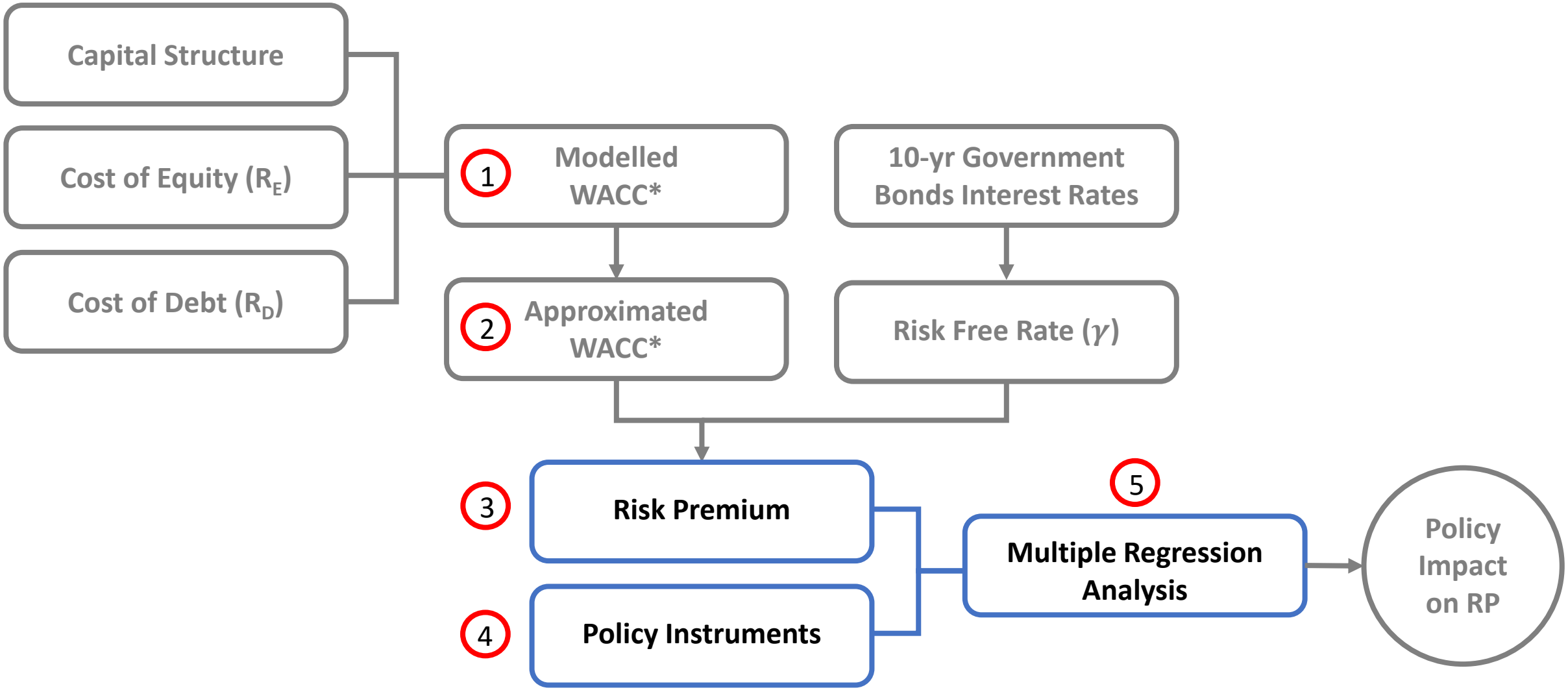


Source: IEA; European Commission

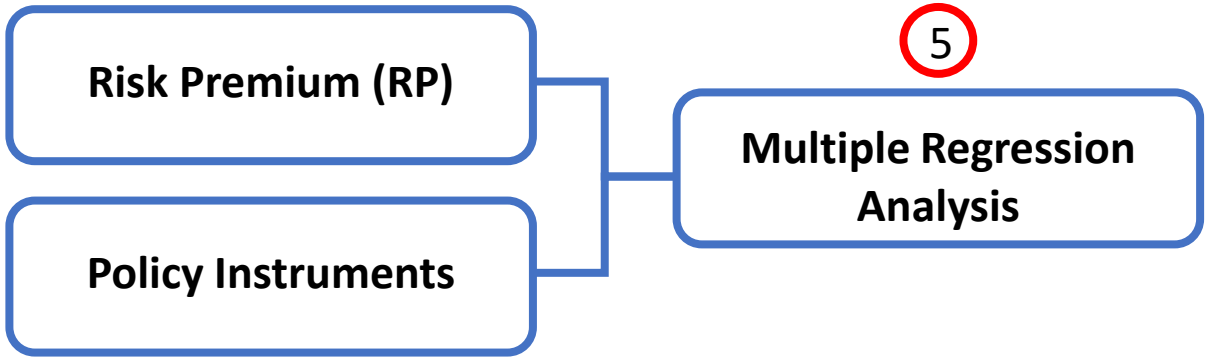
Descriptive statistics: OSW policy instruments

