Unpacking the Green Wage Premium:
The Role of Observables and Unobservables in the Wages of the Green Jobs

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Motivation

- Concern with the environment and green transition
  - Paris Agreement 2015;
  - Resolution of the Council of Ministers No. 107/2019 - Roadmap to Carbon Neutrality 2050 - 90% of GHG until 2050;
  - Resolution of the Council of Ministers No. 53/2020 - National Energy and Climate Plan 2030 - 32.5% of energy consumption and 40% of GHG until 2030.

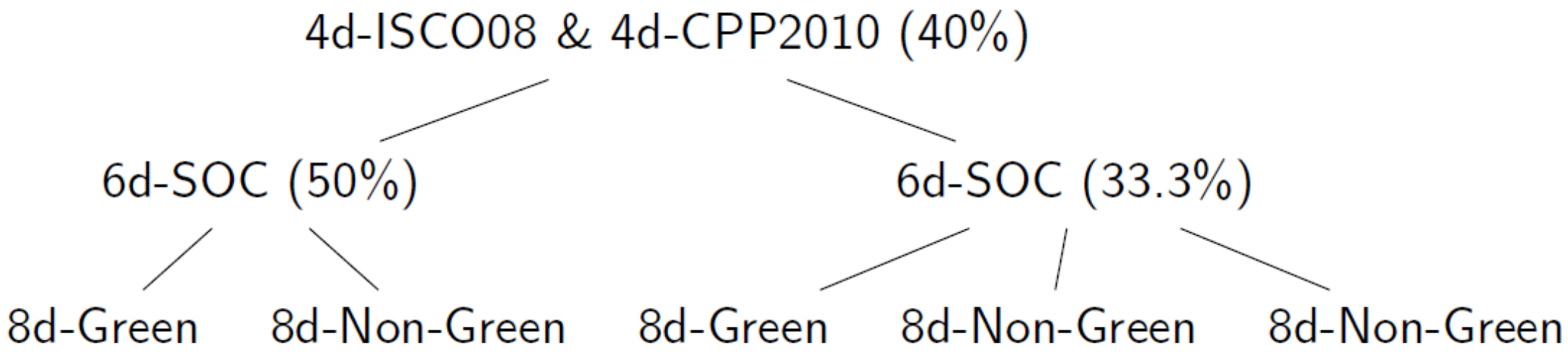
- Worldwide rising popularity of green employment measurement issues
  - Institutional - European Commission (2007), Eurostat (2009), Bezdek (2009), US Department of Commerce (2010), BLS (2012; 2013), Ecorys (2012), BIS (2013), IRENA (2013-2019), Office for National Statistics (2020), Eurostat (2021);
  - Independent Researchers - Consoli et al. (2016), Bowen et al. (2018), Vona et al. (2018), Bowen and Hanck´e (2019), Georgeson and Maslin (2019), Valero et al. (2021).

- Very scarce information about Portugal

Green jobs & green skills

- There is no unique definition of green jobs. However, is it possible to group them by:
  - Sector/industry (OCDE, Eurostat, US Department of Commerce, UNEP, ILO, ITUC, BIS) - Top-down approach
  - Occupation, task and skill (O*NET and ESCO) - Bottom-up approach
- Dierdorff et al. (2009), under O*NET program ”Green Economy”, issued a set of professions to whom activities and technologies of green economy will:
  - Increase demand **- Green Increased Demand Occupations**;
  - Transform the skills and requirements needed to execute the tasks - **Green Enhanced Skills Occupations**;
  - Create new and unique jobs - **Green New and Emerging Occupations**.
- O*NET also issues a list of green tasks resulting from changes in work and worker requirements due to the impact of green activities and technologies.

Green occupations: from O*NET to ISCO08/CPP2010



Dataset

- *Quadros de Pessoal* dataset
  - Longitudinal data set (LEED) that matches firms and workers;
  - Collected through a mandatory annual survey provided by the Ministry of Employment and Social Security;
  - Aggregates individual demographic and job information about workers from the private sector;
  - A unique fictitious number identifies each worker and firm where they are employed. Thus they are unrecognizable but traceable.

