UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Inclusive and Sustainable Industrial Development Working Paper Series

WP 2 | 2025

Industrialization, poverty and climate change: The mediating effects of manufacturing

DIVISION OF INDUSTRIAL POLICY RESEARCH AND STATISTICS

WORKING PAPER 2/2025

Industrialization, poverty and climate change. The mediating effects of manufacturing

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Vienna, 2025

This paper builds on and extends the background note prepared for UNIDO's Industrial Development Report 2024 "The new era of industrial policy. Turning challenges into sustainable solutions."

Acknowledgements

We are grateful to Nobuya Haraguchi for providing comments and suggestions on previous drafts of this paper.

Table of Contents

List of Figures

List of Tables

Abstract

Industrialization is a key driver of progress towards the Sustainable Development Goals (SDGs), not only by contributing directly to SDG 9 (Industry, Innovation and Infrastructure) but also by driving broader development outcomes through indirect channels. This paper explores the direct and indirect effects of industrialization on four key socio-economic and environmental SDGs, namely No Poverty (SDG 1), Zero Hunger (SDG 2), Clean Energy (SDG 7), and Resource Efficiency (SDG 12).Using Causal Mediation Analysis (CMA) and panel data from 177 developing countries covering the period 2000 to 2021, we assess how manufacturing activities contribute not only directly to these goals but also indirectly through economic growth, agricultural productivity and innovation. The findings reveal that these mediating channels play a significant role: 27 per cent of industrialization's impact on poverty reduction is mediated through economic growth, 14 per cent of its effect on hunger alleviation through agricultural productivity, and 48 per cent of its influence on clean energy adoption through innovation. These results highlight the multifaceted nature of industrialization and the critical need for complementary policies that bolster growth, productivity and innovation ecosystems. Our analysis offers new empirical evidence to inform the design of integrated industrial strategies capable of accelerating progress across multiple SDGs simultaneously.

Keywords: Industrialization, Sustainable Development Goals (SDGs), Causal Mediation Analysis (CMA), poverty reduction, agricultural productivity, clean energy, innovation, economic growth, resource efficiency, industrial policy.

1 Introduction

At the halfway mark to the 2030 Agenda, the global economy faces both unprecedented challenges and opportunities. Today's world is defined by resource scarcity, accelerating climate change, and widening socioeconomic disparities, all of which disproportionally affect developing countries. Amidst these challenges, today's world is also characterized by technological breakthroughs that offer significant opportunities to accelerate inclusive and sustainable development. In this context, achieving the Sustainable Development Goals (SDGs) has become both crucial and increasingly more complex.

Recent events, including the COVID-19 pandemic, geopolitical tensions and soaring inflation, have underscored the fragility of the progress made towards the SDGs in recent years. Despite initial signs of advancement, the path towards achieving the 17 SDGs has faced severe disruption since 2020, with some goals even regressing (Sachs et al., 2022). This sobering reality calls for a reassessment of current strategies and mechanisms to accelerate progress towards the SDGs.

In response to these challenges, countries around the globe are increasingly allocating resources to support industrial development, leading to a renewed emphasis on industrial policy in both advanced and developing countries (Santiago et al., 2024). Industrialization is seen as a key catalyst for the achievement not only of SDG 9 (industry, innovation and infrastructure), but also many other SDGs. From this perspective, the manufacturing sector's capacity to drive economic growth, enhance resilience, create employment opportunities, reduce income inequalities, and facilitate transitions to sustainable production and consumption practices positions it as a cornerstone for sustainable development (Lavopa & Donnelly, 2023; UNIDO, 2021).

To what extent are these claims supported by empirical data? This paper seeks to provide some answers. Employing Causal Mediating Analysis (CMA), we assess the direct contributions of industrial activities to specific environmental and socioeconomic SDGs, as well as their indirect influence on these goals through mediators and spillover effects. By exploring these dynamics, this paper aims to provide empirical evidence that can inform the design of industrial policies capable of leveraging both channels of impact.

Our findings show that industrialization has substantial indirect effects that complement its well-known direct effects on other dimensions of sustainable development. For example, 27 per cent of the total impact of industrialization on poverty reduction (SDG 1) is attributable to the positive influence of industrialization on economic growth. Similarly, 14 per cent of its effect on hunger alleviation (SDG 2) results from industrialization's positive impact on agricultural productivity. In the case of clean energy (SDG 7), 48 per cent of the total effect is achieved through industry's role in accelerating technological innovation. These results highlight the multifaceted nature of industrialization's contribution to sustainable development through both direct and indirect channels.

The paper is structured as follows: The first section briefly reviews the literature on the impacts of industrialization on sustainable development; Section 2 outlines the methodology used to assess the direct and indirect effects of industry on selected SDGs; the next section presents and discusses the results of our econometric analysis; and the final section concludes with an overview of the policy implications that can be drawn from our analysis.

2 Literature Review

Industrialization has long been recognized as a key engine of economic development, fostering innovation, creating jobs, and improving living standards (Lavopa & Riccio, 2024; UNIDO, 2015, 2020). Within the framework of the UN Agenda 2030, this means that the development of the manufacturing sector can significantly contribute to the achievement of the SDGs (Haraguchi et al., 2024; UNIDO, 2024). Policies focused on industrial development are particularly effective in advancing multiple SDGs due to industry's strong linkages and multiplier effects on the wider economy.

Industrialization has both a direct and indirect impact on multiple SDGs. Direct effects arise from the production of goods, the creation of jobs and technological innovations. For instance, manufacturing industries are central to accelerating growth (SDG 8), fostering innovation (SDG 9), creating high-quality jobs (SDG 5, SDG 8, SDG 10), and reducing poverty and hunger (SDG 1, SDG 2) (Szirmai & Verspagen, 2015; UNIDO, 2015, 2019).

The indirect effects of industrialization are equally important. Production linkages and technological spillovers amplify industry's direct impacts. Manufacturing not only generates immediate employment opportunities, but also stimulates job creation in other sectors through backward and forward linkages. For example, around the world, every job in manufacturing is estimated to create more than two jobs, on average, in other sectors of the economy (Lavopa & Riccio, 2024). Furthermore, industrialization can reduce poverty through its influence on economic growth. Strong production linkages and the capacity to accelerate economic growth make manufacturing a powerful tool for poverty alleviation (Lavopa & Szirmai, 2012).

The literature also emphasizes the broader socioeconomic benefits of industrialization. It enhances food security (SDG 2) by improving agricultural productivity and reducing food prices (UNIDO, 2017). Industrialization supports health outcomes (SDG 3) through the production of affordable medicines and medical equipment (UNIDO, 2024). It promotes educational advancement (SDG 4) by increasing demand for skilled labour and supporting higher participation rates in education and training programmes (Haraguchi et al., 2019). Moreover, industrial development plays a crucial role in promoting gender equality (SDG 5) by creating job opportunities for women, especially in export-led, labour-intensive industries (Heath & Mobarak, 2015). Finally, industry plays a crucial role in driving the development of green technologies which are essential for achieving clean energy (SDG 7) and sustainable production practices (SDG 12) (Lavopa & Menéndez, 2023).

Despite frequently mentioned in the literature, these indirect channels of impact are typically overlooked in empirical analyses. In a recent study, Karahasan (2023) addresses this gap by examining the mediating role of industrialization in the relationship between economic growth and poverty reduction. Applying Causal Mediation Analysis (CMA), developed by Imai et al. (2010), the study finds that nearly 50 per cent of the impact of economic growth on poverty reduction is attributable to industrialization, highlighting the importance of considering such indirect effects in policy design to avoid distorted policies that fail to capture the indirect channels of industrialization's influence.

