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Regression discontinuity design – a suitable methodology for evaluating the direct incentive effect of state aid on the deployment of renewable energy?

Setting the scene
Why do we examine the Regression Discontinuity Design (RDD)?

1   EU Commission requires that all financial support for renewable energy sources (RES) is allocated through auctions

2   RES support is considered state aid and thus, an ex-post evaluation of the causal impact of the aid is required

3   Counterfactual impact evaluation using **Regression Discontinuity Design (RDD)** or Difference-in-difference, as quasi-experimental design approaches

4   Scarce theoretical and empirical literature and lack of guidelines on the applicability of RDD for RES auction evaluation

Research question:
Is the RDD a suitable method for evaluating the effect of state aid on renewable energy projects in auction-based support schemes?

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Renewable energy auctions and Regression Discontinuity Design (RDD)
A brief introduction

Renewable energy auctions

- The auctioneer, typically the government, auctions a certain volume of support/to be supported
- Project developers participate in the auction with their planned project and submit their required levels of support [€/MWh]
- The auctioneer sorts the projects in ascending order of their bid prices and awards projects until the auctioned volume is reached
- Awarded projects
  - receive financial support (approvals)
  - need to be realised in a certain period of time

Regression Discontinuity Design (RDD)
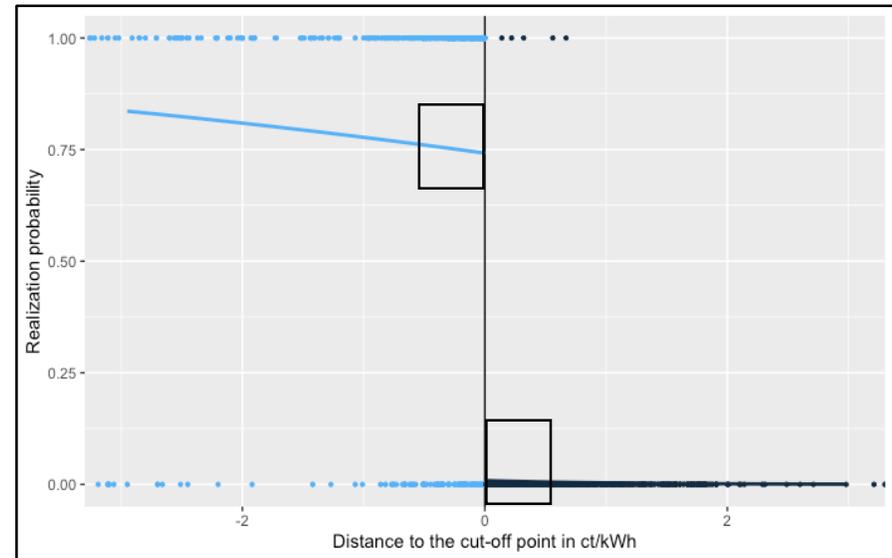
Requirements
1. Continuous assignment variable (for the treatment)
2. Cut-off value/threshold with discontinuity in treatment assignment

Assumptions
1. Assignment variable is continuous at the threshold
2. **Projects do not differ close to the threshold (besides the treatment)**

Our approach

We answer the research question by conducting…

Experiments with randomised data → Understanding the properties of RDD	Case studies with real auction outcomes → Greece and Italy

How to apply the RDD on RES auctions?

Which dependent/outcome variable? → project's realisation [0,1]

Which treatment? → support (approval) [0/1]

Which assignment variable? → submitted bid price [€/MWh, ctkWh] (bids were centered to be able to aggregate data)

