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Globalization and ICT capital endowment: How do they impact on an Inclusive Green Growth Index?

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Motivation (1/2)

About measures of sustainable economic performance

Some stylized facts:

- Measures to understand the health conditions of the economy are grounded in the GDP which targets only economic performance
- The limits of GDP affect the decision of the policymakers and this has at least two main consequences:
  - it challenges the capability of the earth to bear intensive use of resources at the cost of environmental catastrophes;
  - the social dimension of the individuals is overlooked for the sake economic goals.
- Against this background, Stiglitz et al. (2009) argued that it is needed to go beyond the GDP and draw the attention on societal well-being made of multifaceted aspects

Motivation (2/2)

About the drivers of GDP

Some stylized facts:

- Market openness allows capital, goods and service mobility. This dynamics positively impacts on GDP
- Technology investments are also a key driver for improving GDP performance

$\rightarrow$ **What about these drivers on sustainable economic performance?**

Background

Market openness, economic growth and sustainable development

- When one community succeeds, its influence extends beyond its borders, driving change in closed regions. Together, we can create a ripple effect of growth. This dynamics is known as spillover effects brought by globalized markets (Harrison, A., 1996; Ades, A. F. and Glaeser, E. L., 1999; Niebel, T., 2018).
- **Market openness**, especially in non-advanced countries, has a weak overall impact on sustainability, with only marginal improvements driven by trade openness (Yanikkaya, 2003; Ahmed et al., 2021).
- Several studies show mixed effects of **globalization** - positive on the economy but negative on the environment, with uncertain social outcomes (Gurgul & Lach, 2014; Li & Wei, 2021; Osei & Kim, 2020).

Background

Technology endowment, economic growth and sustainable development

- Technology endowment has positive impacts on economic growth and society, such as facilitating people to catch opportunities, reducing time and space barriers (Del Rio Castro et al., 2021)
- Caputo et al. (2020), Del Rio Castro (2021) and Leonhard and von Kospoth (2017) argue that positive impacts of technologies depend on the use and aim that leads socio-economic actor's behaviours
- Current literature addresses singularly the impact of technology endowment on economic (positive effect) and environmental (unclear effect) pillars

The Inclusive Green Growth Index (IGGI)

- The **IGGI** was developed by Jha et al. (2018)
- We were inspired by Zhou et al. (2022) who regressed the IGGI over green finance variables to understand their contribution to sustainable development [paper out in *Ecological Economic* journal]
- It measures sustainability across economic, social, and environmental dimensions, addressing gaps in traditional GDP metrics and aligning with the SDGs and Paris Agreement;
- It is composed of **28 variables** and constructed following several steps summarized in the next slide

IGGI - *continued*

Math to calculate the composite index

$$IGGI = \frac{1}{3}(av.\ economic\ pillar) + \frac{1}{3}(av.\ equity\ pillar) + \frac{1}{3}(av.\ environmental\ pillar) \quad (1)$$

$$CPB = -5 \times \frac{(total\ absolute\ gap - sample\ minimum)}{(sample\ maximum - sample\ minimum)} + 6 \quad (2)$$

$$Balanced\ IGGI = \frac{3}{4}(IGGI) + \frac{1}{4}(CPB) \quad (3)$$

where CPB stands for *Cross Pillar Balance* which captures the pair performance gap between pillars.

Econometric model

Econometric strategy

Our model reads as follows:

$$\text{IGGI}_{it} = \beta_0 + \beta_1 \textit{CapitalOpenness}_{it} + \beta_2 \textit{TradeOpenness}_{it} + \beta_3 \textit{ICTcap}_{it} + \beta_4 \textit{nonICTcap}_{it} + \\ + \beta_j X_{j,it} + \tau_t + \epsilon_{it}$$

where:

β_j (with j$\neq$i) is the set of parameters capturing the impact of controls, that are *Internet server*$_{it}$, *Labour quantity*$_{it}$, *Labour quality*$_{it}$, and *Population growth*$_{it}$. The time fixed effects are captured by τ_t.

The i and t subscripts denote the sectional and time dimensions respectively.

