

EU Bioeconomies and Sustainable Development

Measuring the Contribution of EU Bioeconomies to Sustainable Development

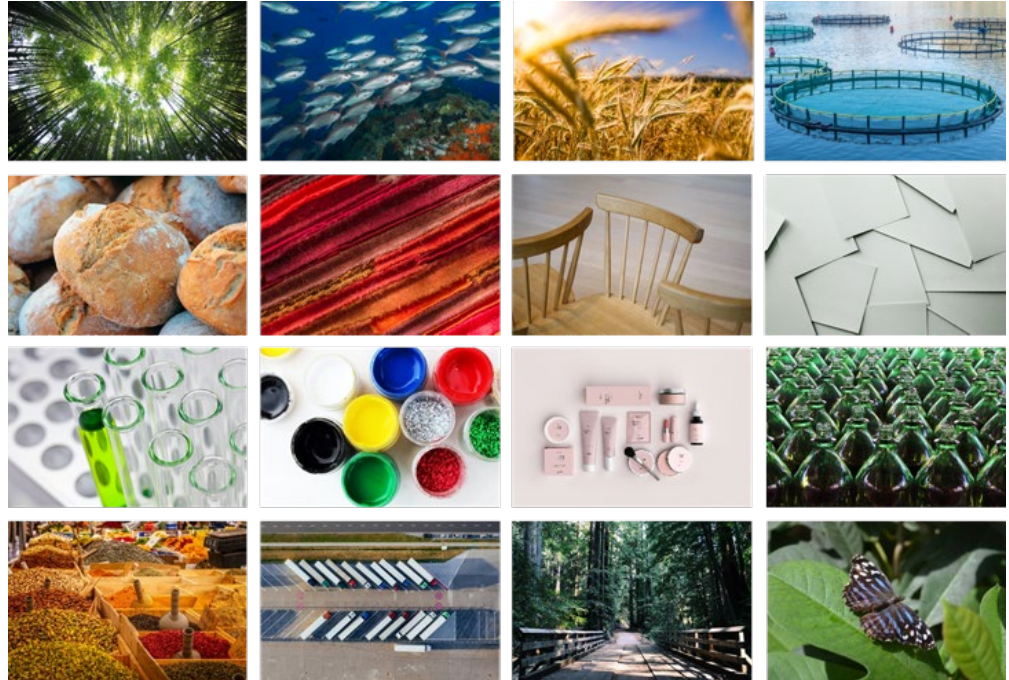
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What is the BioEconomy

EU definition

Bioeconomy encompasses all sectors and associated services and investments that produce, use, process, distribute or consume biological resources, including ecosystem services. From the food we eat to the furniture in our house and the clothes we wear, the bioeconomy, as one of the Union's largest sectors, is already present in our daily lives. Bioeconomy can be the natural enabler and result of the European Green Deal transformation.



EU Green Deal

- “Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, the European Green Deal will transform the EU into a **modern, resource-efficient and competitive economy**, ensuring:
 - - no net emissions of greenhouse gases by 2050
 - - economic growth decoupled from resource use
 - - no person and no place left behind”

0.6 trillion euro investments from the NextGenerationEU Recovery Plan, and the EU’s seven-year budget.

1.0 trillion in total with private sector.

EU BioEconomy Strategy Objectives



Bioeconomy and Sustainable Development

- Assessing well-being goes beyond GDP
- Policy makers promote bioeconomy to contribute meaningfully to societal wellbeing
- Indicators linking bioeconomy development to sustainable development needed

Bioeconomy and Sustainable Development

- Uncertainty not an issue with reversible costs
- Irreversibility causing a problem
- How much irreversibility to tolerate when future benefits and costs are uncertain?
- Opportunity costs need to be considered (Arrow et al., 2003)

Sustainable Investment

- Sustainability related investment projects characterized by the following features:
 - **Irreversibility:** The investments' costs are partially or completely irreversible (i.e. sunk costs)
 - **Uncertainty:** The investment's expected future rewards are uncertain
 - **Flexibility:** The investment's timing is flexible (e.g. Arrow and Fisher, 1974; McDonald and Siegel, 1984; Dixit and Pindyck, 1994; Trigeorgis, 1996; Wessler and Zhao, 2018; ...)