Dataset 1: All workers

	Mean	SD	Min	Max	N
Time spawn					
Year	2015	3	2010	2019	16368859
Green Measures					
Continuous measure	0.14	0.26	0.00	1.00	16368859
Binary measure	0.13	0.34	0.00	1.00	16368859
Socioeconomics indicators					
Age	40.14	10.62	17.00	67.00	16368859
Tenure	8.78	9.10	0.00	55.00	16368859
Potential experience	24.17	12.39	0.00	57.00	16368859
Woman	0.43	0.49	0.00	1.00	16368859

Dataset 1: All workers – green jobs characteristics

	(1)	(2)	(3)
Green Jobs	by Green Skills	by Green Tasks	by Green Occupations
Age (between 25 - 44)	0.016***	-0.018***	0.018***
	(0.000)	(0.000)	(0.000)
Age (older than 44)	0.019***	-0.006***	0.026***
	(0.000)	(0.000)	(0.000)
Women	-0.022***	-0.042***	-0.084***
	(0.000)	(0.000)	(0.000)
Secondary	0.008***	0.008***	-0.015***
	(0.000)	(0.000)	(0.000)
Higher Education	0.059***	0.060***	0.046***
	(0.000)	(0.000)	(0.000)

Dataset 1: All workers – green jobs characteristics

Effective Contract	-0.007***	-0.000*	-0.017***
	(0.000)	(0.000)	(0.000)
Wage (ln)	0.009***	0.050***	0.048***
	(0.000)	(0.000)	(0.000)
Social Capital (ln)	0.001***	-0.004***	-0.003***
	(0.000)	(0.000)	(0.000)
No. Employees (1/1000)	-0.005***	-0.000***	-0.005***
	(0.000)	(0.000)	(0.000)
Share of Foreign Capital (1/100)	0.029***	0.039***	0.093***
	(0.002)	(0.002)	(0.002)
Firm age (2-5 years)	0.000***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)
Firm age (more than 5 years)	-0.002*	0.005***	-0.000*
	(0.000)	(0.000)	(0.000)
Fixed effects	Yes	Yes	Yes
Observations	19688673	19688673	19688673

Green and non-green jobs average real hourly wage (€)

All workers (base year = 2016)

(a) Base and total income

(b) Difference

Dataset 2: Displaced workers

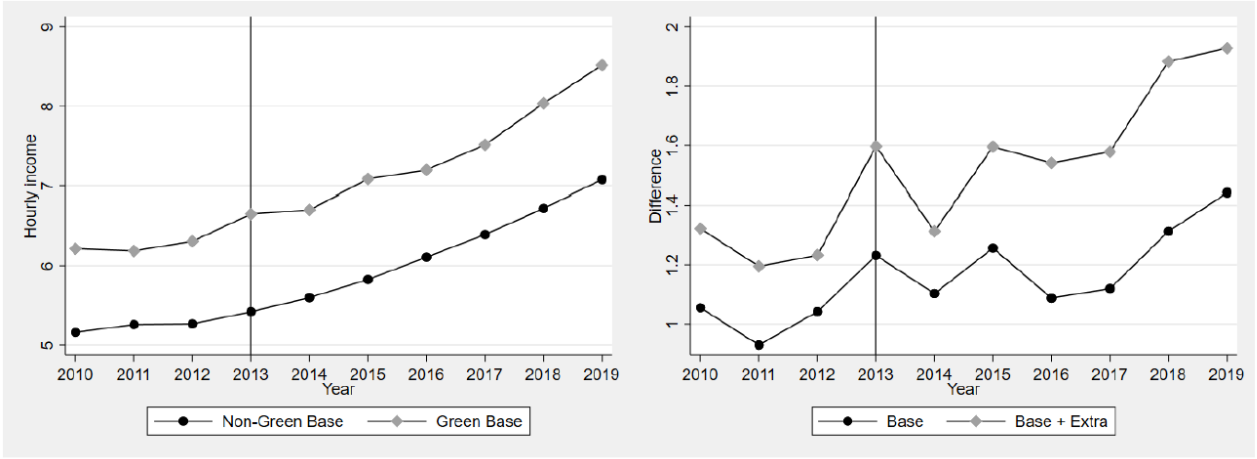
Sample of displaced workers due to firm closures, to reduce the problems generated by endogenous worker–firm mobility.

