



How many jobs can EU CBAM save ? A regional perspective

Sigit Perdana *, Marc Vielle *

18th IAEE European Conference,
Milan, Italy, July 25th, 2023

* École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Background

- **EU Climate Neutrality & Fit 55:** Energy transition with social impacts;
 - Conventional Narrative of **Carbon Border Adjustment Mechanism (CBAM):** competitiveness, welfare and leakage;
 - Besides competitiveness: Political Acceptability of CBAM related to **Regional Employment;**
 - Broad consensus: policies impact differently across regions and sectors;
 - Most negatively impacted sectors are fossil energy sectors and energy-intensive industries;
 - Political resistance to climate policy tends to be more pronounced in these regions.
-

Research Aim, methods & scenarios development

Research Question: What are the impacts of the Fit for 55 on jobs at EU regional level?

- We run scenario of **the fit for 55 without/ with CBAM**
 - We couple GEMINI-E3-EU27+UK with regional statistics
 - We look to exposed regions and regional vulnerability in EU's energy transition
 - Horizon 2030
-

Methodology

- GEMINI-E3 with 27 MS + UK + China +ROW
- GTAP 9 database, base year 2011
- Regional database based on Eurostat with NUTS 2
- 278 European regions (including UK)
- We look on fossil energy sectors and energy intensive industries (EII)
- Which regions are still vulnerable post CBAM implementation

Mapping between Eurostat and GEMINI-E3

Table 1: Mapping between GEMINI sector and NOGA classification

GEMINI-E3 sector	Noga code	Noga Definition
Energy Intensive Industries	C17	Manufacture of paper and paper products
	C20	Manufacture of chemicals and chemical products
	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
	C22	Manufacture of rubber and plastic products
	C23	Manufacture of other non-metallic mineral products
	C24	Manufacture of basic metals
	C25	Manufacture of fabricated metal products, except machinery and equipment
Coal	B05	Mining of coal and lignite
Crude oil Natural gas	B06	Extraction of crude petroleum and natural gas
Refined petroleum products	C192	Manufacture of refined petroleum products

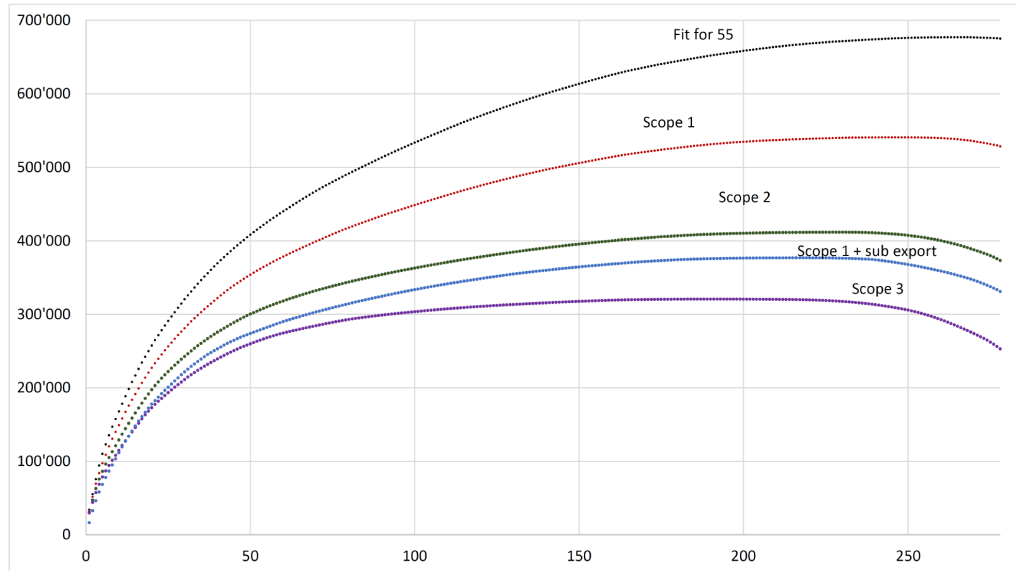
Scenarios

- Reference scenario
- Fit for 55
- Fit for 55 with CBAM scope 1
- Fit for 55 with CBAM scope 1 + sub export
- **Fit for 55 with CBAM scope 2**
- Fit for 55 with CBAM scope 3