Research Objective

Measure the sustainability of the bioeconomy

- Develop two indicators for sustainable development of the bioeconomy
- Based on Arrow et al.'s proposal on genuine investment
- Considering irreversibility and uncertainty explicitly

Compare the sustainability in EU Member States ex-post

- EU-28
- *Between 2005 and 2015*

Genuine Investment under Uncertainty, Irreversibility, and Flexibility

- Standard result of the model (skipping the Math) provides standard threshold function \hat{V}^* :

$$\hat{V}^* = \frac{\beta_1}{\beta_1 - 1} I$$

Hurdle rate

- $\beta_1 > 1; \frac{\beta_1}{\beta_1 - 1} > 1$
- \hat{V}^* current minimum value of investment project justifying immediate implementation
- I irreversible costs of the investment project

Genuine Investment under Uncertainty, Irreversibility, and Flexibility

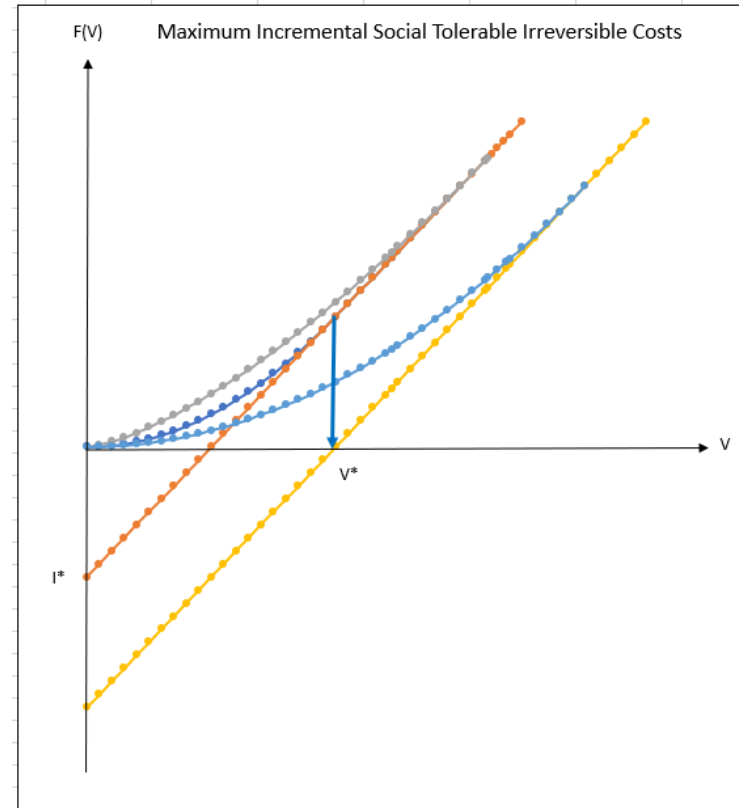
- Reversing the model
- Assessing future benefits and costs: differentiation between reversible and irreversible

- $$I^* = \frac{V}{\beta_1/(\beta_1-1)} - IB$$

V: reversible benefits in NPV of “new policy”

IB: irreversible benefits of “new policy”

I*: **m**aximum **i**ncremental **s**ocial **t**olerable **i**rreversible **c**osts (MISTICs)



Data

- Value of investments into bioeconomy sectors from Cingiz et al. (2021):
 - Bio-based share of value added for 28 EU MS and 36 sectors from 2005 to 2015 using Input-Output tables
- Risk-adjusted discount rate of 10.5% (for the time being)
- Riskless rate of return calculated by the ten-year average long-term interest rate from OECD
- OECD's Air Emission Accounts provided by ISIC Rev. 4 activities

MISTICs Average per Year

$$MISTIC_{sjk} = \frac{\beta_{1jk} - 1}{\beta_{1jk}} * \Delta VA_{jk} - \Delta VA_{jk} * (\chi_{1j} - \chi_{2j}) * CO_2price,$$

$\frac{\beta_1 - 1}{\beta_{1jk}}$ the reverse hurdle rate for sector j and country k ,

ΔVA_{jk} the average yearly change in added bioeconomy value added,

$(\chi_{1j} - \chi_{2j})$ the marginal effect of an additional unit of (non-) bioeconomy value added on gg emissions,