	Mean	SD	Min	Max	N
Time spawn					
Year	2015	3	2010	2019	174652
Greenness Share					
Continuous measure	0.15	0.25	0.00	1.00	174652
Binary measure	0.13	0.34	0.00	1.00	174652
Socioeconomics indicators					
Age	41.18	8.56	17.00	67.00	174652
Tenure	8.18	7.82	0.00	52.00	174652
Potential experience	24.72	10.25	0.00	57.00	174652
Woman	0.39	0.49	0.00	1.00	174652

Green and non-green jobs average real hourly wage (€)

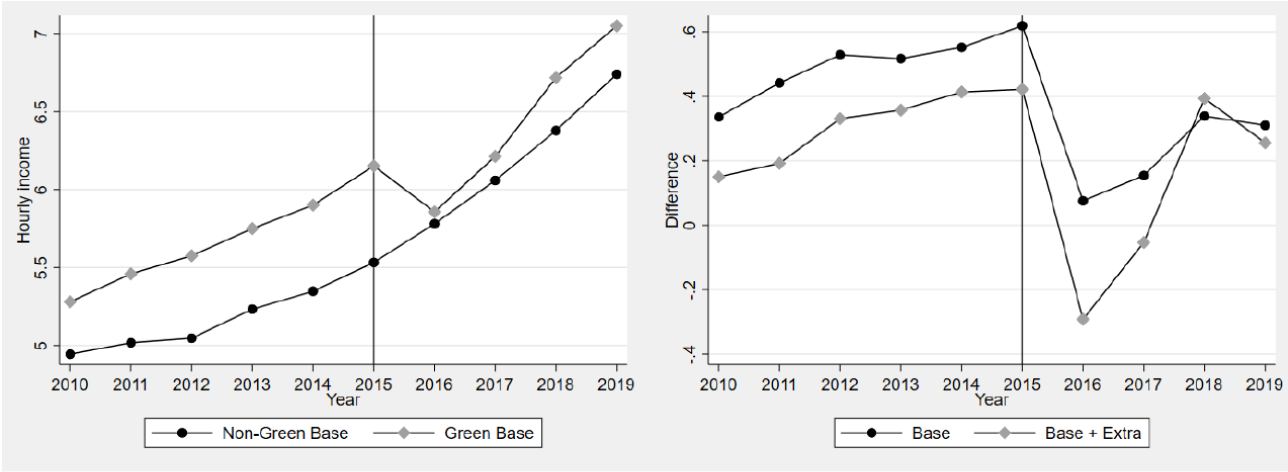
Displaced workers (base year = 2016)

Displaced in 2013



(a) Base and total income (b) Difference

Displaced in 2015



(a) Base and total income (b) Difference

The green wage premium

Model 1

$$\ln(HW_{ift}) = \delta G_{ift} + \mathbf{X}'_{ift}\boldsymbol{\beta} + \alpha_i + \theta_f + \tau_t + \varepsilon_{ift}$$

Hourly wage

"Degree of greenness"

Observable characteristics

Worker f.e.

Firm f.e.

Time f.e.

The green wage premium - Model 1

Table 5: Green wage premium.

	OLS		FE		HDFE	
	Binary	Continuous	Binary	Continuous	Binary	Continuous
Green measure	0.113***	0.187***	0.017***	0.026***	0.018***	0.024***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Secondary	0.249***	0.251***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Higher education	0.747***	0.750***	0.076***	0.076***	0.064***	0.064***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Tenure	0.008***	0.008***	0.005***	0.005***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tenure^2(1/1000)	0.070***	0.065***	-0.133***	-0.133***	-0.137***	-0.137***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Potential experience	0.026***	0.026***	0.010***	0.010***	0.011***	0.011***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Potential experience^2(1/1000)	-0.376***	-0.375***	-0.263***	-0.263***	-0.243***	-0.243***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

The green wage premium - Model 1

Type of contract	0.066***	0.068***	0.033***	0.033***	0.032***	0.032***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Productivity (Ln)	0.084***	0.083***	0.024***	0.024***	0.009***	0.009***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Social capital (Ln)	0.025***	0.025***	0.005***	0.005***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of employees (1/1000)	-0.004***	-0.004***	-0.002***	-0.002***	0.006***	0.006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ownership status (1/100)	1.336***	1.286***	0.494***	0.492***	0.037***	0.036***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Intercept	-0.270***	-0.260***	1.280***	1.279***	1.481***	1.480***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Firm Fixed Effect	No	No	No	No	Yes	Yes
Worker Fixed Effect	No	No	Yes	Yes	Yes	Yes
Industry Fixed Effect	No	No	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	Yes	Yes	Yes	Yes
Observations	16249392	16249392	16238966	16238966	16230175	16230175
R^2	0.522	0.524	0.946	0.946	0.955	0.955

Green wage premium decomposition

Table 2: Two fold Blinder-Oaxaca decomposition.

