Measuring structural transformation process: A Comparative performance of countries and regions across the world

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Abstract: The paper presents a methodology known as the Modified Structural Change/Transformation Index (MSCI) that enables comparisons of the extent of structural transformation/change across countries and regions without considering the historical context of each case's structural transformation. This is significant because developed countries initiated their structural transformation much earlier than emerging and developing countries. The methodology compares the average contributions of economic sectors to GDP between 1970-1975 and 2017-2022 to evaluate structural transformation in countries and regions around the world. The proposed methodology (MSCI) has demonstrated that its findings closely reflect the developmental performance of the countries and regions being assessed based on their average GDP per capita, compared to the results obtained through the traditional Structural Change Index (SCI) for measuring structural transformation. Two goodness-of-fit tests were employed to ensure the reliability of the statistical analysis results. The paper confirms that the proposed methodology requires further research to refine it. Variables such as economic complexity, human capital, and institutional quality could be considered to enhance measurement accuracy.

Key words :Structural change, structural transformation, methodology, Development.

I. INTRODUCTION

Structural transformation - theoretical and applied connotations:

The literature on structural transformation primarily originates from the literature on the development process and from the literature that sought to explain long-term economic growth, before more specific and independent studies on the topic emerged. In this context, the paper highlights the most important contributions that have emerged and paved the way for structural transformation issues in the literature on the interpretation of growth and development. At the level of literature associated with the interpretation of growth come the contributions of the New Classical School (Swan, 1956; Solow, 1956, 1957, 1988), which were based on the contributions of Keynesians (Harrod-Domar) - as well as on growing empirical research on the interpretation of long-term growth. In the Solo-Swan model, the technology variable was used as an exogenous interpreter of growth, based on a basic hypothesis represented in substitution as well as Constant-Returns-to-Scale (CRS) between the two components of production (Labour, capital), in the sense that double employment and capital automatically multiply output, With the law in force of Diminishing Returns in the short-term.

Therefore, the allocation of factors of production and their returns and the transformation between them can be seen as a growth interpreter. The contributions of Romer (1986) and Lucas (1988) agreed with the previous approach but differed in their dealing with the technology and other intangible factors, such as institutions, regulations, human capital, etc, as endogenous factors that explain economic growth rather than complement the unexplained part of it, in what is called "Solow Residual" .In addition to Barrow's contributions, especially those related to Economic Convergence, where poorer or less developed countries or territories (such as developing countries) tend to grow faster than those that are wealthier or more advanced (such as developed countries), there is a potential of structural transformation arising from the Diminishing Returns law, where less developed countries are at increasing Returns stage (Barro and Sala-I-Martin,1991., INESAD,2007).

As part of tracking the roots of structural transformation within the development literature, the pioneering contributions of Clark (1957)., Chinery (1960)., Chenery et al (1986)., Kuznets (1966, 1971) and Syrquin (1988) are founded for structural transformation literature. The concept of "structure" and "structural change", which becomes later referred to as "structural transformation", is associated with the development economics literature, paving the way for the propagation of structural change models. In the context of development economics, the topics of changing sector shares in GDP and changing productivity have emerged as an interpreter of the development process, and the importance of the manufacturing sector as a sector underpinning the structural change process has emerged. Additionally, attention has been given to the pivotal role of the manufacturing sector in the process of structural change, along with the analysis of behavioural and technological relationships, such as technical transactions in the Input-Output Model.

Furthermore, this involves consideration of other macro variables that affect the manufacturing process, including demand and trade structure, expenditure structure, and saving and capital accumulation.

In this context, the researchers' contributions emphasize that structural change is characterized by increases in savings and accumulation rates (Lewis, 1954, and Rostow, 1960), as well as a transformation in the economy's sectoral composition. This transformation involves reallocating "employment" from the primary sector (agriculture, fishing, forestry, mining) to the secondary sector (manufacturing and construction) (Fisher, 1939; Clark, 1940; Lewis, 1954). Later, the focus shifted to "production and production factors" (Kuznets, 1971; Chenery, 1986). Additionally, it encompasses the changing urbanization of economic activity sites and other phenomena associated with the growing industrialization process, such as demographic shifts and income distributions (Syrquin, 1988). These structural transformation features are the requirements for achieving the development process. Thus, it can be emphasized that the structural transformation process has two main features: the first is a long-term trend of accumulation rates growth (savings), and the second is a change in the relative importance of sectors/activities/products in the sense of a reallocation of factors of production (Syrquin, 1988). On the other hand, many applied studies have examined the relationship between structural change and economic growth, as measured by the growth of GDP per capita. These studies emphasize the strength and significance of the relationship between these two variables, although they differ in their estimation of causality. (Amable, 2000., Aboshammala,2020., Memedovic, and Apadre, 2010).

