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CIRCULAR ECONOMY, PATENTS AND INDUSTRIAL DESIGNS: EVIDENCE FROM EUROPEAN COUNTRIES

ENRICO GABRIELE, PHD

LUMSA UNIVERSITY OF ROME (ITALY)

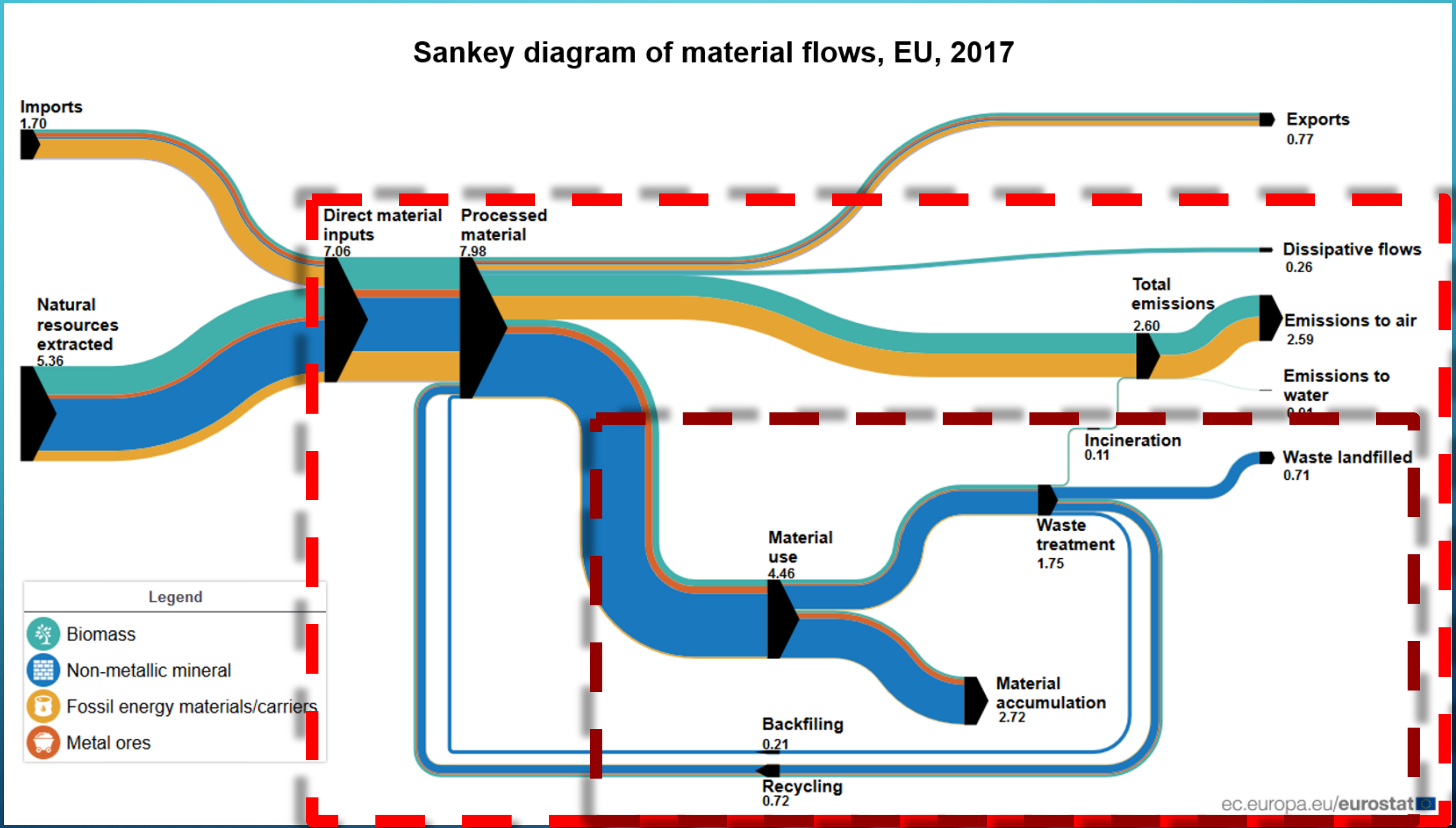
STRUCTURE OF THIS PRESENTATION

- [Premise: The main findings]
- Introduction
- The novelty of this paper
- Text corpus:
  - The power of technological innovation
  - How circular strategies worked
  - [Additional content: to be or not to be: structural breaks]
- Control variables
- Methodological notes
- Results and comments
- Conclusions
- [Data source]

