Are the renewables affecting the income distribution and the risk of poverty of households?

Diogo André Pereira, António Cardoso Marques, José Alberto Fuinhas
Presenter contacts: diogo.andre.pereira@ubi.pt;
pereira.diogo.as@gmail.com

FACULDADE CIÊNCIAS SOCIAIS E HUMANAS
UNIVERSITY OF BEIRA INTERIOR
Covilhã | Portugal

NECE
Núcleo de Estudos em Ciências Empresariais
Research Centre in Business Sciences

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Agenda

- **Motivation**
  - What is already known;
  - Research questions;
- **Methodology**
  - Data assess;
  - Methodology used;
- **Results**
  - The implications of income distribution on the RES deployment;
  - The consequences of RES deployment on the income distribution;
  - The effects of RES implementation on the households risk of poverty;
- **Conclusions**
- **Possible solutions to mitigate the negative effects on society**

Motivation

- The installed capacity of RES have been deployed in high amounts:
  - ***But, the incomes of households are significant to explain this high implementation?***

- The intermittent RES have been deployed mainly by fiscal and financial policies:
  - **Who have payed the cost of this promotion schemes?**
  - **Who have benefiting with this policy-driven guidance?**

- The RES capacities have been deployed at a fast tendency, but the electricity price as increasing likewise:
  - **How poor households have been leading with this increasing electricity prices?**

So, one must understand the impacts of RES implementation on both income distribution, and on the risk of poverty or social exclusion of households.
How should the policy design develop to safeguard the poor households?

What is already Known

- **Public Policies** Supporting Renewables **and CO_2 emissions are drivers of RES** deployment (e.g. Marques et al., 2010, JEPO; Aguirre and Ibikunle, 2014, JEPO; Polzin et al. 2015, JEPO);

- **RES are restricting** the announced **benefits**, and the **fossil fuels** installed capacity have been **required**, and put **into standby** (e.g. Al-Mulali et al., 2014, RSER; Dogan, 2015, RSER; Green and Vasilakos, 2010, JEPO; Marques and Fuinhas, 2016, RSE);

- The **feed-in tariffs** have been an **attractive** instrument do **deploy** large amounts of **solar PV** and **wind power** (e.g. Marques et al., 2010, JEPO; Polzin et al. 2015, JEPO; Frondel et al. 2015, Econ Anal Policy);

- Increasing **electricity prices** have regressive impacts on **poor households** (Nelson et al. 2011, 2012, Econ Anal Policy; Frondel et al. 2014, 2015, Econ Anal Policy).

Research questions

- The income of social classes have been driven RES promotion?
- What have been the consequences of RES deployment on income distribution?
- The RES implementation have been increasing the risk of poverty and social exclusion?

Data

Motivation

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Results

Conclusions

Countries under analysis: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

Time-Span
2005 - 2015

Explained / Explaining variables:

- Installed capacity of all RES;
- Electricity generation from all RES;
- Installed capacity of wind power;
- Electricity generation from wind power;
- Installed capacity of solar PV;
- Electricity generation from Solar PV;
- Installed capacity of hydro power;
- Electricity generation from hydro power;
- Percentage of household's mean disposable income in relation to the total mean disposable income;
- Number of peoples, in households groups, at risk of poverty and social exclusion.

Households groups/types:

- Single person;
- Single person with dependent children;
- Two adults;
- Two adults younger than 65 years;
- Two adults, at least one aged 65 years or over;
- Two adults with one dependent children;
- Two adults with two dependent children;
- Two adults with three or more dependent children;
- Two adults or more without dependent children;
- Two or more adults with dependent children;
- Three or more adults;
- Three or more adults with dependent children;
- All households without dependent children;
- All households with dependent children.

Econometric procedures

Motivation

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Conclusions

Cross-section dependence and unit roots tests

CD-test (Pesaran, 2004); 2nd generation CIPS unit root test (Pesaran, 2007)

Correlation matrix and variance inflation factors

Kao's residual cointegration test

Model Specification tests

Heteroskedasticity, serial correlation, contemporaneous correlation; and Fixed Effects vs. Random Effects

Autoregressive Distributed Lag (ARDL) model

Breakdown of the total effects into both short-run (semi-elasticities) and long-run (elasticities) effects

In short:

Motivation

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Results

Conclusions

Cross-section dependence

- Strongly supported the presence of cross-section in almost of variables.

Unit roots

- Second generation unit roots test, CIPS, proves that all variables are I(1) in their levels.

Cointegration

- The Kao residual cointegration test strongly supported the presence of long-run relationships between series.

Specification tests

- Presence of heteroskedasticity, first order autocorrelation, and panel fixed effects.