Which cut-off value → highest awarded bid price

Using a **logistic regression**, we estimate the average treatment effect (causal impact) of support approvals on the realisation of RE projects
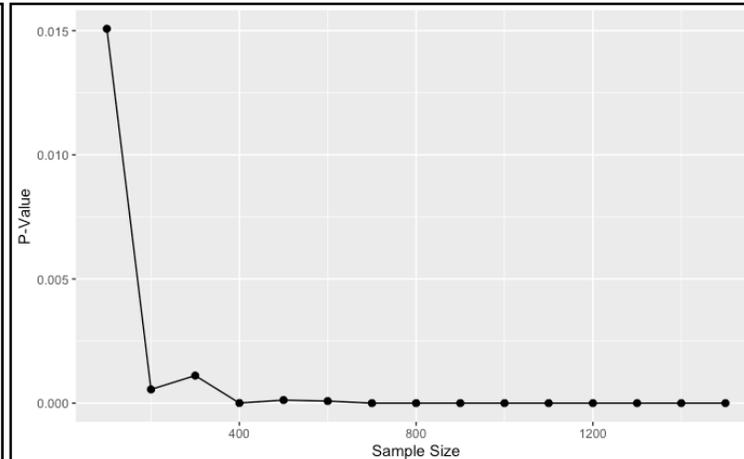
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Results: Randomised auction data
Both significant and insignificant results…
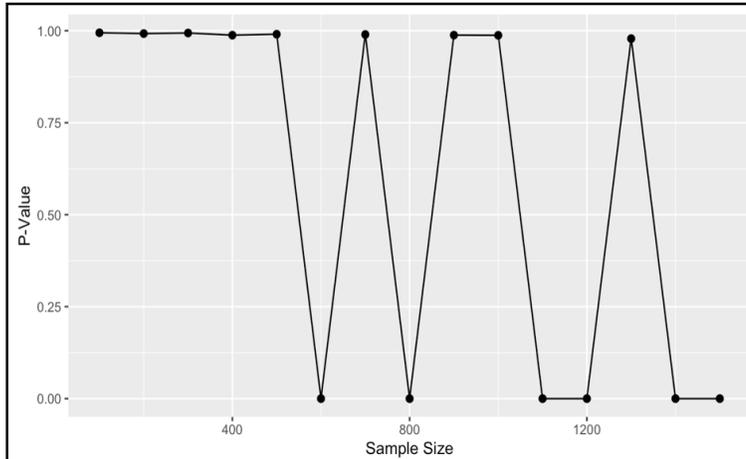
Bandwith 0.4 ct/kWh
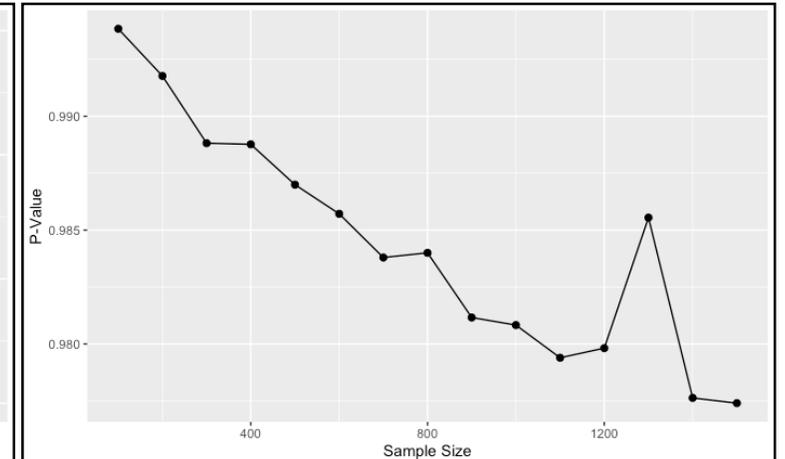**Realisation probability**
- awarded: 0.751
- non-awarded: 0.005
- ➔ both significant and insignificant effects