THE MAIN FINDINGS

- Circular economy is a relatively young economic branch that does still not have a universally accepted definition (Kirchherr et al, 2017). Past evidence of circular economy was restricted to specific business cases (i.e., at a microeconomic level), but failed to figure out its macroeconomic scope
- To untangle its macroeconomic scope, this research used a modified scheme stemming from studies of Kirchherr et al (2017) and Potting et al (2017), in which a role of IPRs is found. This classification may comfortably reach general consensus (as from SDGs, that have a relatively stronger acceptance than alternative approaches)
- Different strategies of circular economy have been detected by using data from the Sankey diagram (Eurostat, 2021)
- Capital-intensity computed from patents (i.e. on environmental technologies; OECD, 2021) and, surprisingly, industrial designs (WDI, 2021) positively contributed to expansion of circular strategies differently (if properly detected)
- Evidence on patents can be extended at the whole Europe, while evidence on designs must be restricted to the EU Inner Six club countries

SANKEY DIAGRAM – EUROSTAT



Source: Eurostat data: env_wassd; env_ac_sd; env_ac_mfa
Available at: https://ec.europa.eu/eurostat/web/products-eurostat-news/product/-/asset_publisher/VWJkHuaYvLIN/content/DDN-20200311-2/pop_up [last visit: December 2022]

INTRODUCTION

- 114 different definitions of circular economy (Kirchherr et al, 2017) and a number of schools of thought (Winans et al, 2017; Homrich et al, 2018; de Jesus et al, 2018; Kinnunen and Kaksonen, 2019) do actually exist. Any demonstration of the macroeconomic scope of circular economy cannot be subordinated to such heterogeneity (which is still disputed, and data cannot be reported accordingly)
- The majority of definitions have been drafted not prior to 2012 (Ellen MacArthur Foundation, 2012; MacArthur, 2013; Kirchherr et al, 2017; Murray et al, 2017), and the most popular are published by the *Journal of Industrial Ecology* and the *Journal of Cleaner Production* (Kirchherr et al, 2017). There is large variety of definitions between peer-reviewed and non-peer-reviewed literature, though they have above all a microeconomic scope (restricted to marginal kinds of waste; for instance municipal waste accounts for only 10% of total waste). Interpretations of circular economy may differ between entrepreneurs and academics
- Ordoñez and Rahe (2013) were the first experts to question the macroeconomic scope of circular economy by surveying business managers, but empirical evidence was missing. Technological innovation seemed to be the key element
- The UN SDG 11.6 announced a set of detailed goals (no instruments or definitions) for Member States to fulfill with objective of sustainable cities and communities (United Nations, 2015): circular practices must «*reduce the adverse per-capita environmental impact of cities, included by paying attention on air quality and municipal and other waste*». This helped us to focus on easy-to-measure effects in place of other variables. As a further suggestion, the Sankey diagram (Eurostat, 2021) is used in accordance to the European *Directive 2009/125/EC* (i.e. directive on eco-design of energy-related products)

THE NOVELTY OF THIS PAPER

- Patents and industrial designs are found to have a macroeconomic relevance for circular economy
- They seemingly pursued goals according to the «*closed-loop economy*» and «*regenerative design*» CE-related schools of thought as recognized by Kirchherr et al (2017), Homrich et al (2018), de Jesus et al (2018), and Kinnunen and Kaksonen (2019)
- Patents (related to environmental technologies) better worked to increase recycling and recovery rates. This signals an improvement of waste treatment
- Industrial designs better worked to reduce the total tonnes of waste disposable in landfills, incinerators, recovery for energy (and other unspecified). This confirms an enlarged consensus for circular practices (and prevention of waste generation, regardless of any specific dimension of the Sankey diagram)

THE POWER OF TECHNOLOGICAL INNOVATION

- **Patents**: protect new inventions (and/or create unprecedented functions, such as new materials)
- **Industrial designs**: preserve intellectual property rights of aesthetic (not purely utilitarian) features of products which make them more comfortable and longlasting their usage
- Gustavsson and Sathre (2006) argued that more efficient energy and raw material use can substantially reduce energy consumption and resource demand, and this implicitly acknowledges the importance of IPRs in relation to innovative technologies. Patents and designs are argued to generate spatial spillover effects since decades (Grupp, 1996) especially with strong localized impact (Thompson and Fox-Kean, 2005; Gumbau-Albert and Maudos, 2009; Hafner, 2014). Hence their macroeconomic impact from geographically restricted cases. This justifies our interest on total waste regardless of specific kinds of waste (it better works for macroeconomic analysis)
- Europe Economics (2015) found out a close positive relationship between industrial designs and GDP. Analogously we can extend it to patents. A compound indicator is needed to measure the «design/patent-intensity» of a country because a marginal effect of a higher capital-intensity is liable of a more circular economy. In addition, institutional factors well explained different levels of the effectiveness of industrial designs