Macro-economic aggregates

	Without CBAM	Scope 1	Scope 1 + Export	Scope 2	Scope 3
GDP	-1.89%	-1.85%	-1.90%	-1.82%	-1.80%
ETS Price (in €₂₀₂₂)	98	101	102	104	106
Leakage Rate	20.80%	18.70%	19.00%	16.70%	12.50%
EII Production	-9.30%	-7.70%	-5.90%	-5.90%	-4.60%
Employment (Job FTE)					
EII	-491,689	-362,878	-220,773	-225,793	-117,683
Fossil Industries	-156,874	-155,994	-193,153	-155,131	-153,401

Cumulative Job losses per region – EU27+UK



Scope 2: The top 50 regions account for 80% of job losses

Regional Vulnerability Concept

IPCC's conceptual framework for vulnerability:

- Exposure to some source of disruption
- Sensitivity to that disruption
- Adaptive capacity to respond and recover

$$Vulnerability = I_e^{\alpha_e} \cdot I_u^{\alpha_u} \cdot (1 - I_a)^{\alpha_a}$$

Climatic Change (2023) 176:7
<https://doi.org/10.1007/s10584-022-03478-w>



Mapping regional vulnerability in Europe's energy transition: development and application of an indicator to assess declining employment in four carbon-intensive industries

Will McDowall¹ · Tobias Reinauer² · Panagiotis Fragkos³ · Michal Miedzinski¹ · Jennifer Cronin¹

I_e Exposed indicator

I_u Unemployment indicator

I_a Adaptive capacity indicator

Most exposed regions (Fit for 55) Year 2030

Expected declines in sectoral related employment

$$Exposure = \frac{Job\ Loss}{Employment}$$

Germany = 28 regions













































Austria = 5 regions

- **Dytiki Macedonia:**
Energy Heart of Greece
- Major centre of coal and lignite
- **Slaskie:** one most carbon-intensive region in EU (Coal Mining, Metalurgic and Chemical)
- **Yugoiztochen:** Fossil Energy Industries leading sectors