	Workers and firms	With skills	With industries
Green jobs	1.905***	1.905***	1.905***
	(0.000)	(0.000)	(0.000)
Non-green jobs	1.725***	1.725***	1.725***
	(0.000)	(0.000)	(0.000)
Difference	0.180***	0.180***	0.180***
	(0.000)	(0.000)	(0.000)
Explained	0.112***	0.116***	0.127***
	(0.000)	(0.000)	(0.000)
Unexplained	0.068***	0.065***	0.053***
	(0.000)	(0.000)	(0.000)
Observations	16249392	16249392	16249392

Standard errors in parentheses

The green wage premium

Model 2

$$\ln\left(HW_{ift}\right) = \mathbf{X}'_{ift}\boldsymbol{\beta}^{G,NG} + \alpha_i + G_{ift} \times \alpha_i + \theta_f + \tau_t + \epsilon_{ift}$$

In matrix form:

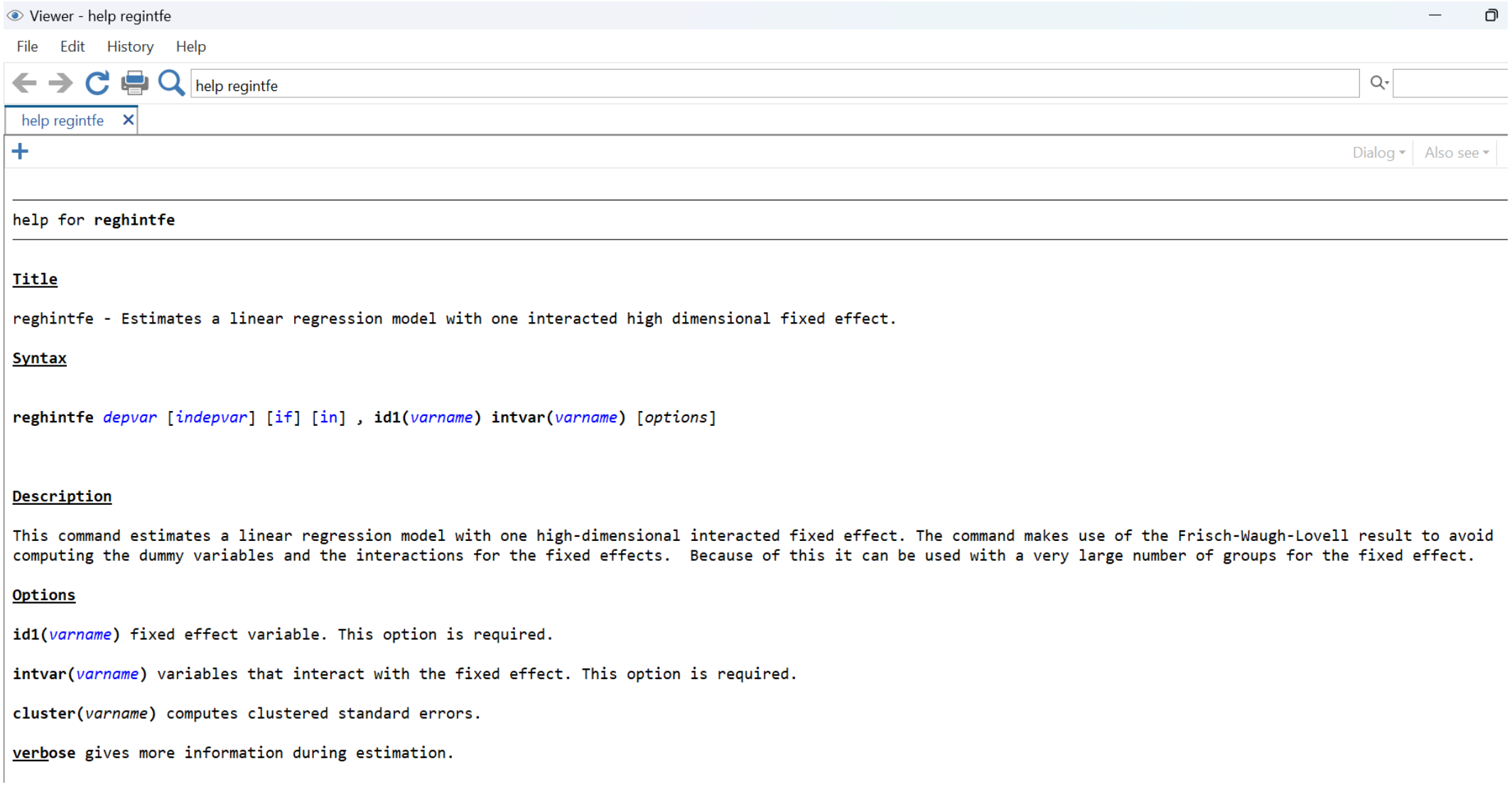
$$\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{D}\boldsymbol{\alpha} + \mathbf{G}\mathbf{D}\boldsymbol{\gamma} + \boldsymbol{\varepsilon}$$