HOW CIRCULAR STRATEGIES WORKED [1/2]

FROM THE LINEAR ECONOMY …

CE Level 1	CE Level 2	CE Level 3
Useful applications of materials	**Extended lifespan of products and its parts**	**Smarter product use and manufacture**
• Recycle • Recover [e.g. backfilling]	• Reuse • Repair • Refurbish • Remanufacture • Repurpose	• Refuse • Rethink • Reduce

… TO A FULL-FLEDGED CIRCULAR ECONOMY

Integrated scheme from studies by Kirchherr et al (2017) and Potting et al (2017) about *the 9R Framework*. It enlists the 10 most widely accepted strategies towards a full-fledged circular economy. The need to compress 10 different circular strategies into 3 main layers comes from the difficulty – among others – to overcome limits of the «*extended producer's responsibility*» (EXPRA, 2016), and of reporting different kinds of waste (where ten different legislations are held throughout the European countries). This creates several problems to pragmatically distinguish «*Level 2*» and «*Level 3*» (see next slides). Data from the Sankey diagram (Eurostat, 2021) compel us to do so.

HOW CIRCULAR STRATEGIES WORKED [2/2]

CE Level 1 = **HIGHER RECOVERY & RECYCLING RATE**

- Recycling and recovery rates
- Better works thanks to patents

→ CE Level 1

The circular strategy closest to linear economy [i.e., ratio between R&R and total treated waste]

The most circular strategies of circular economy [i.e., based on eigenvectors from the principal component analysis]

- Reduction of waste generation
- Better works thanks to Industrial designs

→ CE Level 2

- Prevention of waste generation
- Better works thanks to industrial designs

→ CE Level 3

CE Level 2 + CE Level 3 = **REDUCED TOTAL GENERATED WASTE**

TO BE OR NOT TO BE: STRUCTURAL BREAKS

The «*Legal Review on Industrial Design Protection in Europe*» by the European Commission, Hartwig (2018) and Church et al (2019) gave us arguments to <u>test different kinds of structural breaks</u> (i.e. economic versus institutional). The <u>EU Inner Six countries</u> are those that became party of the <u>1960 Hague Act</u> (i.e. registration of industrial designs).

INDUSTRIAL DESIGN FILINGS [Figures 1-2]: structural breaks

Figure 1.

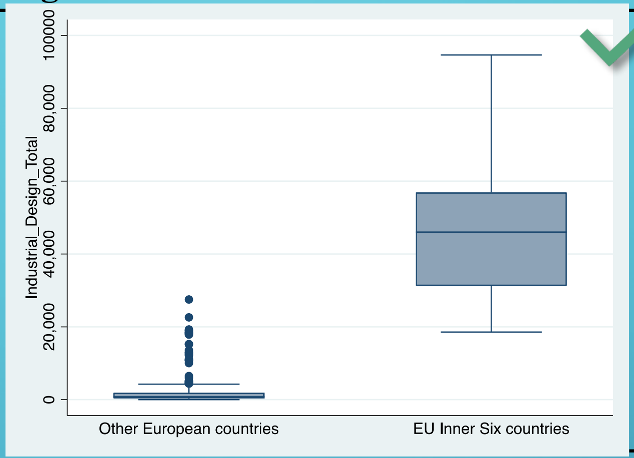
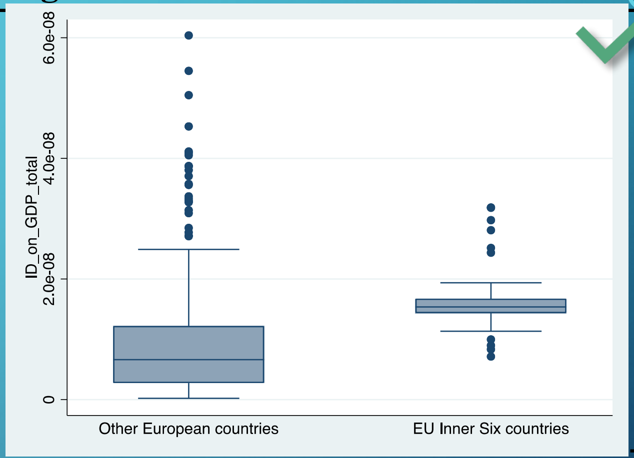


Figure 2.