In this paper we adopt a similar approach and employ CMA techniques to assess both the direct and indirect effects of industrialization on selected SDGs. By decomposing industrialization's total impact into direct and indirect effects, we provide a more comprehensive understanding of how industrial activities influence sustainable development.

3 Methodology

CMA is a statistical method used to decompose the total effect of an intervention or treatment variable on an outcome variable into its direct and indirect effects. The direct effect corresponds to the treatment's impact on the outcome that is not mediated by any intermediate variables, while the indirect effect captures the influence transmitted through one or more mediator variables. This methodology is particularly useful for understanding complex causal relationships in sustainable development, where multiple ramifications often exist.

The CMA framework, originally developed by Imai et al. (2010), aims to open the "black box" of causal relationships by elucidating the mechanisms through which an intervention influences an outcome both directly and indirectly. This approach decomposes the Average Total Effect (ATE) of a treatment variable (T) on an outcome variable (Y) into an Average Direct Effect (ADE), which connects both directly, and an Average Causal Mediation Effect (ACME), which is attributed to the indirect effect of T on Y through a mediator variable (M).

The formal specification of CMA can be represented as follows:

$$M_i = \alpha_2 + \beta_2 T_i + \gamma_2 X_i + \epsilon_{i2} \tag{1}$$

$$Y_i = \alpha_3 + \beta_3 T_i + \omega M_i + \gamma_3 X_i + \epsilon_{i3} \tag{2}$$

where Equation (1) represents the mediator equation, which determines the impact of the treatment (T_i) on the mediator variables (M_i), while controlling for covariates (X_i); and Equation (2) represents the outcome equation, which determines the impact of the treatment (T_i) and the mediator (M_i) on the outcome variables (Y_i), controlling for the same covariates (X_i). By substituting the first equation into the second, the combined model is:

$$Y_i = \alpha_1 + \beta_1 T_i + \gamma_1 X_i + \epsilon_{i1} \tag{3}$$

where $\beta_1 = \beta_3 + \beta_2\omega$ represents the ATE, and the ACME is $\beta_2\omega$.

In our analysis, we apply CMA to explore how industrialization influences other environmental and socioeconomic goals (SDGs 1, 2, 7 and 12) both directly and through mediating factors. The analysis is structured around four baseline models, each corresponding to a specific SDG:

1. **SDG 1 (No Poverty):** In this model we examine industrialization's impact on poverty reduction, both directly and indirectly, through its positive effect on economic growth.
2. **SDG 2 (Zero Hunger):** In this model, we assess the influence of industrialization on hunger alleviation, both directly and indirectly, through its positive effect on agricultural productivity.
3. **SDG 7 (Clean Energy):** In this model we investigate how industry promotes the use of clean energy, both directly and indirectly, through its positive effects on innovation.
4. **SDG 12 (Resource Efficiency):** In this model, we explore the effects of industrialization on resource efficiency, both directly and indirectly, through its positive effect on innovation.

Each model specifies industrialization as the treatment variable (T), a specific SDG-related mediator (M), and the corresponding SDG outcome (Y). A summary of the causal relationships and mediating channels assessed in each model is presented in Table 1.

Table 1. Causal relationships and mediating channels for the four baseline models

Model	Treatment	Mediator	Outcome
1	Industrialization	Economic Growth	No Poverty (SDG 1)
2		Agricultural Productivity	Zero Hunger (SDG 2)
3		Innovation	Clean Energy (SDG 7)
4		Innovation	Resource Efficiency (SDG 12)

For each model, we first estimate the mediator equation (1) to assess the impact of cross-country differences in industrialization on the mediator variables (M_i).[1] If the share of manufacturing in gross domestic product (GDP) has a significant impact on mediator variables, this confirms the relevance of examining indirect channels and the mediating role of these variables. Next, we examine the outcome equation (2) for each model, where both industrialization and the mediator variables are used as exogenous variables to identify the direct and indirect effects on the outcome variables (Y_i). In both regressions, we use the same set of control variables (X_i).

Our primary data sources include official databases such as the UN National Accounts Main Aggregates, the SDG Global Database, the World Bank's World Development Indicators, and the Penn World Table. The final dataset comprises yearly observations from 2000 to 2021 for 177 developing countries[2] and includes four types of variables: (i) treatment, (ii) outcomes, (iii) mediators, and (iv) control. Descriptive statistics of the main variables are provided in Table 2.

Treatment: Central to the four baseline models, we use the manufacturing sector's share in a country's GDP (*manu_GDPsh*) to capture its level of industrialization. This variable is sourced from the UN National Accounts Main Aggregates.

Outcomes: The outcome variables in each model are captured by their respective SDG indexes, calculated using the approach put forward in UNIDO (2024).[3] These include:

- **no_poverty:** This variable captures progress towards two SDG 1 indicators that measure the proportion of the population living below the international poverty line and the proportion of the population living below the national poverty line.

[1] The econometric exercise is implemented using the 'mediate' package in R, developed by Imai et al. (2010).
[2] The full list of countries included in the analysis is presented in Table A.3 of Annex II.
[3] UNIDO (2024) introduces a novel approach to assess developing countries' performance towards achieving the relevant targets of selected SDGs. The indexes constructed implementing this methodology reflect the percentage of achievement towards pre-defined SDGs targets, where a value of 1 represents full target achievement. A detailed explanation of this SDG assessment methodology is available in Annex I.

- **zero_hunger:** This variable measures the target achievement towards two indicators of SDG 2 that determine the prevalence of undernourishment and of moderate or severe food insecurity.
- **clean_energy:** Representing the clean energy dimension of SDG 7, this variable captures the proportion of the population that primarily relies on clean fuels and technology, the share of renewable energy in total final energy consumption, and installed renewable electricity-generating capacity.
- **resource_eff:** This variable focuses on the target achievement towards SDG 12's resource efficiency dimension, which measures the domestic material consumption per unit of GDP.

Mediators: The mediator variables are calculated using the same methodology. These include:

- **econ_growth:** This variable includes two SDG 8 indicators that measure a country's annual growth rate of real GDP per capita and that of real GDP per employed person.
- **agri_prod:** This variable includes the SDG 2 indicator of labour productivity in the agriculture sector.
- **innovation:** This variable represents the target achievement of SDG 9's innovation dimension, which includes the percentage of research and development (R&D) expenditure as a share of GDP and the number of full-time equivalent researchers per million inhabitants.

Control: A set of additional covariates is included in all models to control for demographic and educational variations across countries.

- **hc:** This variable captures a country's level of human capital and is based on the index of years of schooling and returns to education from the Penn World Table (version 10.01).
- **pop:** Reflecting a country's population size, this variable is measured by the total population sourced from the UN National Accounts Main Aggregates.
- **urban_pop:** The variable measures a country's level of agglomeration, indicated by the percentage of the total population residing in urban areas, sourced from the World Bank's World Development Indicators.

Table 2. Descriptive statistics

VARIABLES	Description	Type	No.	Mean	Std. Dev.	Min	Max
manu_GDPsh	Manufacturing share in GDP (current USD) (%)	Treatment	3,370	11.3	5.6	0	34.7
clean_energy	SDG index of clean energy (%)	Outcome	3,454	34.2	12.1	0.8	93.1
resource_eff	SDG index of resource efficiency (%)	Outcome	3,791	64.8	29.0	0.0	100.0
zero_hunger	SDG index of zero hunger (%)	Outcome	2,310	74.8	16.4	25.9	98.8
no_poverty	SDG index of no poverty (%)	Outcome	2,344	75.6	19.1	14.3	100.0
agri_prod	SDG index of agriculture productivity (%)	Mediator	3,328	11.6	15.7	0.0	100.0
econ_growth	SDG index of economic growth (%)	Mediator	2,776	49.3	25.7	0.0	100.0
innovation	SDG index of innovation (%)	Mediator	2,266	9.5	10.8	0.0	66.0
hc	Human capital index	Control	3,060	1.3	1.1	0	4.4
pop	Total population	Control	3,874	15.2	2.4	8.4	21.1
urban_pop	Urban population (% of total population)	Control	3,762	53.1	22.4	8.2	100

Notes: The variable 'pop' is included in the logarithm to address skewness.