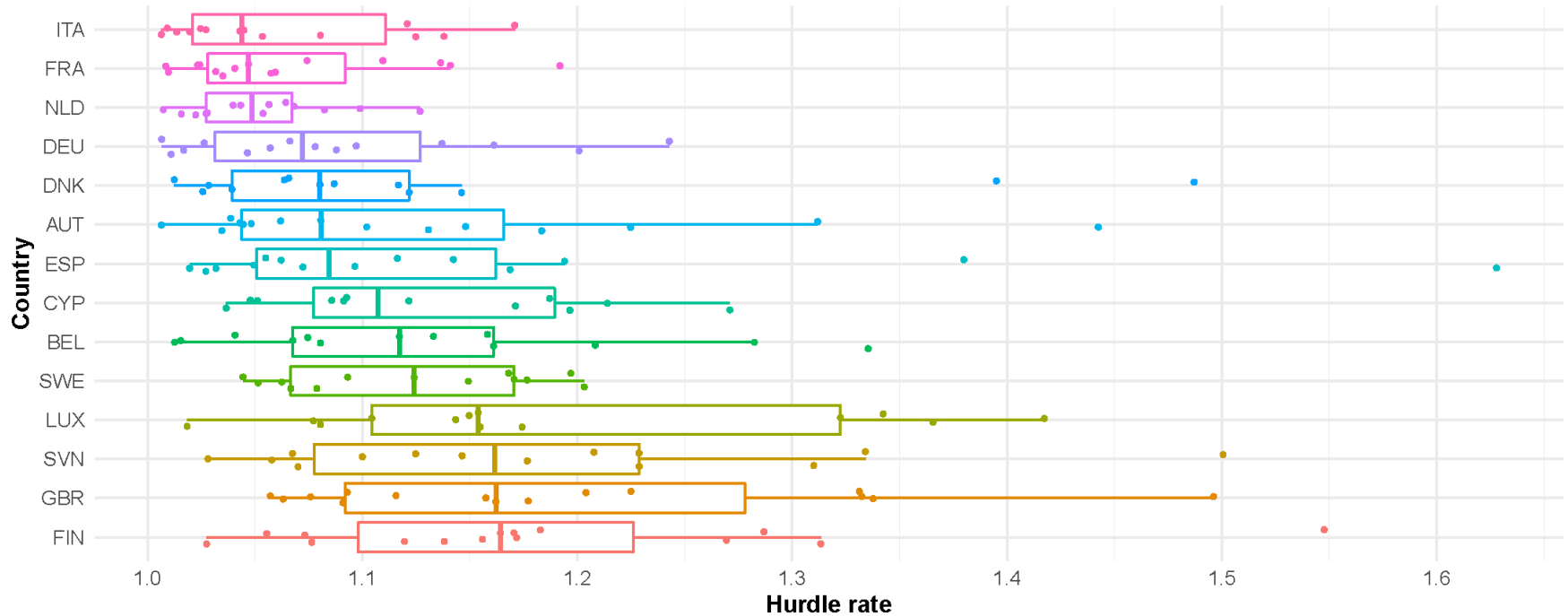
CO_2price the social cost of carbon dioxide.