PATENTS ON ENVIRONMENTAL TECHNOLOGIES FILINGS [Figures 3-4]: no structural break

Figure 3.

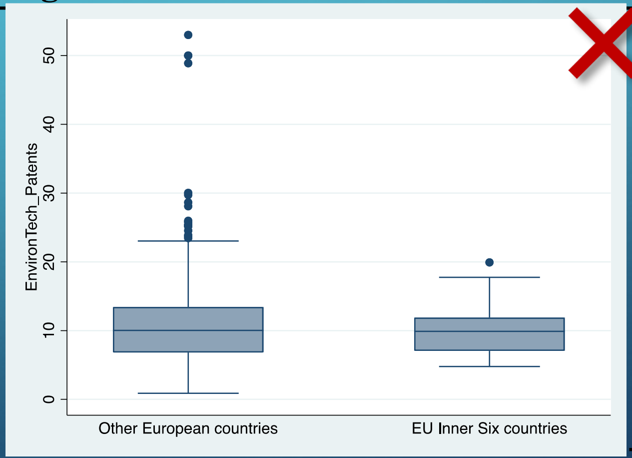
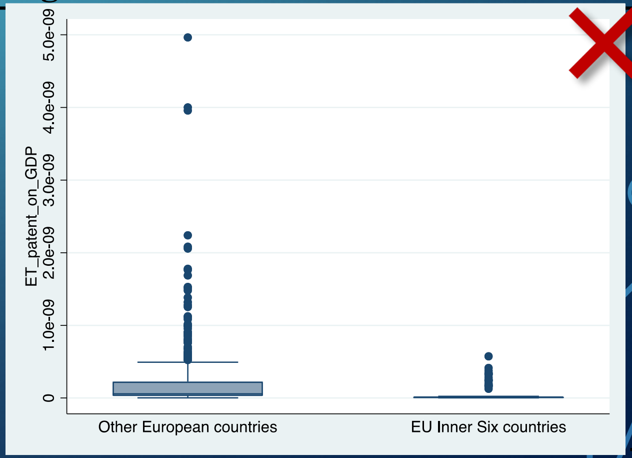


Figure 4.



CONTROL VARIABLES

Inspired to studies by Aguilar and Hernandez (2021) as a revisited version of preliminary studies by Valdivia et al (2013) [author's note: there used for projections, but here to be adapted for our backward-looking empirical study from 2010 to 2019]:

- **Per-capita income** (Cole et al, 1997; Husnain et al, 2021): its non-linear behavior is held similar to that of Environmental Kuznets Curves
- **Employment on population** (Virtanen et al, 2008; Hubacek et al, 2009; Shafiei and Salim, 2014a; Sato and Zenou, 2015; Seto and Ramankutty, 2016; Rashid et al., 2018; Hou et al., 2019; Chen et al., 2021): a standard indicator of lifestyle for empirical studies
- **Renewable energy consumption** (Shafiei and Salim, 2014b; Bagher et al, 2015; Murty, 2017; Urbinati et al, 2017; Zoundi, 2017; Mezősi et al., 2018; Olabi, 2019; Groissböck, 2020): an indicator of abatement of carbon dioxide emissions

Most of them demonstrate statistical negligibility mainly because (socio-economic) dynamics of CE (still troubling and destined to projections on future) are poorly observable, hence the reasons why we still talk about economic transition