4 Results

4.1 Baseline models

Our results provide robust empirical evidence on both the direct and indirect effects of industrialization (SDG 9) on the selected socioeconomic and environmental goals (SDGs 1, 2, 7, and 12) in developing countries. The first set of results, presented in Table 3, illustrates the impact of the treatment variable (*manu_GDPsh*) on the mediator variable across our baseline models.

Table 3. Regression results of the mediator equations

Dependent Variable = Mediator	(1) econ_growth	(2) agri_prod	(3) innovation
manu_GDPsh	0.426**	0.323***	0.627***
	(0.131)	(0.044)	(0.044)
urban_pop	-0.002***	0.003***	0.002***
	(0.000)	(0.000)	(0.000)
hc	-0.008	-0.003*	-0.001
	(0.005)	(0.002)	(0.002)
pop	0.022***	-0.019***	0.003**
	(0.004)	(0.001)	(0.001)
Constant	0.241***	0.209***	-0.136***
	(0.066)	(0.020)	(0.024)
Observations	1,641	1,929	1,960
R-squared	0.06	0.39	0.20

Notes: Robust standard errors in parenthesis.
Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

The results from the mediator equations are compelling. The estimated coefficients for the treatment variable (*manu_GDPsh*) indicate that industrialization has a positive and statistically significant impact on all mediator variables across the three models. These coefficients can be interpreted as follows: In the first model, for instance, the coefficient suggests that a 1 per cent increase in the share of manufacturing in GDP increases the SDG index for economic growth by 0.426, controlling for other factors. In the second model, a coefficient of 0.323 indicates that higher levels of industrialization significantly enhance agricultural productivity. Similarly, results from Model 3 reveal that industrialization has a positive and highly significant impact on innovation. Notably, the treatment variable demonstrates a statistically significant and consistently positive impact across all models, reinforcing the strong influence of industrialization on these mediators.

Next, we examine the outcome equations' regression results (Table 4), which include both the direct effects of industrialization on the outcome variables and the indirect effects mediated through the specified mediators.

Table 4. Regression results of the outcome equations for the four baseline models

Dependent Variable = Mediator	(1) SDG 1	(2) SDG 2	(3) SDG 7	(4) SDG 12
manu_GDPsh	0.242**	0.730***	0.181***	0.789***
	(0.082)	(0.068)	(0.046)	(0.099)
econ_growth	0.201***			
	(0.015)			
agri_prod		0.377***		
		(0.035)		
innovation			0.235***	0.315***
			(0.023)	(0.049)
urban_pop	0.006***	0.003***	0.001***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
hc	0.001	-0.004	0.000	0.001
	(0.003)	(0.003)	(0.002)	(0.004)
pop	-0.008**	0.010***	-0.012***	-0.007**
	(0.003)	(0.002)	(0.001)	(0.003)
Constant	0.481***	0.351***	0.436***	0.212***
	(0.041)	(0.032)	(0.024)	(0.053)
ACME	0.09***	0.12***	0.17***	0.20***
Direct Effect	0.24**	0.73***	0.18***	0.79***
Total Effect	0.33***	0.85***	0.35***	0.99***
% of Total Eff mediated	27%	14%	48%	20%
Observations	1,641	1,929	1,900	1,960
R-squared	0.37	0.30	0.24	0.43

Notes: Robust standard errors in parenthesis.
Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

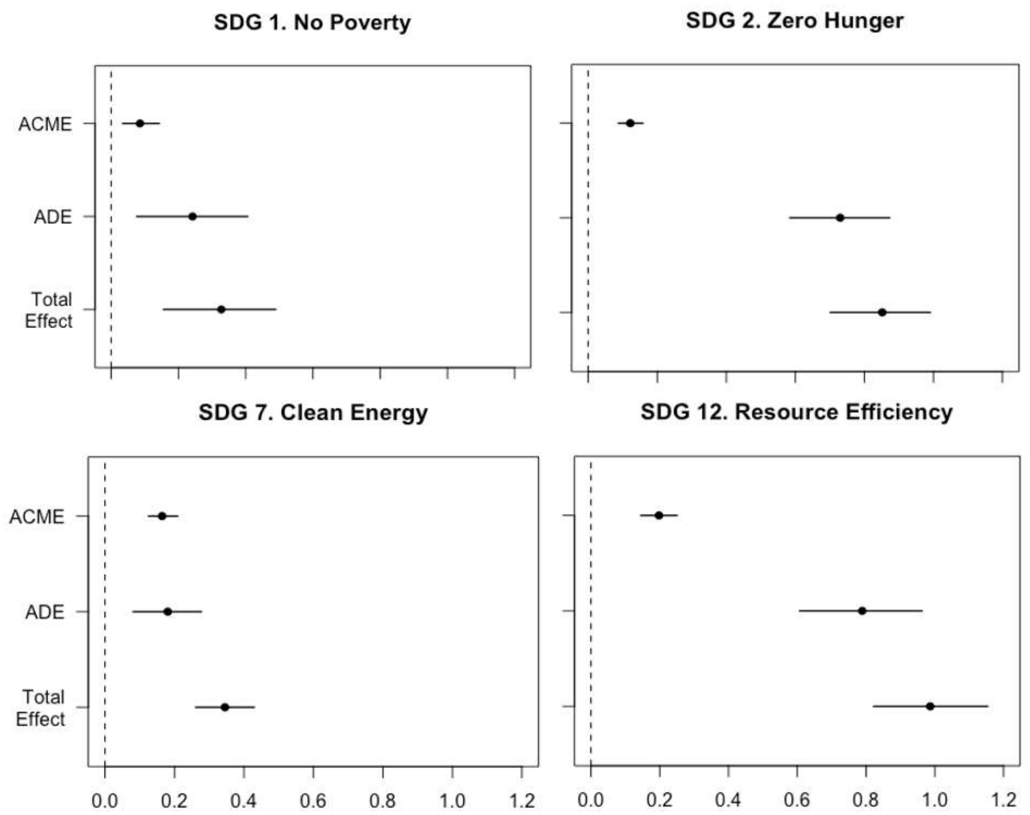
The outcome equations provide key insights on the significant impact of industrialization on various SDGs. In the first model, a 1 per cent increase in the share of manufacturing in GDP is associated with a 0.242 increase in the SDG index for no poverty (SDG 1), holding other factors constant. Moreover, the mediator variable (*econ_growth*) shows a positive and highly significant coefficient of 0.201, reflecting the overall impact of economic growth on SDG 1, of which 0.09 corresponds to the ACME, capturing the impact of industrialization on SDG 1 mediated through economic growth. This implies that a 27 per cent of industrialization's total effect on poverty reduction (0.09 out of 0.33) is mediated by its positive influence on economic growth. Figure 1 illustrates the ACME, ADE and Total Effect for each of the four baseline models with their 95 per cent confidence intervals.

Similarly, results from Model 2 indicate that industrialization plays a crucial role in reducing hunger (SDG 2), with a direct effect of 0.73 that is highly significant. Agricultural productivity mediates part of this effect, with an ACME of 0.12. This implies that industrialization's total effect on the reduction of hunger is 0.85, with 14 per cent mediated through agricultural productivity. While the direct effect remains the primary channel, these findings suggest that industrialization indirectly supports food security through improved food production and processing capabilities.