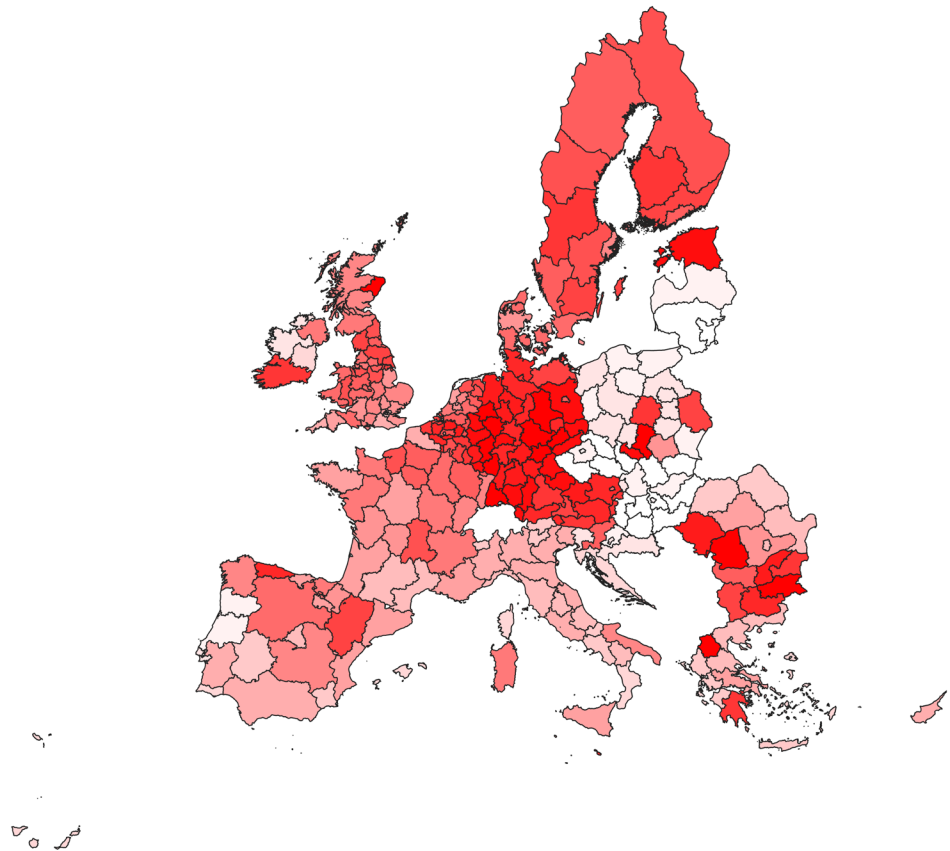
NUTS	Country	Regions	Expos.	#	NUTS	Country	Regions	Expos.	#
EL53		Dytiki Makedonia	3.92%	1	EE00		Eesti	0.78%	26
PL22		Slaskie	1.96%	2	BE31		Brabant Wallon	0.77%	27
BG34		Yugoiztochen	1.56%	3	DE40		Brandenburg	0.76%	28
DEA5		Arnsberg	1.20%	4	DE23		Oberpfalz	0.76%	29
DEB3		Rheinhessen-Pfalz	1.06%	5	DE12		Karlsruhe	0.72%	30
UKM5		North East. Scotland	1.02%	6	DEA4		Detmold	0.71%	31
DEA3		Münster	1.02%	7	DEA2		Köln	0.71%	32
DE13		Freiburg	1.01%	8	DE94		Weser-Ems	0.69%	33
RO41		Sud-Vest Oltenia	1.00%	9	DEB2		Trier	0.66%	34
DEG0		Thüringen	1.00%	10	DE26		Unterfranken	0.63%	35
DE24		Oberfranken	0.98%	11	DE25		Mittelfranken	0.61%	36
DEE0		Sachsen-Anhalt	0.97%	12	BE22		Limburg	0.59%	37
DEB1		Koblenz	0.97%	13	BG32		Severen tsentralen	0.59%	38
CZ04		Severozápad	0.95%	14	DE11		Stuttgart	0.58%	39
AT34		Vorarlberg	0.94%	15	AT12		Niederösterreich	0.57%	40
DED4		Chemnitz	0.92%	16	AT22		Steiermark	0.57%	41
CZ08		Moravskoslezsko	0.92%	17	DE92		Hannover	0.56%	42
DE14		Tübingen	0.89%	18	RO42		Vest	0.56%	43
DEC0		Saarland	0.87%	19	SE31		Norra Mellansverige	0.54%	44
DE22		Niederbayern	0.84%	20	UKD1		Cumbria	0.54%	45
DE72		Gießen	0.84%	21	BE21		Antwerpen	0.53%	46
DED2		Dresden	0.82%	22	UKE1		East Yorkshire, North. Lincolnshire	0.50%	47
DEA1		Düsseldorf	0.82%	23	BG42		Yuzhen tsentralen	0.49%	48
DE27		Schwaben	0.80%	24	DE71		Darmstadt	0.49%	49
AT31		Oberösterreich	0.78%	25	AT33		Tirol	0.49%	50

Most exposed regions (Fit for 55 with CBAM Scope 2) Year 2030

- Relatively No significant change for the TOP 50 exposed regions
- As CBAM imposed to EIU, no direct impact to employment on the Fossil Fuels Industries
- Some regions gain benefit by CBAM
- Other don't
 - North East Scotland (UK): Major Oil & Gas
 - Sud-Vest Oltenia (Romania): Lignite Mining Industry