ARDL modelling

- Adequacy of assessing the short-run dynamics and the long-run equilibrium.
- Allows variables with long memory patterns to be handled appropriately.

ARDL approach estimated by Driscoll-Kraay estimator with fixed effects

Driscoll Kraay (1998) estimator is a covariance matrix estimator, and their small-sample properties (case of this research) are considerably better than the alternative covariance estimators, mainly when cross-sectional dependence, heteroskedasticity, autocorrelation, and contemporaneous correlation are present (Hoechle, 2007, SJ)

Results (RES models)

Motivation

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Results

Conclusions

Moldels	RES_IC	RES_GEN	HYDRO_IC	HYDRO_GEN	WIND_IC	WIND_GEN	SOL_IC	SOL_GEN
Single person	(LR) -**	(LR) -**	(LR) +**		(SR) -* (LR) -***	(LR) -***	(SR) -*** (LR) -***	(LR) -***
Single person with dependent children	(LR) -**	(LR) +***	(SR) +**	(LR) -***	(SR) +**		(SR) -** (LR) -***	
Two adults younger than 65 years	(SR) -*			(SR) +*	(LR) -***	(LR) -**	(SR) -**	
Two adults, at least one aged 65 years or over	(LR) -*		(LR) +***					
Two adults with one dependent child	(SR) -*** (LR) -*	(LR) -***	(LR) +**		(SR) -*** (LR) -***	(SR) -*** (LR) -***	(SR) -*** (LR) -***	(SR) -*** (LR) -***
Two adults with two dependent children			(LR) +**				(LR) +**	(LR) +***
Two adults with three or more dependent children	(LR) -**		(SR) -*** (LR) -***		(SR) -*** (LR) -***	(LR) -**		(LR) +**
Three or more adults			(LR) +*		(LR) -***			(LR) +**
Three or more adults with dependent children	(SR) -*** (LR) -*				(SR) +**		(SR) -** (LR) -***	
Natural gas consumption	(SR) +***	(SR) +***	(LR) +***	(SR) +***	(SR) -***		(SR) -** (LR) -**	(LR) +***
Electricity price	(LR) +***	(LR) +***	(LR) +***	(LR) +**	(SR) -*			(SR) +** (LR) +***
Greenhouse gases intensity		(SR) -***		(SR) -***	(SR) -** (LR) -***	(SR) -*** (LR) -***		(LR) -***
Energy intensity	(SR) -*** (LR) -***				(LR) +***	(SR) -**		(SR) -** (LR) -***
Gross Domestic Product	(LR) -***	(LR) -***	(LR) +***		(SR) -*			(SR) -** (LR) -***
Public expenses on education	(SR) -*** (LR) -***		(LR) -*	(LR) -***			(SR) -**	(SR) -** (LR) -**
People living with very low work intensity	(LR) -*				(SR) +*			(SR) -** (LR) -***
Error Correction Mechanism	-0.0728**	-0.1913***	-0.5133***	-0.9567***	-0.2050***	-0.2355***	-0.1402***	-0.2204***

Key point:

The **velocity of adjustment** of RES models are **slow**, **except on hydro** power models

The Natural gas consumption and the electricity prices has been **drive** the **RES** implementation, **except wind** power;

Almost of the households has been **stimulated the hydro power** deployment;

The **households with two or more adults** have been driven the **solar PV** deployment.

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Results (income models)

Negative	Positive
Single person	Two adults younger than 65 years
Two adults with one dependent children	Two adults, at least one aged 65 years or over
Three or more adults	Two or more adults without dependent children

Wind Power installed capacity

Negative

- Single person with dependent children
- Two adults
- Two adults, at least one aged 65 years or over
- Two adults with one dependent children
- Two adults with two dependent children
- Two or more adults with dependent children
- Three or more adults
- Households with dependent children

Installed capacity of solar PV

Positive

- Households without dependent children
- Single Person

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Results (income models)

Negative	Positive
Two adults younger than 65 years	Single person
Two adults with three or more dependent children	Single person with dependent children
Three or more adults	Two adults, at least one aged 65 years or over

Hydro Power installed capacity

Negative	Positive
Single person	Single person with dependent children
Two adults with three or more dependent children	Two adults with one dependent children
	Three or more adults

Electricity generation from RES

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Results (income models)

Electricity Price

Negative

- Two adults with three dependent children
- Two or more adults without dependent children
- Three or more adults
- Households without dependent children

Positive

- Single person
- Two adults with one dependent children
- Two adults with two dependent children
- Two or more adults with dependent children
- Households with dependent children

Natural gas consumption

Negative

- Single person with dependent children
- Two adults with one dependent children
- Two adults with two dependent children
- Two adults with three or more dependent children
- Two or more adults with dependent children
- Households with dependent children