Bandwith 0.4 ct/kWh
Realisation probability
- awarded: 0.751
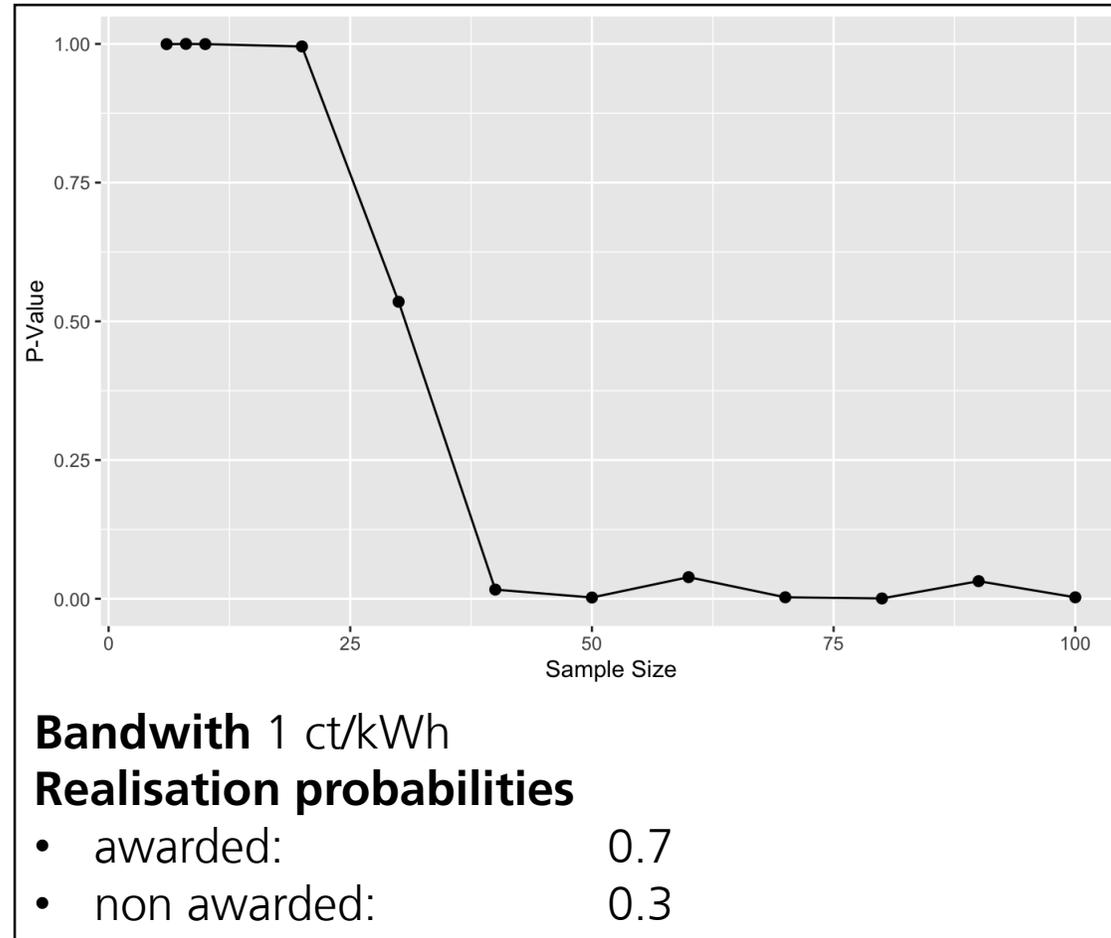- non-awarded: 0.4
- ➔ significant effects

Bandwith 0.4 ct/kWh
Realisation probability
- awarded: 1
- non-awarded: 0.4
- ➔ insignificant effects

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Results: Randomised auction data

...even with small sample sizes

Bandwith 1 ct/kWh
Realisation probabilities
- awarded: 0.7
- non awarded: 0.3

Case study auction data
Publicily available auction outcomes (awarded + submitted bids)

Greece
- 4 solar PV auctions (2016-2019)
- 2 onshore wind auctions (2018)

Italy
- 3 onshore wind auctions (2013-2016)

Italy onshore wind

		Bids		
		not awarded	awarded	total
Realization	not realized	68	3	71
	realized	1	29	30
	total	69	32	101
Realization rate		0.014	0.906	

Greece solar PV

		Bids		
		not awarded	awarded	total
Realization	not realized	49	16	65
	realized	0	30	30
	total	49	46	95
Realization rate		0	0.652	

Greece onshore wind

		Bids		
		not awarded	awarded	total
Realization	not realized	10	8	18
	realized	0	6	6
	total	10	14	24
Realization rate		0	0.429	

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Results: Greece (solar PV and onshore wind auctions)