NUTS	Country	Regions	Expos.	‡	Δ‡	NUTS	Country	Regions	Expos.	‡	Δ‡
EL53		Dytiki Makedonia	3.97%	1	-	DE23		Oberpfalz	0.57%	26	+3
PL22		Slaskie	1.77%	2	-	DEA2		Köln	0.57%	27	+5
BG34		Yugoiztochen	1.44%	3	-	CZ08		Moravskoslezsko	0.56%	28	-11
UKM5		North East, Scotland	0.95%	4	+2	BE31		Brabant Wallon	0.55%	29	-2
RO41		Sud-Vest Oltenia	0.92%	5	+4	DE12		Karlsruhe	0.55%	30	-
DEA5		Arnsberg	0.91%	6	-2	DEA4		Detmold	0.54%	31	-
DEA3		Münster	0.88%	7	-	DE94		Weser-Ems	0.53%	32	+1
DEB3		Rheinessen-Pfalz	0.81%	8	-3	AT31		Oberösterreich	0.50%	33	-8
DE13		Freiburg	0.77%	9	-1	DEB2		Trier	0.50%	34	-
DEE0		Sachsen-Anhalt	0.76%	10	+2	DE26		Unterfranken	0.48%	35	-
DEG0		Thüringen	0.76%	11	+7	DE25		Mittelfranken	0.46%	36	-
DE24		Oberfranken	0.74%	12	-1	DE11		Stuttgart	0.44%	37	+2
DEB1		Koblenz	0.73%	13	-	DE92		Hannover	0.43%	38	+4
DED4		Chemnitz	0.69%	14	+2	RO42		Vest	0.43%	39	+4
DED2		Dresden	0.68%	15	+7	BE22		Limburg	0.42%	40	-3
DE14		Tubingen	0.68%	16	+2	BE21		Antwerpen	0.41%	41	+5
DEC0		Saarland	0.67%	17	+2	BG32		Severen tsentralen	0.40%	42	-4
DE22		Niederbayern	0.64%	18	+2	DED5		Leipzig	0.39%	43	+9
DEA1		Düsseldorf	0.64%	19	+4	MT00		Malta	0.38%	44	+9
DE72		Gießen	0.64%	20	+1	AT12		Niederösterreich	0.38%	45	-5
DE40		Brandenburg	0.64%	21	+7	DE71		Darmstadt	0.37%	46	+3
EE00		Eesti	0.63%	22	+4	AT22		Steiermark	0.36%	47	-6
DE27		Schwaben	0.61%	23	+1	DE91		Braunschweig	0.35%	48	+8
AT34		Vorarlberg	0.60%	24	-9	DE93		Lüneburg	0.34%	49	+6
CZ04		Severozápad	0.60%	25	-11	BG42		Yuzhen tsentralen	0.33%	50	-2

Most exposed regions Fit for 55 with **CBAM Scope 2**



Vulnerability Index

Sensitivity indicator:

- Region with high level of unemployment are particularly sensitive to job losses
- Eurostat Data % Unemployment Rate per Labor Force

Adaptive Capacity: Innovation Potentials

- European Regional Innovation Scoreboard (RIS) (JRC, 2019)
- RIS: innovation capacity including education, labor skill, infrastructures etc

Table 5: Top 50 vulnerable regions - Scenario: Fit for 55 with CBAM scope 2 - Year 2030