Positive

- Two or more adults without dependent children
- Three or more adults
- households without dependent children

Results (risk models)

Single Person

Decrease	Increase
Hydro power	Solar PV
Energy	Natural gas consumption
	Greenhouse gas emissions

Single Person with dependent children

Decrease	Increase
Hydro power	Solar PV
Electricity Price	Natural gas consumption
Greenhouse gas emissions	Energy

Two adults

Decrease	Increase
Hydro power	Greenhouse gas emissions
RES generation	
Natural gas consumption	
Energy	

Two adults younger than 65 years

Decrease	Increase
Hydro power	Wind power
Natural gas consumption	Solar PV
Greenhouse gas emissions	RES generation
Energy	

Two adults, at least one with 65

Decrease	Increase
Solar PV	Hydro power
RES generation	Greenhouse gas emissions
Natural gas consumption	
Energy	

Two adults with one children

Decrease	Increase
Wind power	Hydro power
Natural gas consumption	Solar PV

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Results (risk models)

Two adults with two children

Decrease	Increase
Electricity price	Solar PV
	Natural gas consumption
	Greenhouse gas emissions
	Energy

Two or more adults without children

Decrease	Increase
Natural gas consumption	Greenhouse gas emissions

Two or more adults with children

Decrease	Increase
Electricity price	Hydro power
Greenhouse gas emissions	RES generation
Energy	Natural gas consumption

Three or more adults

Decrease	Increase
Hydro power	Wind power
RES generation	Electricity price
Natural gas consumption	
Energy	

Three or more adults with children

Decrease	Increase
Wind Power	Hydro power
Solar PV	RES generation
Greenhouse gas emissions	Electricity price

Households with children

Decrease	Increase
RES generation	Hydro power
Electricity price	Solar PV
Greenhouse gas emissions	

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Conclusion

- The electricity price has stimulated the RES, which discloses that they are ready to operate at market prices, and to compete with fossil fuels;
- The income of households not have been stimulating the wind power, this emphasizes that these high investments should continue to be financed through public policies;
- The solar PV has decreased the income of households, consequently, it increases their risk of poverty and social exclusion;
- The hydro power installed capacity has been effective to reduce the risk of poverty of households.

The public energy policies should be focused to help households to save electricity, in order to reduce their electricity cost burden. Consequently, helping them support the costs of energy transition.

Possible solutions to mitigate the effects

- Integrating renewables is not only about building new wind farms or PV power plants;
- Besides, integrating RES is not give dispatch priority, it is need match the electricity demand with the availability of natural resources.
- To decrease the impact on income distribution, the economy ought to be prepared for (instance):
  - ✓ Promoting the energy conservation;
  - ✓ Subsiding energy efficiency home appliances, instead RES deployment;
  - ✓ Rewarding change of consumption routines, for instance through electricity tariffs;
  - ✓ Distribute the cost of RES deployment by taxations, instead by electricity price;
  - ✓ Promoting further generation of their own electricity.

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Results (income models)

Motivation

Methodology

Results

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Models INC	Single person	Single person with dependent children	Two adults	Two adults younger than 65 years	Two adults, at least one aged 65 years or over	Two adults with one dependent child	Two adults with two dependent children	Two adults with three or more dependent children	Two or more adults without dependent children	Two or more adults with dependent children	Three or more adults	Three or more adults with dependent children	Households without dependent children	Households with dependent children
Low work	(SR) -*** (LR) -**	(SR) -*** (LR) -***	(LR) -***			(SR) -*** (LR) -***	(SR) -*** (LR) -***	(SR) +***		(SR) -**	(SR) -** (LR) -***	-		
HYDRO_IC	(SR) +***	(SR) +***		(SR) -* (LR) -*	(SR) +***			(SR) -***			(SR) -***	-		
WIND_IC	(LR) -***			(LR) +*	(LR) +***	(SR) -*** (LR) -***			(LR) +***		(SR) -***	-		
SOL_IC	(SR) -** (LR) +***	(SR) -** (LR) -***	(SR) -**		(SR) -**	(SR) -** (LR) -***	(LR) -***			(LR) -*	(LR) -***	-	(LR) +**	(LR) -***
RES_GEN	(LR) -***	(LR) +***				(LR) +**		(LR) -***			(SR) +*** (LR) +***	-		
GASCONS	(SR) -***	(SR) -*** (LR) -***				(LR) -***	(LR) -***	(LR) -***	(LR) +**	(LR) -***	(LR) +***	-	(LR) +***	(LR) -***
PRICE_ELE	(SR) +**					(LR) +***	(SR) +*** (LR) +**	(SR) -*	(SR) -*** (LR) -**	(SR) +** (LR) +**	(SR) -*** (LR) -***	-	(SR) -*** (LR) -***	(SR) +*** (LR) +***
GEH_INTS	(LR) -***	(LR) -**	(LR) -**	(SR) +* (LR) +***	(SR) -**			(LR) +***	(SR) -*			-	(SR) -**	
ENERG_INTS	(SR) +***	(LR) -**	(LR) -***	(LR) +***	(LR) -***	(SR) -**	(SR) -** (LR) -***					-		
GDP	(LR) -***	(LR) -***	(SR) -***	(SR) -* (LR) +***	(SR) -*** (LR) -***	(LR) -***	(SR) -** (LR) -***	(LR) +***	(SR) -***	(SR) +** (LR) +***	(SR) -**	-	(SR) -*	(SR) +**
EDU_EXPS	(SR) -*** (LR) -***		(SR) -***	(SR) -**	(SR) -***	(SR) -*	(SR) +** (LR) +***	(SR) +***	(SR) -*	(SR) +*** (LR) +***	(SR) +**	-	(SR) -*** (LR) -***	(SR) +*** (LR) +***
ECM	-0.6545***	-0.7246***	-0.5196***	-0.6323***	-0.6213***	-0.8272***	-0.7082***	-0.8544***	-0.6167***	-0.6361***	-0.8724***	-	-0.5918***	-0.5853***