	I	II	III	IV	V	VI	VII	VIII
	RECYCLING & RECOVERY RATES [Level 1]				TOTAL BAD DISPOSAL WASTE [Level 2 & 3]			
	OVERALL	**OVERALL**	**BREAK: EU INNER 6**	**BREAK: RICHEST**	**OVERALL**	**OVERALL**	**BREAK: EU INNER 6**	**BREAK: RICHEST**
CONSTANT	-0.8165134*** [0.2144496]	-0.8427814*** [0.2774188]	-0.8355372*** [0.2820822]	-0.8205892*** [0.2824816]	$1.01 \cdot 10^{7}$ [$2.48 \cdot 10^{7}$]	$2.90 \cdot 10^{7}$ [$2.80 \cdot 10^{7}$]	$4.34 \cdot 10^{7}$ [$2.74 \cdot 10^{7}$]	$4.14 \cdot 10^{7}$ [$2.81 \cdot 10^{7}$]
ID_ON_GDP		8810881* [4634955]	8896888* [4700475]	9212645* [4738563]		$-1.51 \cdot 10^{14}$ [$2.05 \cdot 10^{14}$]	$-1.07 \cdot 10^{14}$ [$1.98 \cdot 10^{14}$]	$-9.74 \cdot 10^{13}$ [$2.02 \cdot 10^{14}$]
INNERSIX_EU*ID_ON_GDP			-6074006 [$3.48 \cdot 10^{7}$]				**$-1.04 \cdot 10^{16}$*** [$3.49 \cdot 10^{15}$]	
LARGEST_ECONOMIES*ID_ON_GDP				$-1.08 \cdot 10^{7}$ [$2.26 \cdot 10^{7}$]				$-5.05 \cdot 10^{15}$** [$2.30 \cdot 10^{15}$]
ET_PATENT_ON_GDP	**$+1.01 \cdot 10^{8}$*** [$3.39 \cdot 10^{7}$]				$6.12 \cdot 10^{14}$ [$3.93 \cdot 10^{15}$]			
INNERSIX_EU*ET_PATENT_ON_GDP	∅				∅			
LARGEST_ECONOMIES*ET_PATENT_ON _GDP	∅				∅			
PERCAPITAINCOME	0.0000398** [0.0000169]	0.000015 [0.0000337]	0.0000143 [0.0000341]	0.0000148 [0.0000338]	-2263.651 [1954.372]	-2721.655 [3368.915]	-3801.811 [3259.03]	-2838.751 [3305.063]
SQ_PERCAPITAINCOME	$-2.52 \cdot 10^{-10}$* [$1.37 \cdot 10^{-10}$]	$-5.01 \cdot 10^{-11}$ [$2.93 \cdot 10^{-10}$]	$-4.41 \cdot 10^{-11}$ [$2.96 \cdot 10^{-10}$]	$-4.88 \cdot 10^{-11}$ [$2.94 \cdot 10^{-10}$]	0.0164575 [0.0158035]	0.0225485 [0.0294404]	0.0315693 [0.0284649]	0.0232793 [0.0288805]
EMPLOYMENT_ON_POP	0.0060895 [0.0064508]	0.0160647 [0.0106774]	0.016318 [0.108112]	0.0160174 [0.107209]	1180227 [746755.1]	899174.6 [1038858]	1206152 [1004043]	836800.9 [1019432]
RES_CONSUMPTION_PERCENT	0.0048785 [0.0029984]	0.0019647 [0.0034794]	0.0020533 [0.0035519]	0.0022612 [0.0035561]	-925808.9*** [347093.9]	-851799.7** [360199.8]	-656460* [352411.9]	-692715.6* [360694.7]
No. observations	164	121	121	121	164	125	125	125
F-statistics [p-value]	0.0000	0.0000	0.0001	0.0003	0.0482	0.1638	0.0111	0.0496
AIC	436.6622	317.5411	315.5811	315.8381	5655.327	4293.568	4284.437	4289.457
BIC	-421.1629	-303.5621	-298.8063	-299.0633	5673.926	4310.538	4304.236	4309.255

CONCLUSIONS

- Further research is needed to confirm these findings at world level (not only at the European level) or to find more accurate indicators (if the 9R Framework was considered a viable approach)
- Future investigations may be committed to measure quantitative impact of IPRs on specific kinds of waste (e.g. municipal waste or packaging waste)
- Patents and designs could be good instruments to promote the extended producers' responsibility (OECD, 2001; Ashby and Johnson, 2010; EXPRA 2016) if jointly implemented
- EXPRA (2016) suggested that the presence of 10 different legal frameworks on waste management among the European countries creates some problems to distinguish each of the strategies contained in the 9R Framework (and this inevitably creates some arbitrariness on their reporting)

THANK YOU FOR YOUR ATTENTION

DATA SOURCE

- [1] World Bank (2021); World Development Indicators [see Appendix].
- [2] Eurostat (2021); Title: management of waste by waste management operations and type of material – Sankey diagram data. Original database code: env_wassd (metadata format).
- [3] OECD (2021); Patents in environment technologies. doi: 10.1787/fff120f8-en (Accessed on 29 June 2021).