Econometric model

The aim is to analyse different measures of openness.
Trade openness is calculated as the ratio between total foreign trade (the sum of exports and imports of goods and services measured) and the Gross Domestic Product (Dowrick S. & Golley J., 2004) :

$$\frac{Import + Export}{GDP} \tag{4}$$

Capital openness is calculated as the ratio between the sum of Foreign Direct Investment both inflows and outflows and Gross Domestic Product (Clausing K.A., 2007):

$$\frac{FDIin + FDIout}{GDP} \tag{5}$$

Data

Data sources and descriptive statistics of the whole sample

- Yearly data over the period **2010–2020** are used. Data are taken for **95 world countries** classified by income (World Bank Atlas method);
- Data were collected from the World Bank and Total Economy Database (TED) databases;
- The IGGI is the dependent variable and it uses World Bank and Our World in Data-Global Carbon Project databases.

Table 1 Source, Variable description and Descriptive statistics

Variable	Source	Mean	Std. Dev.	Min	Max
IGGI	WB	3.274896	.2212636	2.778027	3.914654
Capital Openness$_{i,t}$	WB	9.25e+08	9.91e+09	-82.36132	1.50e+11
Trade Openness$_{i,t}$	WB	90.37559	58.08144	20.72252	380.1042
ICT cap$_{i,t}$	TED	2.780362	1.483745	.093	8.789
nICT cap$_{i,t}$	TED	47.5263	9.780124	20.601	82.716
Internet server$_{i,t}$	WB	247442.2	2100335	2	4.67e+07
Lab. quantity contr$_{i,t}$	TED	.1990373	2.080643	-16.064	10.335
Lab. quality contr$_{i,t}$	TED	.3076258	.4668544	-3.642	3.954
Population growth$_{i,t}$	WB	1.110611	1.439293	-2.258464	11.79402

Main results (1/2) I

Table 2 Main results - dep. var IGGI, full sample of 95 countries and timeframe spanning from 2010 to 2020.

Variable	POLS		FE	
Capital Openness$_{i,t}$	-1.13e-12***	-3.27e-13*	-6.72e-13***	-5.25e-13***
	(1.91e-13)	(1.80e-13)	(8.63e-14)	(9.33e-14)
Trade Openness$_{i,t}$	-0.0010***	-0.0009***	0.0005	0.0006*
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
ICT cap$_{i,t}$	0.0099*	0.0117***	0.0137*	0.0140*
	(0.0055)	(0.0049)	(0.0072)	(0.0071)
nICT cap$_{i,t}$	0.0020**	-0.0009	0.0002	0.0002
	(0.0008)	(0.0008)	(0.0013)	(0.0013)
Internet server$_{i,t}$	-1.02e-08***	-1.05e-08***	-1.06e-09**	-1.06e-09**
	(3.31e-09)	(2.92e-09)	(4.27e-10)	(4.22e-10)
Lab. quantity contr$_{i,t}$		0.0039**		-0.0014**
		(0.0019)		(0.0006)
Lab. quality contr$_{i,t}$		0.0056		0.0045***
		(0.0073)		(0.0018)
Population growth$_{i,t}$		0.062***		0.0047*
		(0.0071)		(0.0025)
cons	3.208***	3.2577***	3.1439***	3.130***
	(0.0492)	(0.0327)	(0.0622)	(0.0608)
N	1,045	1,045	1,045	1,045
R^2	0.11	0.27	0.41	0.43
Time dummies	✓	✓	✓	✓
B-P LM test	0.000	0.000	-	-
Hausman test	-	-	0.193	0.880
p-value	0.000	0.000	0.000	0.000

***, ** and * refer to significance level at 1%, 5% and 10%, respectively.
Standard error in parentheses.

Main results (2/2) I

Table 2 Main results - dep. var IGGI, full sample of 95 countries and timeframe spanning from 2010 to 2020.

Variable	**RE**	
Capital Openness$_{i,t}$	-6.38e-13*	-4.97e-13
	(3.49e-13)	(3.53e-13)
Trade Openness$_{i,t}$	0.0003*	0.0002*
	(0.0001)	(0.0001)
ICT cap$_{i,t}$	0.0136***	0.0134***
	(0.0034)	(0.0034)
nICT cap$_{i,t}$	0.0005	0.0004
	(0.0007)	(0.0007)
Internet server$_{i,t}$	-1.10e-09	-1.14e-09
	(8.80e-10)	(8.87e-10)
Lab. quantity contr$_{i,t}$		-0.0012**
		(0.0005)
Lab. quality contr$_{i,t}$		0.0044***
		(0.0016)
Population growth$_{i,t}$		0.0065***
		(0.0023)
cons	3.154***	3.148***
	(0.0432)	(0.0421)
N	1,045	1,045
R^2	0.41	0.43
Time dummies	✓	✓
B-P LM test	0.000	0.000
Hausman test	0.193	0.880
p-value	0.000	0.000

***, ** and * refer to significance level at 1%, 5% and 10%, respectively.
Standard error in parentheses.

Results from sample split into different income levels

Table 3: Sample split into income levels - dep. var IGGI, timeframe spanning from 2010 to 2020. Random Effects.