Insignificant results
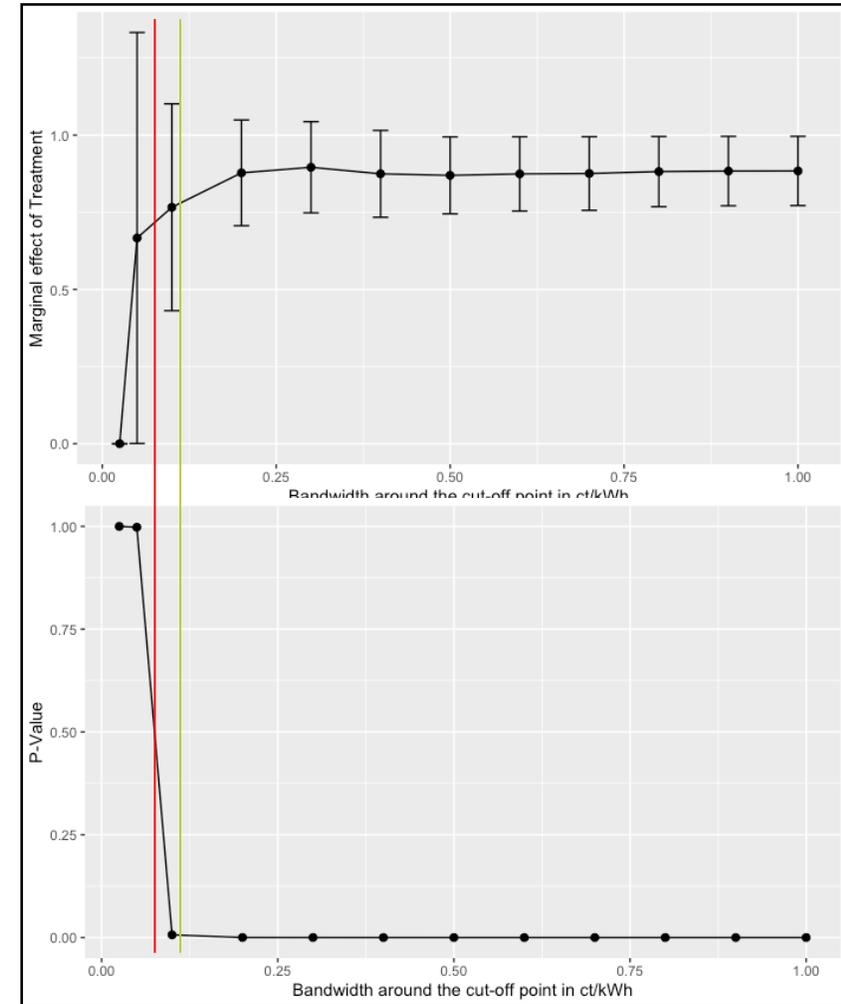

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