Models 3 and 4 further highlight the critical role of innovation as a mediator. In Model 4, industrialization reveals a substantial impact on resource efficiency, with a direct effect of 0.789 and a total effect of 0.99. Of this, 20 per cent is mediated through innovation, a significant indirect channel that emphasizes the critical role of industrial advancements in fostering technological innovations that support sustainable production practices.

Most notably, Model 3 reveals that 48 per cent of the total effect of industrialization on clean energy (SDG 7) is mediated through innovation. Industrialization has a direct and significant impact on clean energy, with an estimated coefficient of 0.181. Innovation, however, significantly mediates this effect, with an ACME of 0.17. This nearly equal distribution between direct and indirect effects underscores the profound influence of industrial innovation in advancing clean energy solutions. It also suggests that industrial development alone is insufficient for significant improvements in clean energy; it must be accompanied by a culture of innovation. By fostering advancements in green technologies, industrial policy can substantially increase the use of clean energy.

Figure 1 ACME, ADE and Total Effect for each of the four baseline models



Note: Dots indicate the estimated effects, and lines signify their 95% confidence interval.

4.2 Robustness checks

To verify the robustness of our results, we performed a series of checks using different model specifications and samples. Detailed regression results for the mediator and outcome equations from these robustness checks are presented in Annex III. Overall, our findings remain consistent, confirming the significant impact of industrialization on socioeconomic and environmental goals, both directly and through mediating variables.

In the first robustness check, we substituted the composite SDG indexes used as the mediator and outcome variables, with individual indicators included in each of the SDGs.[4] This substitution seeks to verify whether the relationships identified in our baseline analysis hold when using raw

[4] For Model 1 (SDG 1 - No Poverty), we used the proportion of the population below the international poverty line as the outcome variable and the annual growth rate of real GDP per capita as the mediator. For Model 2 (SDG 2 - Zero Hunger), we used the prevalence of undernourishment as the outcome variable and labour productivity in the agriculture sector (in logarithmic terms) as the mediator. For Model 3 (SDG 7 - Clean Energy), we used the proportion of the population that relies primarily on clean fuels and technology as the outcome variable, and R&D expenditure as a percentage of GDP as the mediator. For Model 4 (SDG 12 - Resource Efficiency), the outcome variable was domestic material consumption per unit of GDP, and R&D expenditure as a percentage of GDP represented the mediator.

indicators directly sourced from the SDG Global Database. The regression results, presented in Table A.4 of Annex III and reported as beta standardized coefficients to facilitate a relative comparison across variables within each model, confirm the robustness of our findings in the baseline models. Under this alternative setting, industrialization (*manu_GDPsh*) continues to exhibit a significant positive effect on the mediator variables. The outcome equations also maintained their significance, demonstrating that a substantial percentage of industrialization's total effect on the outcome variables is mediated through the mediator variables.

The second robustness check expanded the sample to include advanced economies, i.e. countries classified as "High Income Industrial Economies" by UNIDO's International Yearbook of Industrial Statistics (UNIDO, 2023). This expanded dataset covered 214 countries over the period 2000 to 2021. The findings, reported in Table A.5 of Annex III, are consistent with the baseline results: Industrialization maintains a significant positive impact on the mediators and the outcome equations. This result confirms that the proposed causal pathways are not limited to developing countries but also hold in advanced economies.

These results may be influenced by the specific variable used to capture industrialization. To address this potential bias, we also explored an alternative treatment variable: The share of manufacturing employment in total employment (*manu_EMPsh*), sourced from the ILO Modelled Estimates.[5] Using this variable, our main results hold (see Table A.6 of Annex III), indicating that industrialization has a significant impact on the mediator variables. The outcome regressions also confirmed that a relevant share of industrialization's total effect on each outcome variable was mediated by the variables used.

Another potential source of bias in the reported results concerns the time frame of the analysis, given the exceptional dynamics triggered by the COVID-19 pandemic. To address this potential bias, we considered the subperiod 2010-2019 to focus on more recent years but exclude the potential effects of the COVID-19 pandemic. Once again, the main findings (reported in Table A.7 of Annex III) remained consistent: Industrialization had a significant impact on the mediator variables during this alternative period of analysis, and a notable percentage of its total effect on the outcomes was mediated through these variables.

In our baseline model, the effects of income disparities are only indirectly accounted for through some of the control variables (i.e. human capital). While this strengthens the model's parsimony, the exclusion of income variables may introduce bias in the interpretation of results. To address

[5] Visit: https://ilostat.ilo.org/data/

this potential bias, we expanded the model to include an additional control variable that captures each country's income level relative to that of the United States (*rel_us*), using GDP per capita at constant 2017 international dollars, an indicator frequently used in cross-country comparative analyses to benchmark economic development (Szirmai & Verspagen, 2015). The results, presented in Table A.8, show that the relationship between industrialization and the selected SDGs remains robust even after controlling for income differences.[6] A noteworthy finding emerges in Model 3 (SDG 7), where the direct effect of *manu_gdpsh* on clean energy is negative, suggesting that higher levels of industrialization may initially correlate with lower levels of clean energy adoption. However, the total effect remains positive (0.23), as the negative direct impact is offset by the positive indirect effect mediated through innovation. This highlights the critical role of industrial innovation in promoting the development of green technologies necessary for the clean energy transition.

Finally, we also introduced regional dummy variables as additional controls to account for unobserved regional heterogeneity. This included dummy variables for each of the four developing regions identified by UNIDO (2024): (i) Africa, (ii) Asia-Pacific, (iii) Eastern Europe, and (iv) Latin America and the Caribbean (LAC).[7] The inclusion of these controls (as reported in Table A.9 of Annex III) did not change the significance or magnitude of the estimated coefficients in both the mediator and outcome equations, confirming the robustness of our results.

4.3 Sensitivity analysis

One crucial component of CMA is the assumption of Sequential Ignorability (SI), which is essential for identifying causal channels. This assumption requires that the error terms in the mediator and outcome equations should be independent of each other, which in turn implies that the correlation (denoted as ρ) between the error terms of the mediator equation (ϵ_{i2}) and the outcome equation (ϵ_{i3}) should be zero.

To ensure the robustness of our CMA results, we performed a sensitivity analysis to evaluate how violations of the SI assumption would affect the estimated ACME. This sensitivity analysis aimed to quantify the extent to which the SI assumption would need to be violated to nullify the estimated ACME (Imai et al., 2010). Essentially, this analysis illustrates how sensitive our

[6] This robustness check was applied to all models except Model 1 (SDG 1 – No Poverty) due to data limitations, since the lack of poverty data in high-income countries significantly reduced the sample size and its variability, limiting the results' validity.

[7] Developing regions are defined in accordance with the IDR 2024's regional classification. Africa and Asia-Pacific include all developing economies in Africa and Asia-Pacific, respectively, defined as those not classified by UNIDO as high-income industrial economies. Eastern Europe and LAC include all Eastern European and Latin American and Caribbean States, respectively, listed in the corresponding UN regional group of the General Assembly.