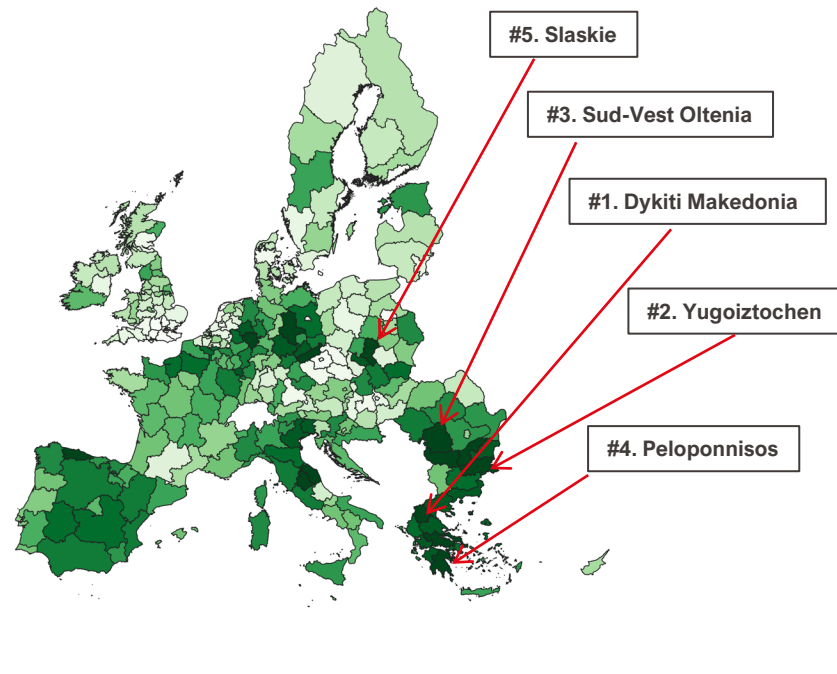
NUTS	Country	Regions	Vuln.	#	NUTS	Country	Regions	Vuln.	#
EL53		Dytiki Makedonia	0.916	1	DEG0		Thüringen	0.221	26
BG34		Yugoiztochen	0.370	2	CZ04		Severozápad	0.220	27
RO41		Sud-Vest Oltenia	0.337	3	ES43		Extremadura	0.218	28
EL65		Peloponnisos	0.278	4	ES70		Canarias	0.217	29
PL22		Slaskie	0.277	5	DECO		Saarland	0.217	30
DEE0		Sachsen-Anhalt	0.261	6	ITH4		Friuli-Venezia Giulia	0.217	31
ES12		Principado de Asturias	0.259	7	DE40		Brandenburg	0.215	32
BG31		Severozapaden	0.257	8	ES42		Castilla-la Mancha	0.214	33
ES64		Ciudad de Melilla	0.253	9	CZ08		Moravskoslezsko	0.214	34
BG32		Severen tsentralen	0.253	10	BE31		Brabant Wallon	0.213	35
ES63		Ciudad de Ceuta	0.248	11	DEA1		Düsseldorf	0.212	36
EL63		Dytiki Ellada	0.245	12	ES61		Andalucía	0.211	37
DEA5		Arnsberg	0.243	13	BE32		Hainaut	0.210	38
EL64		Stereá Ellada	0.243	14	BG42		Yuzhen tsentralen	0.201	39
EL51		Anatoliki Makedonia, Thraki	0.235	15	IT4		Lazio	0.201	40
EL61		Thessalia	0.234	16	ITH3		Veneto	0.201	41
EL52		Kentriki Makedonia	0.231	17	DED2		Dresden	0.201	42
EL54		Ipeiros	0.230	18	ES41		Castilla y León	0.199	43
EL41		Voreio Aigaio	0.229	19	DE24		Oberfranken	0.199	44
DEA3		Münster	0.229	20	ES24		Aragón	0.199	45
DED4		Chemnitz	0.227	21	RO42		Vest	0.198	46
IT3		Marche	0.227	22	EL62		Ionia Nisia	0.198	47
EL30		Attiki	0.226	23	ITH5		Emilia-Romagna	0.198	48
IT2		Umbria	0.224	24	ITG2		Sardegna	0.196	49
BG33		Severoiztochen	0.223	25	EL42		Notio Aigaio	0.196	50

Vulnerability Index Fit for 55 with CBAM Scope 2

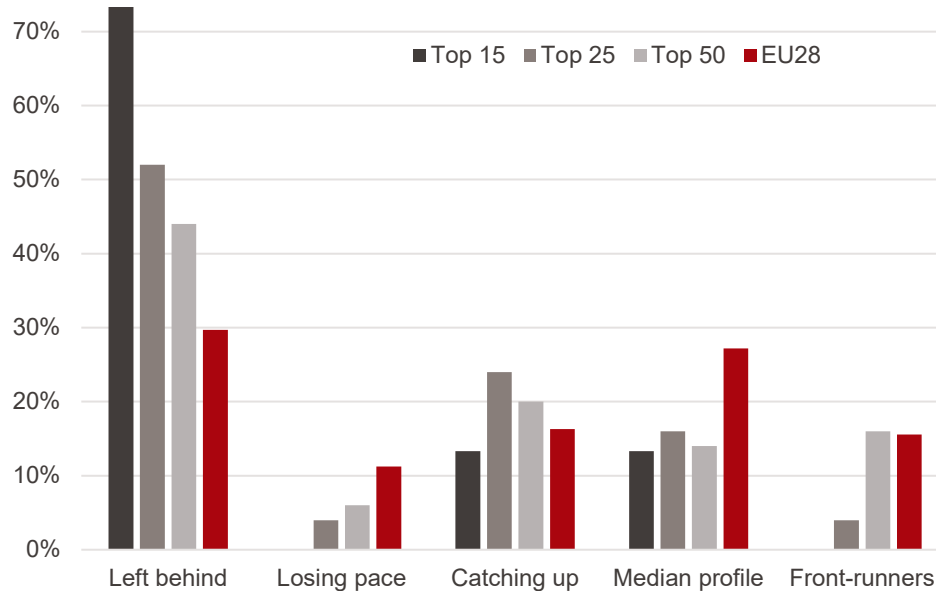
Among Top 50:

- **Greece:** 12 Regions
- **Germany:** 10 Regions
- **Spain:** 9 Regions
- **Italy:** 7 Regions
- **Bulgaria:** 5 Regions
- **Belgium, Czechia:** 2 Regions
- **Poland:** 1 Region

More regions in **Southern Europe**
(Greece, Italy, Spain)



Distribution of Top 50 Vulnerable Regions



- **Left Behind:** Low income, low-medium income growth, southeast & southern EU, UK and Central EU
- **Losing Pace:** Medium income, low income growth, all around EU, some might be left behind in long run.
- **Catching Up:** Low-Medium income, high income growth, mainly in Central EU and Peripheral Area (Scottish Highland, Galicia /Norte)
- **Median Profile:** Medium income & Income Growth, all except southeast EU
- **Front Runners:** High income, medium high income growth, capital and strong economic regions.

(<https://www.espon.eu/tools-maps/espon-database>)

Sensitivity Analysis

$$Vulnerability = I_e^{\alpha_e} \cdot I_u^{\alpha_u} \cdot (1 - I_a)^{\alpha_a}$$

- Weighted factor is exogenously chosen
- Sensitivity analysis, varying each weighted indicators (α_i) for robustness
- Total 15 Scenarios
- In Top 50: 47 common regions
- Top 4: same regions
- Top 10: 7 commons regions

Table 7: Sensibility analysis - Top 50 vulnerable regions using the median - Scenario: Fit for 55 with CBAM scope 2

NUTS	Country	Regions	Med.	#	NUTS	Country	Regions	Med.	#
EL53		Dytiki Makedonia	1	1	ES42		Castilla-la Mancha	28	26
BG34		Yugoiztochen	2	2	CZ04		Severozápad	29	27
RO41		Sud-Vest Oltenia	3	3	BG33		Severoiztochen	30	28
EL65		Peloponnisos	6	4	IT44		Friuli-Venezia Giulia	30	29
ES64		Ciudad de Melilla	6	5	DED4		Chemnitz	32	30
ES63		Ciudad de Ceuta	8	6	EL62		Ionia Nisia	32	31
EL64		Stereia Ellada	9	7	FRM0		Corse	34	32
BG31		Severozapaden	10	8	CZ08		Moravskoslezsko	35	33
BG32		Severen tsentralen	11	9	DEA3		Münster	36	34
EL63		Dytiki Ellada	11	10	BE32		Hainaut	38	35
PL22		Slaskie	12	11	IT4		Lazio	38	36
EL61		Thessalia	14	12	BG42		Yuzhen tsentralen	39	37
ES12		Principado de Asturias	15	13	ES41		Castilla y León	39	38
EL51		Anatoliki Makedonia, Thraki	15	14	IT43		Veneto	41	39
DEE0		Sachsen-Anhalt	17	15	EL42		Notio Aigaio	42	40
EL52		Kentriki Makedonia	17	16	DEC0		Saarland	43	41
EL54		Ipeiros	18	17	ITG2		Sardegna	44	42
EL41		Voreio Aigaio	19	18	DE40		Brandenburg	45	43
EL30		Attiki	20	19	DEG0		Thüringen	46	44
IT43		Marche	22	20	ES24		Aragón	46	45
ES70		Canarias	22	21	RO42		Vest	46	46
ES43		Extremadura	23	22	IT45		Emilia-Romagna	48	47
IT42		Umbria	24	23	ITG1		Sicilia	49	48
ES61		Andalucía	26	24	BE31		Brabant Wallon	51	49
DEA5		Arnsberg	27	25	FRD2		Haute-Normandie	53	50

Main findings 1/2

- Employment loss is reduced by implementing CBAM;
- In 2030, within the fit for 55, we estimate the job losses equal to 500'000 in EII and 125'000 in fossil industries;
- CBAM with scope 2 saves 250'000;
- The impacts at the regional level are quite different;
- Job loss are concentrated in number of regions;

Main findings 2/2

- Regions in Germany: most Exposed
- If we consider adaptative capacity and current unemployment, the most impacted regions would be in Greece, Spain, Italy
- Risk of increasing **Territorial Inequality**