Descriptive Statistics [N=39]	Variables	Categories	Frequency [N=39]	Frequency [%]
	Policy Instruments	FIT	5	12.8
		Sliding FIP	15	38.5
		TGC with floor price (TGC_{w})	6	15.4
		TGC without floor price ($TGC_{w/o}$)	9	23.1
		No policy in place	4	10.3
	Additional Factors	Tenders	10	25.6
		Retroactive changes	3	7.7
	Types of respondent	Consultants & Academics	21	**53.9**
		Depth providers	14	35.9
		Equity providers	4	10.3
		Developers or OSW farm owners	0	**0**

Steps 5: Multiple regression analysis



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* = risk premium (RP)
- **Independent variables**:
  - *x* = 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:

$$\boldsymbol{risk\ premium_i = \alpha + \beta_1 FIP + \beta_2 TGC + X\delta + u_i}$$

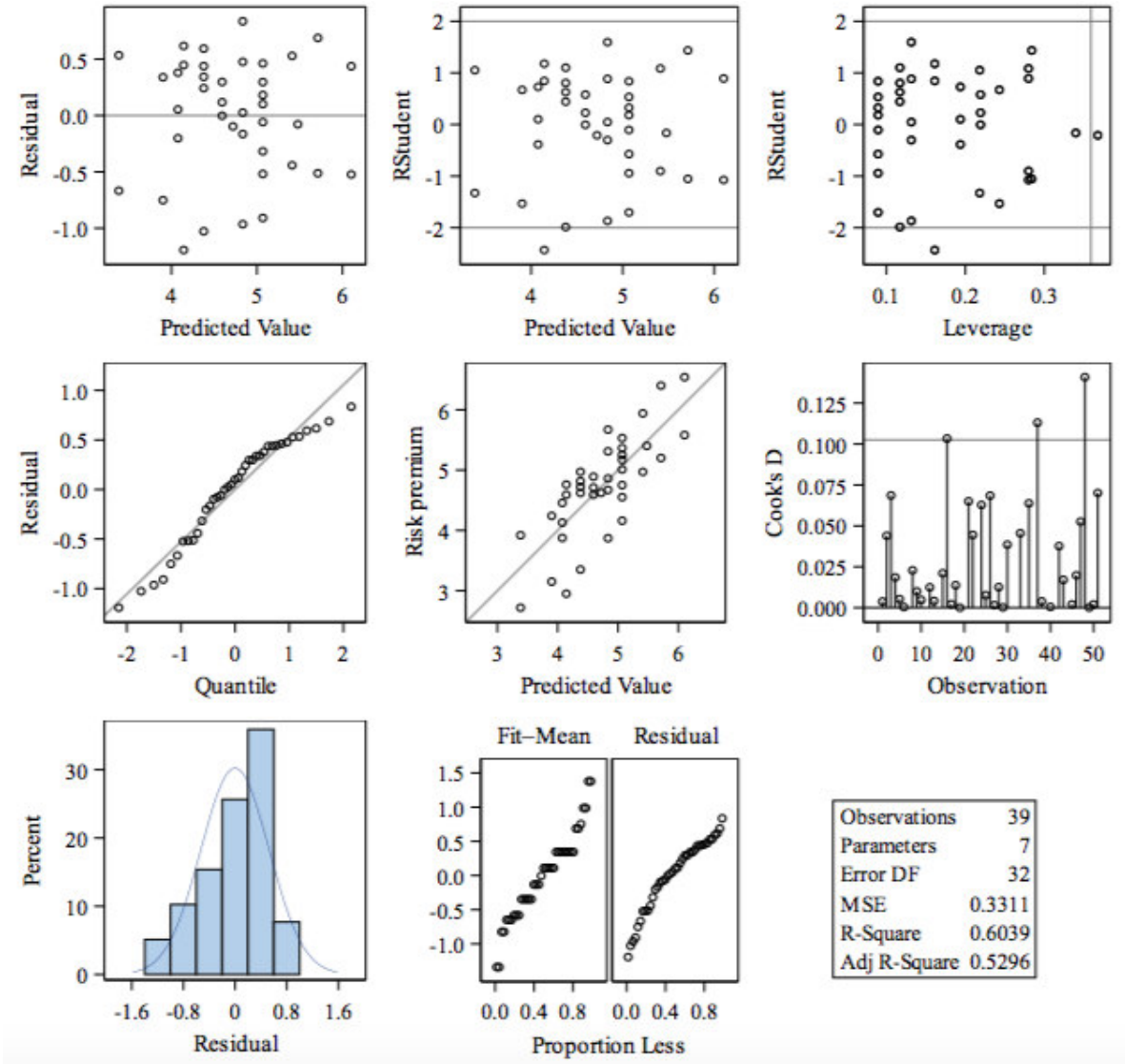
i: interview-observations
α: y-intercept; Y, when X=0
β_1 & β_2: slope of the regression line; change in Y for 1-unit change of X
$X\delta$: control matrix containing [NOPD, TYPD]
u_i: error term

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%** (α=0.1), indicates:
  - The risk premium tends to **increase** by an estimate of **01.03 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$_w$**, 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. Levarage 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!

Source: IREA (2018)

Discussion

- 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 ($WACC_{approx.}$)
  - Overall, **OSW cost of capital is higher** than onshore wind (DiaCore results)
  - **Effect of recall or retrieval**: DiaCore $WACC_{approx.}$ **>** Interviews $WACC_{approx.}$
  - 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 of capital; and those should probably be addressed in future research work

Questions

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