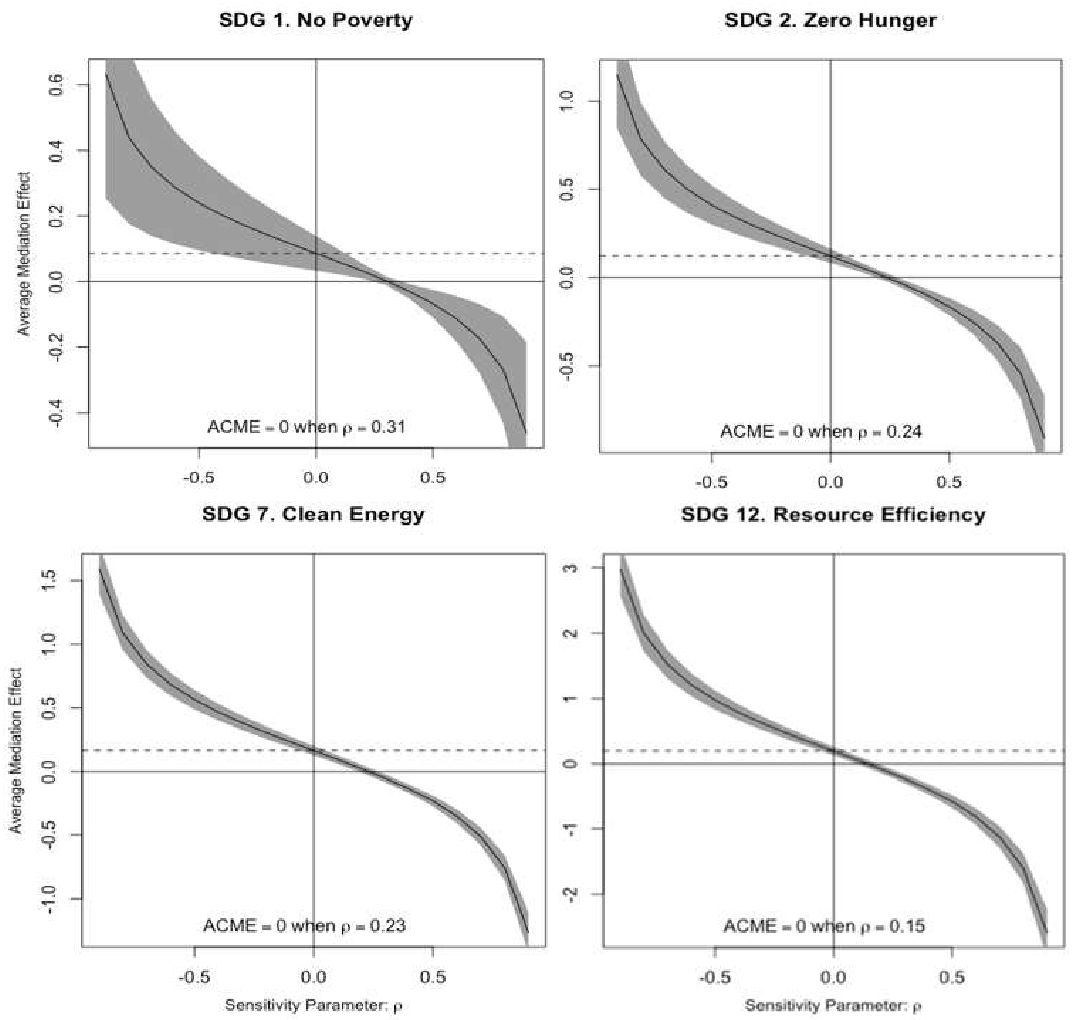
mediation effect is to a potentially omitted variable bias that affects both the mediator and outcome.

Sensitivity analyses rely on the correlation between the error terms of the mediator and outcome equations (ρ), which serves as the sensitivity parameter. If ρ equals zero, it indicates that the SI assumption holds. Non-zero values of ρ imply potential violations of the SI assumption due to omitted variables, thus introducing a bias into the estimated ACME. The goal of a sensitivity analysis is to quantify how much ρ must deviate from zero for the ACME to become insignificant or substantively different from the estimate obtained under the SI assumption. If small deviations in ρ lead to significant changes in the ACME, it implies that the mediation results are sensitive to the SI assumption and therefore less robust.

We conducted sensitivity analyses for the four baseline models to determine the extent to which ρ must be violated for the ACME to be equal to zero. The results are illustrated in Figure 2, which shows the estimated ACME and their 95 per cent confidence intervals as a function of ρ.

The sensitivity analysis reveals that the ACME is equal to zero when ρ is equal to 0.31 in Model 1 (SDG 1 - No Poverty), to 0.24 in Model 2 (SDG 2 - Zero Hunger), to 0.23 in Model 3 (SDG 7 - Clean Energy), and to 0.15 in Model 4 (SDG 12 - Resource Efficiency). These results suggest that a relatively high degree of error correlation is need for the ACME to be equal to zero. In other words, substantial violations of the SI assumption are necessary to nullify the mediation effects observed in our baseline models. Therefore, our findings indicate that the estimated ACME is robust to moderate violations of the SI assumption, reinforcing the validity of our mediation analysis.

Figure 2 Sensitivity analyses for the four baseline models: ACME (ρ)



Note: The dashed line represents the estimated ACME when ρ is zero, and the solid line denotes the estimated ACME at different values of ρ. The grey areas indicate the 95% confidence intervals.`

5 Conclusion

Recent research has increasingly focused on assessing the interconnections between the SDGs, exploring how synergies and trade-offs can either facilitate or hinder progress towards the 2030 Agenda (Anderson et al., 2021; Kroll et al., 2019; Messerli et al., 2020; Miola et al., 2019; Wu et al., 2022). These studies underscore the importance of understanding these interactions to enhance policy coherence, highlighting key SDGs that serve as systemic multipliers or virtuous cycles, which can potentially accelerate outcomes across multiple goals. This body of work emphasizes the need to identify context-specific interactions and develop strategies that maximize co-benefits while managing trade-offs, particularly as sustainable development evolves dynamically over time.

However, these studies often adopt a broad approach, focusing on systemic interactions across goals such as poverty, inequality and environmental sustainability, while rarely considering the central role of industrialization, as outlined in SDG 9. Despite its transformative potential as a driver of economic growth, job creation and technological advancement, the impact of industrialization is often overlooked. Yet, without addressing SDG 9, analyses may underestimate the structural influence of industry on sustainable development and its essential role in achieving socioeconomic and environmental progress.

One possible explanation for this oversight is that the developmental effects of industrialization are often mediated through its impact on other variables, such as economic growth, agricultural productivity and innovation. For example, while an expanding industrial sector might not directly lift a significant number of people out of extreme poverty, it creates the conditions to stimulate economic growth, which, in turn, can substantially reduce poverty levels. This pattern holds across various SDGs; industrialization's influence on hunger reduction, clean energy adoption and resource efficiency often operates through indirect channels, thereby amplifying the sector's impact on sustainable development.

This paper aims to address this limitation by explicitly incorporating both the direct and indirect effects of industrialization on selected SDGs. By employing CMA, a recent method developed by Imai et al. (2010), and leveraging a newly developed dataset on SDG achievement across countries, this study is among the first to disentangle the channels through which industrialization influences socioeconomic and environmental outcomes.

The results of this analysis demonstrate that industrialization has a profound impact on several SDGs, not only through direct but also through significant indirect channels. First, industrialization's potential to lift people out of poverty is amplified by its ability to enhance economic growth. Additionally, industry's role in fighting hunger is complemented by its capacity to improve agricultural productivity, showcasing the synergy between industrial and agricultural advancements. Industrialization also contributes to enhanced resource efficiency, with innovation playing a critical mediating role. Finally, innovations driven by industrialization play a key role in promoting clean energy solutions to achieve environmental sustainability.

These dual channels underscore the importance of coupled strategies: The direct and indirect benefits of industrialization can be further enhanced by promoting conditions that lead to wider economic growth, implementing agricultural reforms that benefit from industrial innovations, and fostering innovative practices within the industrial sector to maximize environmental gains.