Estimation model 2

- Apply the Frisch–Waugh–Lovell (FWL) theorem:
  - Expurgate from **Y** and **X** the effect of **D** and **GD**.
  - Calculate the residuals $\mathbf{e_Y}$=**MY** and $\mathbf{e_X}$ =**MX** where **M** is the projection matrix **M**=**I**-**Z**(**Z**'**Z**)**Z**' with **Z**=[**D GD**]
  - By the FWL theorem a regression of $\mathbf{e_Y}$ on $\mathbf{e_X}$ yields the OLS estimate of β.
  - The estimates for α and γ are obtained similarly.

- We can do this using the STATA command `regintfe`, a Stata module to estimate a linear regression model with one interacted high dimensional fixed effect, by Paulo Guimarães and Pedro Portugal (2010). "A Simple Feasible Alternative Procedure to Estimate Models with High-Dimensional Fixed Effects", Stata Journal, 10(4), 628-649.

Estimation model 2 - command `regintfe`



help for **reghintfe**

Title

reghintfe - Estimates a linear regression model with one interacted high dimensional fixed effect.

Syntax

reghintfe *depvar* [*indepvar*] [**if**] [**in**] , **id1**(*varname*) **intvar**(*varname*) [*options*]

Description

This command estimates a linear regression model with one high-dimensional interacted fixed effect. The command makes use of the Frisch-Waugh-Lovell result to avoid computing the dummy variables and the interactions for the fixed effects. Because of this it can be used with a very large number of groups for the fixed effect.

Options

id1(*varname*) fixed effect variable. This option is required.

intvar(*varname*) variables that interact with the fixed effect. This option is required.

cluster(*varname*) computes clustered standard errors.

verbose gives more information during estimation.

Results model 2

- Negative correlation between α and γ:

$$\rho_{\alpha\gamma} = -0{,}21^{***}$$

returns to unobservable workers' skills decrease with the degree of the greenness of occupations

The green wage premium – Displaced workers sample

Table 8: Green wage premium displaced workers.

	OLS		FE		HDFE	
	Binary	Continuous	Binary	Continuous	Binary	Continuous
Green measure	0.128***	0.216***	0.014***	0.029***	0.014***	0.024***
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
Secondary	0.210***	0.209***	0.019***	0.019***	-0.002	-0.002
	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)
Higher education	0.632***	0.633***	0.055***	0.055***	0.030***	0.030***
	(0.003)	(0.003)	(0.007)	(0.007)	(0.006)	(0.006)
Tenure	-0.002***	-0.002***	0.002***	0.002***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tenure^2(1/1000)	0.247***	0.240***	-0.102***	-0.102***	-0.112***	-0.112***
	(0.011)	(0.011)	(0.007)	(0.007)	(0.008)	(0.008)
Potential Experience	0.036***	0.036***	0.011***	0.011***	0.013***	0.013***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Potential experience^2(1/1000)	-0.512***	-0.510***	-0.247***	-0.247***	-0.263***	-0.263***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)

$\rho_{\alpha\gamma}$=–0,170***

Results are robust to endogenous worker occupation mobility

Summary and conclusions

- Workers in green jobs receive on average 11% more than (observable) similar workers in non-green occupations;
- Moving to a green(er) occupation have a positive impact on wages;
- Returns to unobservable workers' abilities decrease as the degree of "greenness" of an occupation increases.
- Further research is needed to explain the later result.