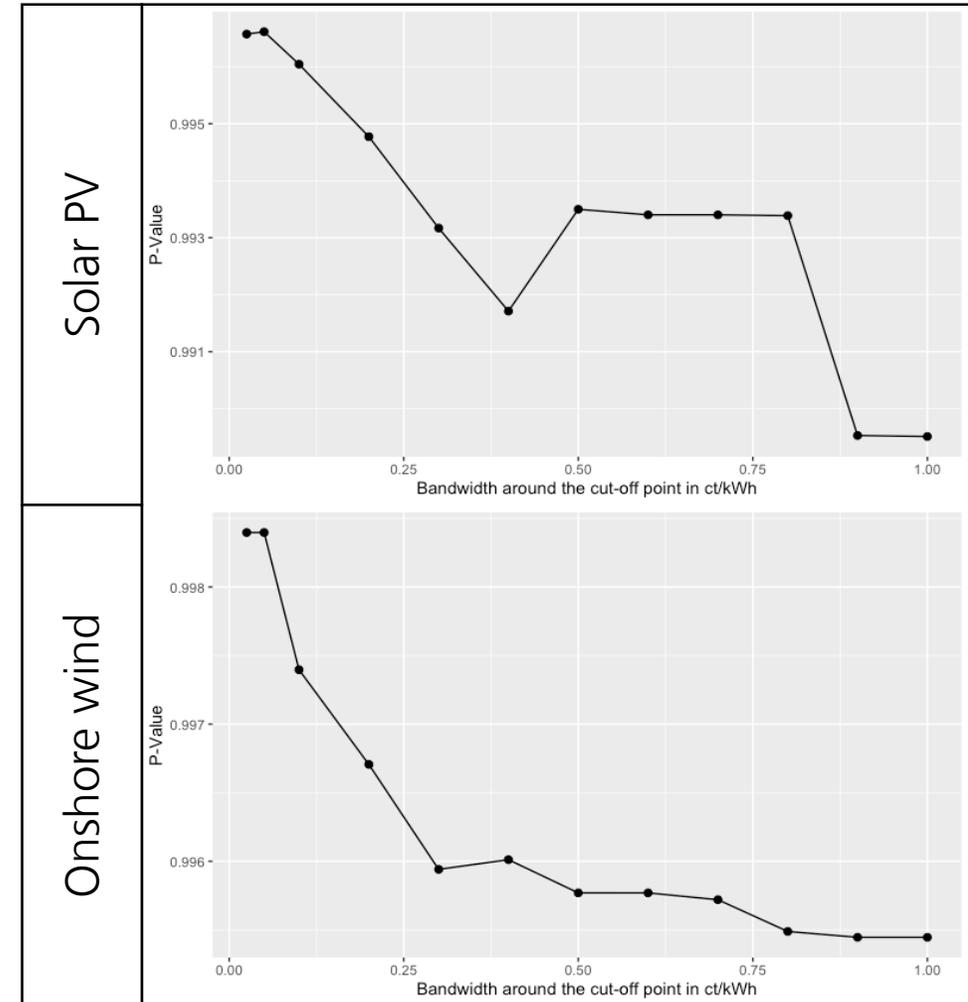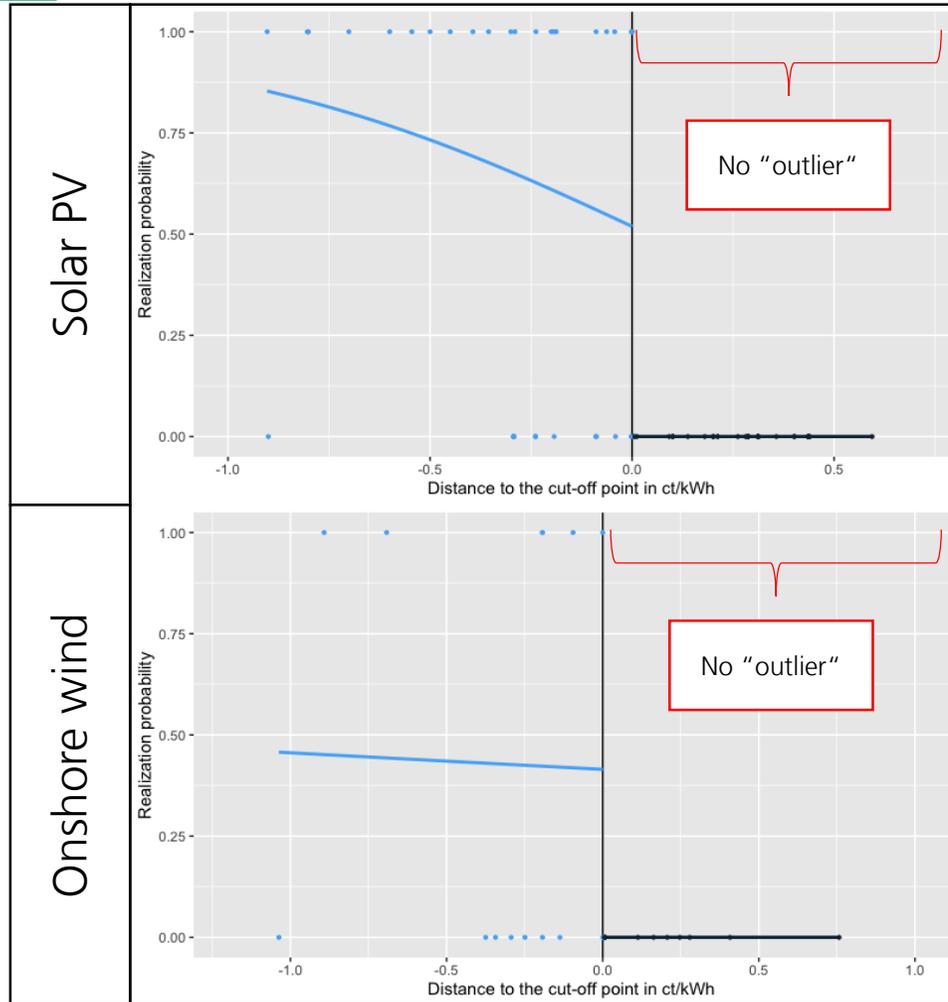
Results: Italy (onshore wind auctions)