Leveraging both the direct and indirect channels of industrial impact should be central to the design of effective industrial policies. Policymakers should foster environments that enhance not only manufacturing capabilities but also support complementary sectors such as agriculture and innovation. By integrating targets across multiple SDGs, industrial policies can multiply their developmental impact. Such strategies will be crucial for achieving the transformative potential of modern industrial policy to turn global challenges into sustainable solutions.

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Annexes

Annex I: SDG Assessment Methodology

UNIDO (2024) has introduced a novel approach to assessing the progress of developing countries towards achieving the relevant targets of selected SDGs. This assessment is based on the global indicator framework of the 2030 Agenda for Sustainable Development, which was developed by the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs), and adopted by the United Nations General Assembly (UNGA) in 2017, with further refinements made in subsequent years.

- **Data selection:** The analysis sourced data exclusively from the SDG Global Database, using its most recent data from September 2023. The dataset spans the period from 2000 to 2021 and includes all countries with available data.
- **Indicators:** Indicators selected from the official SDG indicators list had to meet the following two criteria to be included in our analysis (Table A.1 presents these indicators):
    1. Country coverage: Data should be available for at least one year between 2015 and 2021 in countries representing 50 per cent or more of the total population in each of the four developing regions included in the IDR 2024.
    2. Analytical relevance: The indicator should be relevant for UNIDO and related to some of the analytical dimensions used in the analysis.
- **Setting of targets:** For each indicator included in the analysis, a quantitative and fixed target is established for the year 2030 (the complete list of indicators with the defined quantitative target and type of target is available in Table A.1). The selection is based on the following rules:
    1. Ideal target: Whenever possible, the target is aligned with the ideal outcome outlined in the 2030 Agenda. These typically represent a fixed value identified in the wording of the specific target (for instance, indicators such as “population with access to electricity” have a clear goal of 100 per cent coverage, reflecting the SDGs’ universal objectives).
    2. Best observed performance: In cases where no ideal value is specified, the target is defined using the best performance observed within the dataset, excluding outliers. This method accounts for the directionality of indicators and sets realistic and achievable targets by avoiding anomalous values that could distort the objective:
        a. Positive direction indicators: For indicators where higher values indicate better outcomes, the target is set at the 95th percentile (p95) of the distribution of all observed values over the period covered by the data.

b. Negative direction indicators: For indicators where lower values signify better performance, the target is set at the 5th percentile (p05) of the observed distribution in the period covered by the data.

Table A.1. Official SDG indicators and targets used in the assessment

SDG	Indicator	Dimension	Indicator series used	Target type	Target value
1	1.1.1	No Poverty	Employed population below the international poverty line, by sex and age (%)	Ideal	0
	1.1.1	No Poverty	Proportion of population below the international poverty line (%)	Ideal	0
	1.2.1	No Poverty	Proportion of population living below the national poverty line (%)	Ideal	0
2	2.1.1	Zero Hunger	Prevalence of undernourishment (%)	Ideal	0
	2.1.2	Zero Hunger	Prevalence of moderate or severe food insecurity (%)	Ideal	0
	2.3.0	Agricultural Productivity	Labour productivity in the agriculture sector	Best performer	56,652
7	7.1.2	Clean energy	Proportion of population with primary reliance on clean fuels and technology (%)	Ideal	100
	7.2.1	Clean energy	Renewable energy share in total final energy consumption (%)	Ideal	100
	7.b.1	Clean energy	Installed renewable electricity-generating capacity (watts per capita)	Best performer	1,260
8	8.1.1	Economic growth	Annual growth rate of real GDP per capita (%)	Best performer	7.5
	8.2.1	Economic growth	Annual growth rate of real GDP per employed person (%)	Best performer	6.7
9	9.5.1	Innovation	R&D expenditure as a share of GDP (%)	Best performer	3.1
	9.5.2	Innovation	Researchers (in full-time equivalent) per million inhabitants (per 1,000,000 population)	Best performer	8,714
12	12.2.2	Resource efficiency	Domestic material consumption per unit of GDP (kg per constant 2015 USD)	Best performer	0.1

- **Data gaps imputations:** After establishing the targets, any missing data points in the official SDG dataset are completed using standard imputation techniques. This process follows a three-step algorithm designed to apply the most appropriate imputation method given the data's characteristics and the pattern of missing data:
    1. Linear interpolation is applied when missing values occur between two years with existing data;
    2. Automatic ARIMA (Auto Regressive Integrated Moving Average) is used to impute forward values when there are at least five consecutive years of available data;

3. Last Observation Carried Forward (LOCF) is used to impute missing data forward in time, and the Next Observation Carried Backward (NOCB) method is applied to backward imputation, when neither of the previous two methods is feasible.

- **Normalization:** After completing all possible gaps in the country-level series, the resulting data are normalized to ensure comparability across all indicators, countries and years.
    - Each indicator is normalized on a scale from 0 to 1 using a min-max normalization technique. This method adjusts the data points so that a score of 1 directly corresponds to the achievement of the predefined fixed target. A value of 1 signifies optimal target achievement. The normalization is universally applied across all countries and years included in the analysis.
    - For indicators where a higher value indicates better performance (positive direction), normalization directly scales the values towards the defined target, with the target representing the maximum (1) on the scale. Conversely, for indicators with a negative direction, where lower values are better, the transformation is on the inverse so that lower values approach the maximum normalized value (1).
- **Clustering by dimension:** To conduct the SDG assessment, the indicators included in the analysis are clustered into analytical dimensions for each SDG. Table A.2 provides an overview of the indicators included in each dimension of our analysis. The data are aggregated into these dimensions by calculating a simple average of the normalized values of the indicators within each dimension. This method provides a composite score for each dimension, reflecting the collective performance of the indicators it encompasses.

Table A.2 Official indicators included in each dimension of the SDGs under analysis

SDG	Dimension	Indicators
1	No poverty	1.1.1, 1.2.1
2	Zero hunger	2.1.1, 2.1.2
2	Agricultural productivity	2.3.0
7	Clean energy	7.1.2, 7.2.1, 7.b.1
8	Economic growth	8.1.1, 8.2.1
9	Innovation	9.5.1, 9.5.2
12	Resource efficiency	12.2.2

Annex II: Countries included in the econometric exercise

Table A.3 Developing countries included in the analysis and geographical region

Africa (55)			
Algeria	Djibouti	Liberia	Senegal
Angola	Egypt	Libya	Seychelles
Benin	Equatorial Guinea	Madagascar	Sierra Leone
Botswana	Eritrea	Malawi	Somalia
Burkina Faso	Eswatini	Mali	South Africa
Burundi	Ethiopia	Mauritania	South Sudan
Cabo Verde	Former Sudan	Mauritius	Sudan
Cameroon	Gabon	Morocco	Togo
Central African Republic	Gambia	Mozambique	Tunisia
Chad	Ghana	Namibia	Uganda
Comoros	Guinea	Niger	United Rep. of Tanzania
Congo	Guinea-Bissau	Nigeria	Zambia
Côte d'Ivoire	Kenya	Rwanda	Zimbabwe
D.R. of the Congo	Lesotho	Sao Tome and Principe	
Asia-Pacific (55)			
Afghanistan	Indonesia	Mongolia	Syrian Arab Republic
Bahrain	Iran (Islamic Republic of)	Myanmar	Tajikistan
Bangladesh	Iraq	Nepal	Thailand
Bhutan	Jordan	Oman	Timor-Leste
Cambodia	Kazakhstan	Pakistan	Tonga
China	Kiribati	Palau	Turkey
China, Hong Kong SAR	Kuwait	Papua New Guinea	Turkmenistan
China, Macao SAR	Kyrgyzstan	Philippines	Tuvalu
Cook Islands	Lao People's D.R.	Qatar	United Arab Emirates
Cyprus	Lebanon	Samoa	Uzbekistan
D.P.R. of Korea	Malaysia	Saudi Arabia	Vanuatu
Fiji	Maldives	Solomon Islands	Viet Nam
French Polynesia	Marshall Islands	Sri Lanka	Yemen
India	Micronesia (F.S. of)	State of Palestine	