Variable	High income		Up.-mid. inc.		Lower-mid. & Low inc.	
	(1)	(2)	(3)	(4)	(5)	(6)
Capital Openness$_{i,t}$	-6.07e-13**	-4.02e-13	-0.0020	-0.0019	0.0004	-0.0006
	(3.00e-13)	(3.03e-13)	(0.0016)	(0.0017)	(0.0015)	(0.0013)
Trade Openness$_{i,t}$	0.0003**	0.0005***	0.0004	0.0003	0.0001	0.0014***
	(0.0002)	(0.0002)	(0.0004)	(0.0004)	(0.0005)	(0.0004)
ICT cap$_{i,t}$	-0.0079	-0.0026	0.0138**	0.0135**	0.0286***	0.0208***
	(0.0056)	(0.0057)	(0.0061)	(0.0061)	(0.0070)	(0.0066)
Controls		✓		✓		✓

***, ** and * refer to significance levels at 1%, 5%, and 10%, respectively.
Standard errors are in parentheses.

Robustness checks

- **IV estimator** - We used the first lag of the explanatory variable ICT investment as an instrument to address possible a correlation between the regressor and the error term
- **Controlling for ICT capital service** - A further check was run by adding the variables ICT and nonICT capital services, proxying the contribution of the services regarding the ICT and non-ICT assets to the IGGI performance
- **Lagged independent variables** - A further check is conducted assuming that the current dynamics of IGGI are due to past dynamics of the independent variables

Policy recommendations

- **Global markets**
  1. they have to be addressed and reshaped towards paths that account for the multiple dimensions of sustainability;
  2. International agreements regulating the markets should embed clauses to safeguard people's lives and jobs
- **ICTs capital endowment** need heterogeneous regulation based on the level of development that characterizes the country, this being more necessary for high income countries where the variability increases may be affected by differences within the country itself;

Conclusions

- The present study analyses the impact of global markets (proxied by capital and trade openness), and ICT capital investments on a growth indicator accounting for the three economic, environmental, and social dimensions of sustainability.
- **Prior studies**: positive economic returns, negative environmental returns, unclear social returns.
- **This study**: there is no sustainable goal achieved if one of the three dimensions is overlooked.
- Our results suggest that:
  1. **globalization** has weak impact only with the trade dimension and mostly in not advanced economies;
  2. **ICTs capital endowment** is a relevant driver to support the overall sustainability;
  3. **the labour quality contribution** seems to be a good driver for the IGGI.
- Our limitations suggest that:
  - We do not distinguish the IGGI in the long and short run impacts;
  - ICT investments targeting green/social and non green/social purposes.

Thank you for your attention

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Appendix I

Table A.2 List of countries

low-income economies	lower middle-income economies	upper middle-income economies	high-income economies
Burkina Faso	Bolivia	Bulgaria	Australia
Ethiopia	Cambodia	North Macedonia	Austria
Madagascar	Cote d'Ivoire	Serbia	Bahrain
Mozambique	India	Turkey	Belgium
Niger	Kyrgyz Republic	Albania	Canada
Rwanda	Morocco	Algeria	Chile
Uganda	Nigeria	Argentina	Croatia
	Pakistan	Armenia	Cyprus
	Senegal	Azerbaijan	Czechia
	Tunisia	Belarus	Denmark
	Ukraine	Bosnia and Herzegovina	Estonia
	Zimbabwe	Brazil	Finland
		China	France
		Colombia	Germany
		Costa Rica	Greece
		Ecuador	Hungary
		Georgia	Iceland
		Guatemala	Ireland
		Indonesia	Israel
		Jordan	Italy
		Kazakhstan	Japan
		Lebanon	Kuwait
		Malaysia	Latvia
		Mexico	Lithuania
		Moldova	Luxembourg
		Namibia	Malta
		Paraguay	Mauritius
		Peru	Netherlands
		Russian Federation	New Zealand
		South Africa	Norway
		Sri Lanka	Oman
		Thailand	Poland
			Portugal
			Qatar
			Romania
			Singapore
			Slovakia
			Slovenia
			Spain
			Switzerland
			United Kingdom
			United States
			Uruguay