Significant results, if outlier is included in the analysis

No "outlier"
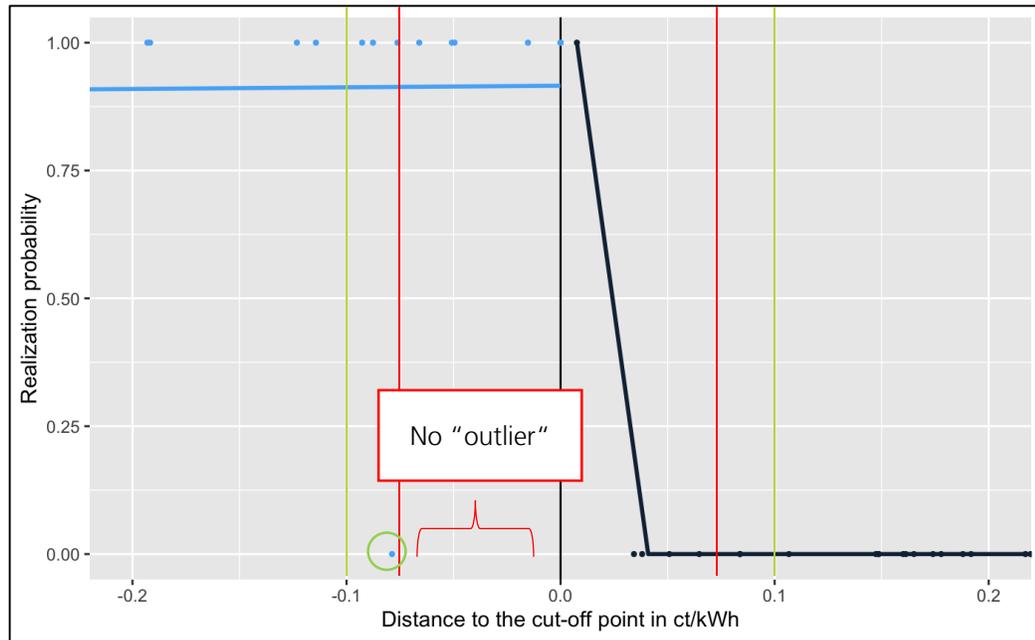
Significant results with
only 18 observations

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Conclusions and discussion

Case studies:
- In Italy, the treatment effect was significant and more than 70%-points ➔ significant causal impact of aid
- In Greece, treatment effect was insignificant ➔ no causal impact of aid?

Applicability of the RDD
- In principle, RDD can be an adequate method to evaluate the impact of RE support allocated through auctions
- But several requirements need to be met:
  - Auction rounds need to be oversubscribed (➔ otherwise no treatment group)
  - Award must be based on price only and in ascending order (➔ otherwise RDD can hardly be applied)
  - Treatment and control group both need at least realised and non-realised projects close to the threshold (➔ otherwise insignificant results; perfect fit of logistic regression)

Alternative approaches
- Methodological
  - Aggregation of data (➔ assumptions?)
  - Difference-in-difference/Instrumental variable (➔ stronger assumptions and/or more complex)
  - Theory-based/qualitative evaluation (➔ less robust/quantitative insights)
- Other variables
  - Dependent variables: WACC (➔ lack of data), project size (➔ lack of control group)
  - Assignment variables: project size (➔ typically endogenous); and support is typically awarded based on submitted bid prices

➔ In a nutshell: RDD can be an adequate method to evaluate RE auctions, but many requirements need to be met

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Acknowledgements

More information on
RES auctions:
http://aures2project.eu/project/