Eastern Europe (24)			
Albania	Croatia	Latvia	Romania
Armenia	Czechia	Lithuania	Russian Federation
Azerbaijan	Estonia	Montenegro	Serbia
Belarus	Georgia	North Macedonia	Slovakia
Bosnia and Herzegovina	Hungary	Poland	Slovenia
Bulgaria	Kosovo	Republic of Moldova	Ukraine
Latin America and the Caribbean (43)			
Anguilla	Chile	Guyana	Puerto Rico
Antigua and Barbuda	Colombia	Haiti	Saint Kitts and Nevis
Argentina	Costa Rica	Honduras	Saint Lucia
Aruba	Cuba	Jamaica	Sint Maarten (Dutch part)
Bahamas	Curaçao	Mexico	St. Vincent and the Grenadines
Barbados	Dominica	Montserrat	Suriname
Belize	Dominican Republic	Netherlands Antilles	Trinidad and Tobago
Bolivia (P.S. of)	Ecuador	Nicaragua	Turks and Caicos Islands
Brazil	El Salvador	Panama	Uruguay
British Virgin Islands	Grenada	Paraguay	Venezuela (B.R. of)
Cayman Islands	Guatemala	Peru	

Note: EE = Eastern Europe, LAC = Latin America and the Caribbean.

Annex III: Regression results of robustness checks

Table A.4. Robustness Check 1: Different mediators - Regression results

Dependent Variable = Mediator	**(1) growth_pc**	**(2) agriprod**	**(3) rd_exp**	**(4) rd_exp**
manu_gdpsh	0.106***	0.074***	0.311***	0.306***
	(0.024)	(0.016)	(0.020)	(0.020)
urbanpop	-0.133***	0.635***	0.285***	0.308***
	(0.022)	(0.015)	(0.020)	(0.020)
hc	-0.043	-0.008	-0.001	-0.000
	(0.022)	(0.015)	(0.020)	(0.020)
pop	0.080***	-0.239***	0.144***	0.158***
	(0.024)	(0.015)	(0.020)	(0.020)
Observations	1,945	2,369	2,089	2,149
R-squared	0.04	0.48	0.20	0.20
Dependent Variable = Outcome	**(1) SDG 1**	**(2) SDG 2**	**(3) SDG 7**	**(4) SDG 12**
manu_gdpsh	-0.079***	-0.176***	0.101***	-0.129***
	(0.020)	(0.017)	(0.015)	(0.018)
growth_pc	-0.160***			
	(0.019)			
agriprod		-0.574***		
		(0.022)		
rd_exp			0.165***	-0.096***
			(0.015)	(0.018)
urbanpop	-0.573***	-0.053*	0.701***	-0.590***
	(0.019)	(0.021)	(0.014)	(0.018)
hc	-0.006	0.031	-0.006	-0.000
	(0.018)	(0.016)	(0.013)	(0.017)
pop	0.110***	-0.086***	-0.140***	0.068***
	(0.020)	(0.018)	(0.0140)	(0.018)
ACME	-0.017***	-0.042***	0.051***	-0.029***
Direct Effect	-0.079***	-0.176***	0.101***	-0.129***
Total Effect	-0.095***	-0.218***	0.152***	-0.189***
% of Tot Eff mediated	18%	19%	34%	19%
Observations	1,945	2,369	2,089	2,149
R-squared	0.35	0.35	0.62	0.40

Notes: Robust standard errors in parenthesis. Beta standardized coefficients. In Model 2, the variable agriprod is introduced in logarithmic form. Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

Table A.5. Robustness Check 2: Different sample - Regression results

Dependent Variable = Mediator	(1) *econ_growth*	(2) *agri_prod*	(3) *innovation*	(4) *innovation*
manu_gdpsh	0.426*** (0.131)	0.408*** (0.047)	1.000*** (0.083)	1.114*** (0.081)
urbanpop	-0.002*** (0.000)	0.004*** (0.000)	0.006*** (0.000)	0.006*** (0.000)
hc	-0.008 (0.005)	-0.003 (0.002)	0.000 (0.003)	0.000 (0.003)
pop	0.022*** (0.004)	-0.021*** (0.001)	0.012*** (0.002)	0.014*** (0.002)
Constant	0.241*** (0.066)	0.200*** (0.022)	-0.488*** (0.043)	-0.523*** (0.043)
Observations	1,641	1,989	2,440	2,500
R-squared	0.06	0.44	0.33	0.33

Dependent Variable = Outcome	(1) SDG 1	(2) SDG 2	(3) SDG 7	(4) SDG 12
manu_gdpsh	0.242** (0.082)	0.722*** (0.066)	-0.097** (0.049)	0.748*** (0.082)
econ_growth	0.201*** (0.015)			
agri_prod		0.320*** (0.031)		
innovation			0.353*** (0.012)	0.193*** (0.019)
urbanpop	0.006*** (0.000)	0.003*** (0.000)	0.001*** (0.000)	0.007*** (0.000)
hc	0.001 (0.003)	-0.004 (0.003)	0.001 (0.002)	0.000 (0.003)
pop	-0.008** (0.003)	0.009*** (0.002)	-0.014*** (0.001)	-0.005** (0.002)
Constant	0.481*** (0.041)	0.367*** (0.031)	0.531*** (0.026)	0.203*** (0.043)
ACME	0.09**	0.13**	0.35**	0.22**
Direct Effect	0.24**	0.72**	-0.10	0.75**
Total Effect	0.33**	0.85**	0.26**	0.96**
% of Tot Eff mediated	27%	15%	138%	23%
Observations	1,641	1,989	2,440	2,500
R-squared	0.37	0.33	0.44	0.53

Notes: Robust standard errors in parenthesis. Sample includes developing countries and advanced countries –those classified as High-Income Industrial Economies by UNIDO's Industrial Statistical Yearbook (UNIDO, 2023)-. Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

Table A.6. Robustness Check 3: Different treatment - Regression results

Dependent Variable = Mediator	(1) *econ_growth*	(2) *agri_prod*	(3) *innovation*	(4) *innovation*
manu_EMPsh	0.350**	0.327***	0.907***	0.836***
	(0.127)	(0.038)	(0.033)	(0.033)
urbanpop	-0.002***	0.003***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
hc	-0.008	-0.003*	-0.001	-0.001
	(0.005)	(0.002)	(0.002)	(0.002)
pop	0.024***	-0.018***	0.004***	0.005***
	(0.004)	(0.001)	(0.001)	(0.001)
Constant	0.230***	0.205***	-0.124***	-0.138***
	(0.065)	(0.020)	(0.022)	(0.022)
Observations	1,657	1,929	1,920	1,980
R-squared	0.06	0.39	0.36	0.33

Dependent Variable = Outcome	(1) SDG 1	(2) SDG 2	(3) SDG 7	(4) SDG 12
manu_EMPsh	1.194***	1.102***	0.173***	1.194***
	(0.074)	(0.056)	(0.043)	(0.087)
econ_growth	0.189***			
	(0.014)			
agri_prod		0.313***		
		(0.033)		
innovation			0.212***	0.087*
			(0.025)	(0.051)
urbanpop	0.005***	0.002***	0.001***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
hc	0.001	-0.003	0.000	0.000
	(0.003)	(0.003)	(0.002)	(0.004)
pop	-0.013***	0.010***	-0.011***	-0.004
	(0.002)	(0.002)	(0.001)	(0.003)
Constant	0.529***	0.358***	0.434***	0.178***
	(0.038)	(0.030)	(0.024)	(0.051)
ACME	0.07**	0.10**	0.19**	0.08
Direct Effect	1.19**	1.10**	0.17**	1.19**
Total Effect	1.26**	1.20**	0.37**	1.27**
% of Tot Eff mediated	5%	9%	53%	6%
Observations	1,657	1,929	1,920	1,980
R-squared	0.46	0.39	0.24	0.47