The **RES deployment have a negative impact on the income distribution**, **benefiting** the wealthy households, and **harming** the low-income households. Low-income households have been **threatened by energy poverty**.

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Results (risk models)

Motivation

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Models RISK	Single person	Single person with dependent children	Two adults	Two adults younger than 65 years	Two adults, at least one aged 65 years or over	Two adults with one dependent child	Two adults with two dependent children	Two adults with three or more dependent children	Two or more adults without dependent children	Two or more adults with dependent children	Three or more adults	Three or more adults with dependent children	Households without dependent children	Households with dependent children
Low work	(SR) +***	(SR) +*** (LR) +***	(SR) +*** (LR) +***	(SR) +*** (LR) +***	(SR) +***	(SR) +*** (LR) +***	(SR) +*** (LR) +***	-	(SR) +*** (LR) +***	(SR) +*** (LR) +***	(SR) +*** (LR) +***	(SR) +***	(SR) +*** (LR) +***	(SR) +*** (LR) +***
HYDRO_IC	(SR) -*	(SR) -***		(LR) -***	(LR) +**	(SR) +**		-		(SR) +***	(LR) -***	(SR) +** (LR) +***		(SR) +***
WIND_IC			(LR) -**	(SR) +* (LR) -***		(SR) +** (LR) -***		-			(SR) +* (LR) +***	(SR) -**		
SOL_IC	(SR) +**	(SR) +*** (LR) +***		(SR) +** (LR) +***	(SR) -***	(SR) +* (LR) +***	(LR) +***	-				(LR) -***		(LR) +**
RES_GEN			(LR) -***	(SR) +*	(SR) -** (LR) -***			-		(LR) +***	(SR) -** (LR) -***	(SR) +** (LR) +***		(LR) -***
GASCONS	(SR) +**	(SR) +*** (LR) +***	(LR) -***	(SR) -* (LR) -***	(LR) -***	(SR) -***	(LR) +***	-	(LR) -**	(LR) +***	(LR) -***			
PRICE_ELE		(LR) -***					(LR) -***	-		(LR) -***	(LR) +***	(SR) +**		(LR) -*
GEH_INTS	(LR) +**	(SR) -*** (LR) -**	(LR) +***	(SR) -**	(LR) +***		(SR) -** (LR) +**	-	(LR) +***	(SR) -***		(LR) -**	(SR) +* (LR) +***	(SR) -*** (LR) -***
ENERG_INTS	(SR) -*** (LR) -***	(LR) +***	(SR) -**	(LR) -***	(SR) -***		(SR) +*	-		(LR) -***	(SR) -***			
GDP		(LR) +***		(LR) -***	(SR) -**		(SR) +**	-		(LR) -***		(SR) -** (LR) -***		
EDU_EXPS	(SR) +*** (LR) +***	(LR) -***		(LR) -***	(SR) +** (LR) +***	(SR) +*		-						
ECM	-0.4812***	-0.9335***	-0.5869***	-0.7926***	-0.4255***	-0.8610***	-0.9840***	-	-0.6345***	-0.8380***	-0.9431***	-0.8745***	-0.4831***	-0.8514***

The ECM values reveals the **presence of long memory** in the data, further, all are **stable** and able to **return to the equilibrium path** after a disturbance.