Thanks



sigit.perdana@epfl.ch



marc.vielle@epfl.ch

Coupling GEMINI-E3 and Employment NUTS 2

$$L_{region}^{2030, scenario i} = L_{region}^{reference year} \cdot \frac{L_{country}^{2030, scenario i}}{L_{country}^{reference year}}$$

with region \in country (1)

reference year \in [2016, 2018]

and scenario \in [reference, fit for 55, scope 2]

Table 9: Fit for 55 scenario percentage change wrt to reference scenario in 2030

	EII production	EEI employment	GDP	Welfare	DWL
AUT	-13.9%	-26	-2.50%	0.65%	-5.29%
BEL	-12.9%	-22	-2.47%	-0.15%	-4.65%
CYP	-6.3%	0	-1.26%	2.23%	-1.07%
CZE	-2.9%	-3	-0.92%	-3.33%	-2.08%
DNK	-8.1%	-5	-2.39%	1.85%	-5.67%
EST	-22.2%	-4	-3.76%	10.74%	-5.80%
FIN	-9.6%	-8	-2.27%	-3.12%	-4.29%
FRA	-7.8%	-65	-1.72%	-0.91%	-3.14%
DEU	-19.3%	-306	-3.19%	-2.18%	-6.92%
GRC	-7.5%	-3	-0.23%	-1.36%	-0.42%
HUN	-0.8%	2	-0.71%	-1.76%	-1.10%
IRL	-1.9%	-1	-1.10%	0.01%	-5.21%
ITA	-5.1%	-41	-1.10%	-1.30%	-1.81%
LAT	-1.1%	0	-0.79%	-2.53%	-0.80%
LIT	1.1%	1	-0.41%	-3.02%	-0.51%
LUX	-18.6%	-6	-2.62%	7.16%	-5.38%
MLT	-18.5%	-2	-2.56%	14.48%	-0.43%
NLD	-9.8%	-23	-2.59%	3.64%	-6.32%
POL	-3.4%	-10	-1.42%	-3.05%	-2.26%
POR	-2.7%	-3	-0.45%	-0.89%	-0.61%
SVK	-4.3%	-3	-0.99%	-3.99%	-1.50%
SVN	-3.7%	-1	-1.11%	-2.14%	-1.78%
SPN	-5.8%	-35	-0.61%	-0.80%	-1.02%
SWE	-8.3%	-13	-2.06%	-1.69%	-4.65%
BGR	-14.5%	-20	-1.56%	-6.12%	-2.13%
ROU	-14.5%	-13	-1.04%	-3.14%	-1.37%
HRV	-14.5%	-1	-0.81%	-2.37%	-0.90%
EU-27	-9.3%	-612	-1.89%	-1.15%	-3.80%
GBR	-10.4%	-89	-1.36%	-1.81%	-2.32%