Notes: Robust standard errors in parenthesis. The treatment variable (manu_EMPsh) is the share of manufacturing employment in total employment. Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

Table A.7. Robustness Check 4: Different period - Regression results

Dependent Variable = Mediator	(1) *econ_growth*	(2) *agri_prod*	(3) *innovation*	(4) *innovation*
manu_gdpsh	0.498**	0.447***	1.012***	0.911***
	(0.162)	(0.075)	(0.073)	(0.072)
urbanpop	-0.003***	0.003***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
hc	-0.003	-0.001	0.002	0.002
	(0.006)	(0.003)	(0.003)	(0.003)
pop	0.022***	-0.021***	0.000	0.000
	(0.005)	(0.002)	(0.002)	(0.002)
Constant	0.251***	0.217***	-0.113**	-0.120**
	(0.079)	(0.033)	(0.038)	(0.038)
Observations	1,029	969	950	980
R-squared	0.10	0.37	0.24	0.23

Dependent Variable = Outcome	(1) SDG 1	(2) SDG 2	(3) SDG 7	(4) SDG 12
manu_gdpsh	0.322**	0.549***	0.220**	0.650***
	(0.105)	(0.106)	(0.075)	(0.145)
econ_growth	0.191***			
	(0.020)			
agri_prod		0.406***		
		(0.045)		
innovation			0.234***	0.352***
			(0.031)	(0.059)
urbanpop	0.005***	0.002***	0.001***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
hc	0.002	-0.002	0.002	0.002
	(0.004)	(0.004)	(0.003)	(0.006)
pop	-0.008**	0.012***	-0.015***	-0.009**
	(0.003)	(0.003)	(0.002)	(0.004)
Constant	0.518***	0.359***	0.499***	0.313***
	(0.051)	(0.046)	(0.036)	(0.071)
ACME	0.10**	0.18**	0.24**	0.33**
Direct Effect	0.32**	0.55**	0.22**	0.65**
Total Effect	0.42**	0.73**	0.46**	0.97**
% of Tot Eff mediated	23%	25%	52%	33%
Observations	1,029	969	950	980
R-squared	0.34	0.27	0.25	0.42

Notes: Robust standard errors in parenthesis. Sample only includes the subperiod 2010-2019. Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

Table A.8. Robustness Check 5: Control by income differences - Regression results

Dependent Variable = Mediator	(2) *agri_prod*	(3) *innovation*	(4) *innovation*
manu_gdpsh	0.336*** (0.043)	0.880*** (0.073)	1.073*** (0.073)
urbanpop	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
hc	-0.002 (0.002)	0.002 (0.003)	0.002 (0.003)
pop	-0.019*** (0.001)	0.028*** (0.002)	0.029*** (0.002)
rel_us	0.262*** (0.012)	0.351*** (0.012)	0.302*** (0.012)
Constant	0.215*** (0.020)	-0.624*** (0.038)	-0.662*** (0.038)
Observations	1,955	2,400	2,460
R-squared	0.55	0.51	0.48
Dependent Variable = Outcome	**(2) SDG 2**	**(3) SDG 7**	**(4) SDG 12**
manu_gdpsh	0.639*** (0.065)	-0.133** (0.050)	0.853*** (0.081)
econ_growth			
agri_prod	0.146*** (0.033)		
innovation		0.412*** (0.013)	0.069*** (0.022)
urbanpop	0.002*** (0.000)	0.001*** (0.000)	0.006*** (0.000)
hc	-0.003 (0.003)	0.000 (0.002)	0.002 (0.003)
pop	0.007*** (0.002)	-0.018*** (0.001)	0.005** (0.002)
rel_us	0.244*** (0.020)	-0.067*** (0.009)	0.182*** (0.014)
Constant	0.426*** (0.030)	0.595*** (0.026)	0.069 (0.043)
ACME	0.05**	0.36**	0.07**
Direct Effect	0.64**	-0.13**	0.85**
Total Effect	0.69**	0.23**	0.92**
% of Tot Eff mediated	7%	160%	8%
Observations	1,955	2,400	2,460
R-squared	0.39	0.45	0.55

Notes: Robust standard errors in parenthesis. The variable "rel_us" is calculated comparing a country's GDP per capita (in constant 2017 intl USD) relative to the US GDP per capita. Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

Table A.9. Robustness Check 6: Regional dummy variables - Regression results

Dependent Variable = Mediator	(1) *econ_growth*	(2) *agri_prod*	(3) *innovation*	(4) *innovation*
manu_gdpsh	0.259**	0.201***	0.554***	0.513***
	(0.126)	(0.045)	(0.036)	(0.037)
urbanpop	-0.003***	0.003***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
hc	-0.004	-0.003*	0.001	0.001
	(0.005)	(0.002)	(0.001)	(0.002)
pop	0.020***	-0.018***	0.013***	0.013***
	(0.004)	(0.001)	(0.001)	(0.001)
dum_LAC	-0.107***	0.015**	-0.049***	-0.057***
	(0.019)	(0.007)	(0.005)	(0.005)
dum_Africa	-0.151***	-0.035***	0.020***	0.019***
	(0.014)	(0.005)	(0.005)	(0.005)
dum_EE	0.081***	-0.002	0.130***	0.127***
	(0.020)	(0.007)	(0.005)	(0.005)
Constant	0.398***	0.243***	-0.313***	-0.326***
	(0.067)	(0.022)	(0.021)	(0.021)
Observations	1,641	1,929	1,900	1,960
R-squared	0.18	0.41	0.51	0.49

Dependent Variable = Outcome	(1) SDG 1	(2) SDG 2	(3) SDG 7	(4) SDG 12
manu_gdpsh	0.035	0.478***	-0.077*	0.664***
	(0.069)	(0.056)	(0.041)	(0.102)
econ_growth	0.081***			
	(0.014)			
agri_prod		0.254***		
		(0.028)		
innovation			0.244***	0.194***
			(0.024)	(0.060)
urbanpop	0.004***	0.002***	0.000**	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
hc	0.003	-0.001	0.000	0.001
	(0.003)	(0.002)	(0.002)	(0.004)
pop	-0.011***	0.004**	-0.007***	-0.006*
	(0.002)	(0.002)	(0.001)	(0.003)
dum_LAC	-0.107***	-0.113***	0.145***	-0.010
	(0.010)	(0.008)	(0.006)	(0.015)
dum_Africa	-0.206***	-0.176***	-0.001	-0.099***
	(0.008)	(0.007)	(0.005)	(0.013)
dum_EE	-0.006	0.028***	0.081***	0.032**
	(0.011)	(0.008)	(0.006)	(0.015)
Constant	0.790***	0.595***	0.418***	0.292***
	(0.037)	(0.028)	(0.024)	(0.060)
ACME	0.02**	0.05**	0.13**	0.10**
Direct Effect	0.04	0.48**	-0.08	0.67**
Total Effect	0.06	0.53**	0.06	0.77**
% of Tot Eff mediated	21%	10%	206%	13%
Observations	1,641	1,929	1,900	1,960
R-squared	0.57	0.57	0.46	0.46

Notes: Robust standard errors in parenthesis. Regional dummy variables aligned to the IDR 2024 regional classification. Significance at the 1% level is denoted by ***; at the 5% level by **; and at the 10% level by *.

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