Results

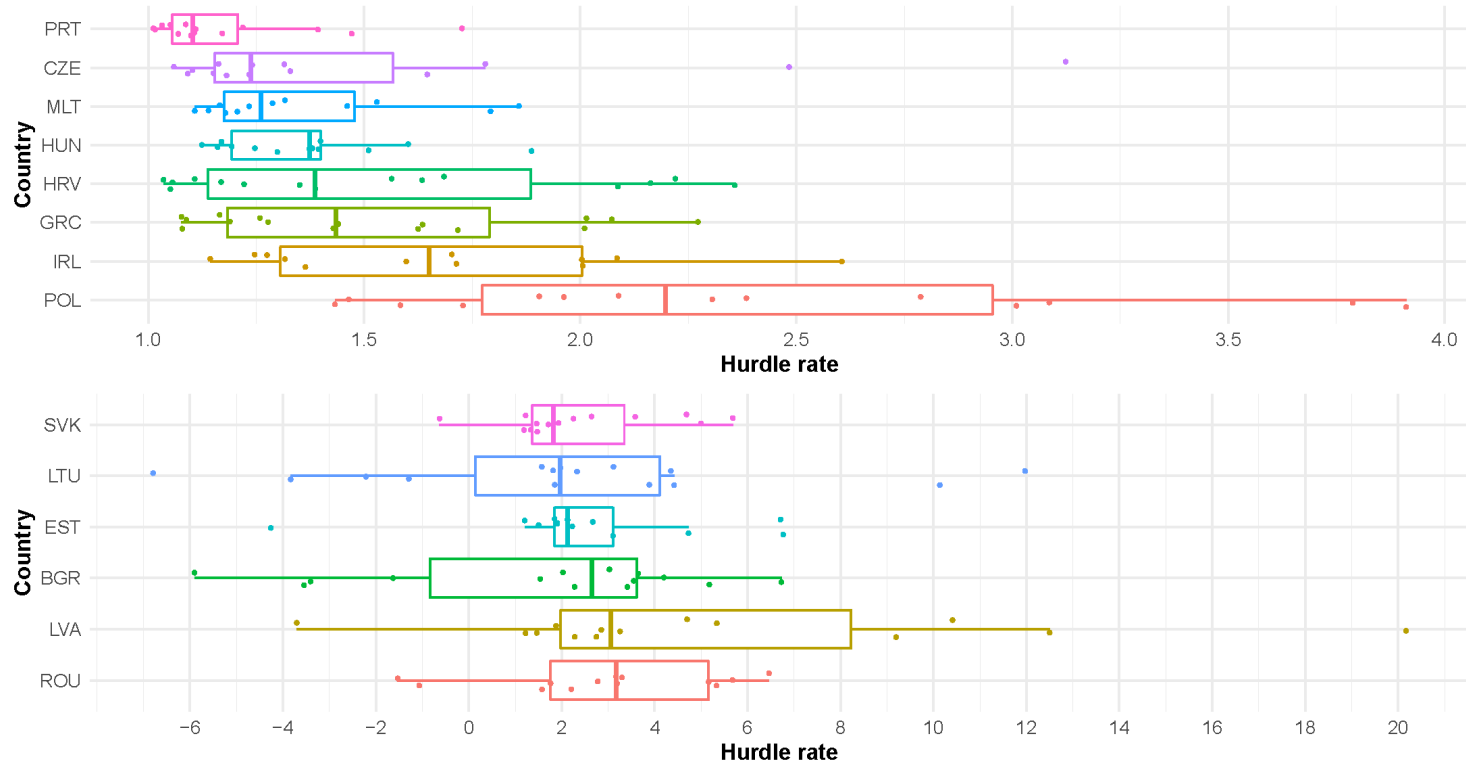
Hurdle rates on country level

Country	Hurdle rate		Country	Hurdle rate	
	Bioeconomy			Bioeconomy	
	Bio	Non-bio		Bio	Non-bio
AUT	1.02	1.02	HUN	1.33	1.56
BEL	1.02	1.02	IRL	2.95	1.72
BGR	1.68	12.81	ITA	1.01	1.01
CYP	1.02	1.07	LTU	3.91	4.60
CZE	1.14	1.27	LUX	1.04	2.12
DEU	1.02	1.01	LVA	3.16	4.90
DNK	1.03	1.03	MLT	1.07	3.37
ESP	1.03	1.03	NLD	1.01	1.01
EST	2.79	2.89	POL	1.76	2.52
FIN	1.05	1.03	PRT	1.01	1.02
FRA	1.02	1.01	ROU	1.68	-3.20
GBR	1.09	1.18	SVK	1.93	3.70
GRC	1.04	1.09	SVN	1.05	1.13
HRV	1.08	1.09	SWE	1.08	1.11

Hurdle rates per sector



Hurdle rates per sector and country



MISTICS on country level

Country	MISTICS		Country	MISTICS	
	Mio (€)	€ per capita		Mio (€)	€ per capita
AUT	-23.8	-2.84	HUN	-114.2	-11.45
BEL	-61.2	-5.63	IRL	-318.5	-70.87
BGR	-7	-0.95	ITA	-164	-2.75
CYP	3.6	4.42	LTU	-45	-14.52
CZE	-51.1	-4.89	LUX	-2.3	-4.49
DEU	-263.1	-3.23	LVA	-12.9	-6.13
DNK	-111.8	-20.18	MLT	-1.2	-2.87
ESP	-28.2	-0.61	NLD	-14.7	-0.89
EST	-4.2	-3.16	POL	-12.7	-0.33
FIN	-98.9	-18.44	PRT	70.5	6.71
FRA	-388.9	-6.00	ROU	41.6	2.04
GBR	-60.7	-0.97	SVK	-64	-11.83
GRC	23.9	2.17	SVN	-7.9	-3.87
HRV	4.7	1.10	SWE	-278.8	-29.71

MISTICs per sector

- Most frequently the highest:

- 1) Electricity, gas, water supply, sewerage, waste, and remediation services
- 2) Other business sector services
- 3) Textiles, wearing apparel, leather and related products

- Most frequently the lowest:

- 1) Agriculture, forestry, and fishing
- 2) Food products, beverages, and tobacco
- 3) Chemicals, and pharmaceutical products

Discussion

- Lower hurdle rates for the bio-based part than for the non-bio-based part => high potential for further sustainable investments
- Lowest hurdle rates: Italy, the Netherlands, and Portugal, followed closely by Austria, Belgium, Cyprus, Germany, and France.
- Sectorial hurdle rates vary strongly within and between countries => Prioritize investment in the bioeconomy in specific sectors

Discussion

- Mostly negative MISTICs => bioeconomy projects need to provide irreversible benefits in addition to CO₂ emission
- All countries have bioeconomy sectors with positive MISTICs
- MISTICs provide info on which sectors are more sustainable

Limitations

- Limited data availability for all EU MSs, sectors, and an extended period
- High risk-adjusted rate of return (sensitivity analysis)
- Assuming constant sectorial GHG intensity between countries
- Internalization of CO₂-emissions pricing not included (possible double counting)

The end

Thank you for your attention!

Any suggestions/feedback?