Production changes at MS level

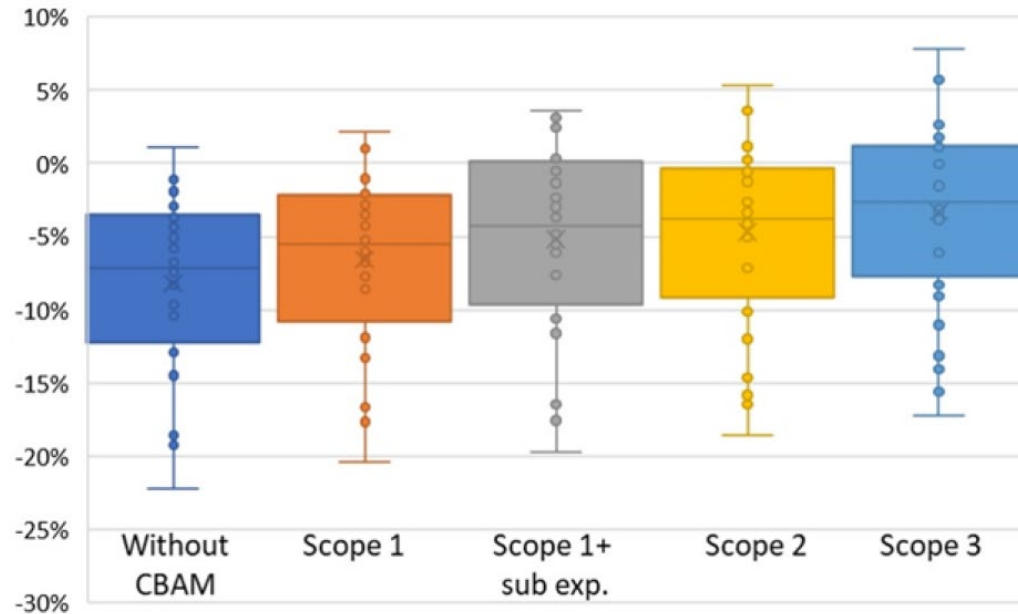
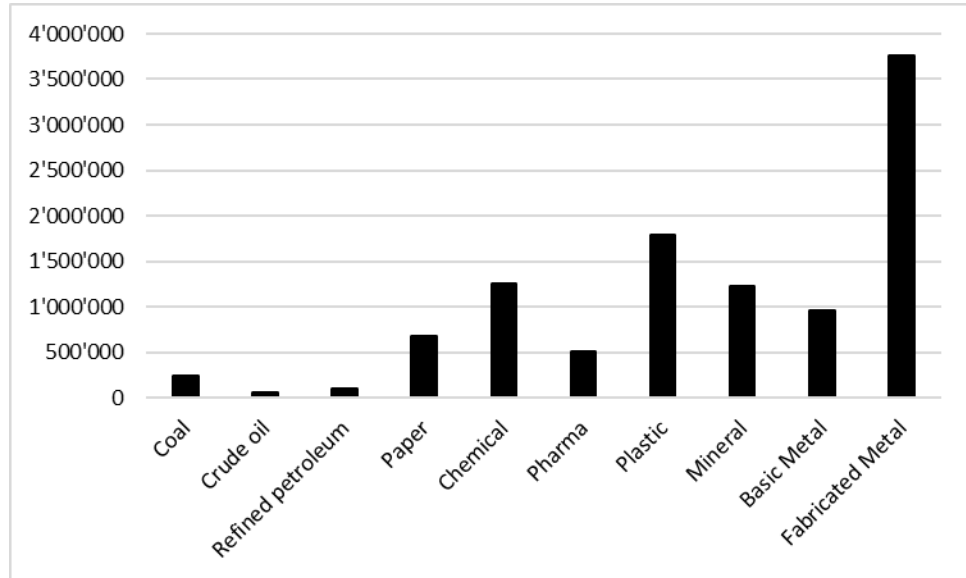


Figure 1: Box and Whisker Plot of EII production change wrt to the reference scenario

Industrial Employments directly linked to the energy transition in 2018 (EU27+UK)

**10.6
million
jobs (FTE)**



Adaptative capacity

Based on Regional Innovation Scoreboard

- Population with tertiary education
- Lifelong learning
- International scientific co-publications
- Most-cited publications
- Digital skills
- R&D expenditures public sector
- R&D expenditures business sector
- Non-R&D innovation expenditures
- Innovation expenditures per person employed
- IT specialists
- Product process innovators
- Business process innovators
- Innovative SMEs collaborating with others
- Public-private co-publications
- PCT patent applications
- Trademark applications
- Design applications
- Employment knowledge-intensive activities
- Employment in innovative SMEs
- Sales of new-to-market and new-to-firm innovations
- Air emissions by fine particulates



Correlation Between Vulnerability and EU Scepticism

- Schraff, Dominik, Ioannis Vergioglou, and Buket Buse Demirci. "The European NUTS-level election dataset: A tool to map European electoral geography." *Party Politics* 29, no. 3 (2023): 570-579.
- Deviation of Regional Vote Share (%) to the country average, 1990-2020
- Merge the EU-NED and Populist datasets (Rooduijn et al.,2019)

	Vulnerability/eu scept	Vulnerability /popu	Vulnerability /fright
DE	0.40	0.40	0.42
FR	0.60	0.60	0.66
IT	-0.06	-0.20	0.30
UK	0.21	0.39	0.39
SP	0.49	0.49	0.49
PL	0.22	0.22	0.22
BE	0.84	0.91	0.91
AT	-0.22	-0.22	-0.22
BG	0.17	0.08	0.17
CZ	0.82	0.83	0.76
EL	-0.21	-0.10	0.07
DK	0.34	0.82	0.82
FI	-0.15	-0.15	-0.15
HU	0.18	0.18	0.18
NL	0.07	0.19	0.00
SE	0.67	0.61	0.61
SK	-0.10	0.97	0.76