However, over the past four decades, researchers have concentrated on investigating the factors that lead to structural transformation, aiming to understand why some states and territories have undergone rapid transformation while others have not. These studies have emphasized the significance of the manufacturing sector in a country's ability to diversify and develop its export portfolio. The varying levels of progress from country to country are evident clearly in their export product lists. Ultimately, achieving structural transformation depends on transforming a country's product and industry composition. This involves transitioning from producing simple goods (as in developing countries) to producing more complex goods (as in developed countries), considering the opportunities generated by each transformation; it involves the possibility of producing new products within the so-called "Product Space" in an ongoing development process. Accelerate structural transformation as well as economic diversification, based on the fact that each product relies on specific inputs such as knowledge, physical assets, intermediate goods, labour training requirements, infrastructure adequacy and quality, property rights, regulatory requirements, etc., which in turn qualify to produce various other commodities lists, which will, in turn, qualify latterly to produce other commodity lists, And so... (Hausmann and Rodrik, 2003., Hausmann et al., 2023).

According to the results of these applied studies, the structural transformation process in the short-term tends to move to new activities associated with existing activities, so countries must consider guiding the long-term transition towards products with higher technical content, which means achieving long-term development (McNerney et al., 2021). The studies also highlighted the underlying causes that may impede such a transition or structural transformation, the most important of which is "Marker failure", with broad causes such as inadequate education and training, monopoly, etc. Therefore, governments have an essential role in formulating and implementing policies to address bottlenecks in the transformation process and to ensure its sustainability (Hausmann & Klinger, 2006).

Overall, Dealing with the issue of structural transformation (change) by researchers based on econometric methods and modelling has given many dimensions to measuring structural change, and considerations have emerged, such as how close (distant) the economy is from equilibrium/stability, where the model is stable Econometricly when the structure is fixed (unchanged). This analysis has allowed for the investigation of variables such as inequalities in the "factors production return" between sectors. So, a country of instability cannot persist if left restricted, as the movement resulting from such discrepancies leads to structural change.

In this context, instability leads to structural changes. Where Factors of production move between sectors in response to differences in productivity and factor returns. However, experience shows that this temporary situation can become long-term if the transition occurs slowly. For example, there may be a wage gap (labour return) between sectors, which is supposed to drive structural change. This change is expected to be facilitated by the flexibility of labour markets and movement freedom, allowing inequalities to disappear as workers move from lower-paid sectors to higher-paid ones until a balance is achieved. However, reality may involve external constraints that may prevent, disrupt or slow down the movement of factors of production between sectors, thus disrupting the dynamic of such structural change, such as those related to a market failure (UNCTAD,2014., ILO,2014).

Experience from various countries indicates that addressing imbalances and implementing structural changes can promote economic growth by utilizing resources more efficiently. Due to greater imbalances across sectors and productivity disparities, developing countries are anticipated to benefit more from this

than developed and emerging countries. According to certain studies, this structural shift contributes to over one-third of these nations' total factor productivity (TFP) growth (Rodrik et al., 2016).

Studies and research on catching up and measuring structural transformation over time have faced numerous reviews and criticisms regarding their methodologies and results. The criticism mainly stems from the evolution and expansion of databases used to analyze and interpret structural transformation. These databases have increased the availability of data for a larger number of countries, especially from developing countries. Additionally, the expansion is a result of the extension of time series associated with the recalculation of historical data in many countries. All these factors have contributed to generating new results to interpret and document the stages and characteristics of structural transformation (University of Groningen, 2023).

II. METHODOLOGY

Structural Transformation Measurement:

Lewis and Chenery's methodology relies on the contribution of productive sectors to employment or output. Structural transformation involves reallocating labour from traditional to modern activities that drive economic growth or from lower-value-added primary activities to higher-value-added activities. The critical lesson is not simply to transition from one sector or activity to another but to focus on increasing productivity and growth as the drivers of transformation and long-term growth towards studies aimed at interpreting structural transformation by indicating the quality of activities/products, based on their embedded knowledge/ technology content (Hausmann et al,2022., UNCTAD,2016).

Theoretical foundations, understanding, and interpretation of structural transformation have seen significant advancements. Many previous studies measuring and interpreting the structural transformation of a country or group of countries have produced varied or conflicting results when re-measured. This can be attributed to three main factors: First, the amount of available data has increased due to the inclusion of more countries, particularly from developing countries. Second, time series data has expanded by "moving forward" in time or by estimating historical data for numerous countries worldwide "moving backwardsLastly, advancements in statistical and econometric methods, as well as technical capabilities for processing data, have contributed to these advancements (University of Groningen,2023).

The most important structural transformation measurement approaches can be elaborated in two core approaches. The first is based on measuring structural transformation through changes in the supply structure (Production) Using labour share or value-added share in economic sectors; the second depends on measuring structural transformation through shifts in demand structure (expenditure), including changes in consumption structure, investment and foreign trade (Rodrik, et. al,2016).

There are many observations that researchers have made about various approaches and measures aimed at assessing the ability of each approach to reflect the reality of structural transformation accurately. For instance, supporters of measuring structural transformation through supply-based labour Sectoral shares argue that it is necessary to rely on the criterion of "hours worked." However, this criterion is unavailable for many countries, especially in most developing countries. As an alternative, the criterion of "number of workers" is used, but it is less accurate in explaining the development of productivity across sectors and economic activities. On the other hand, the value-added structure data or expenditure structure on current or constant prices has its advantages and results that may not align. The most important reason for the differences between the results of structural transformation measurement methods may be that both employment quotas and value-added are linked to production; in contrast, expenditure quotas are associated with consumption, and therefore, their measures may show different behaviours because value-added varies from the final consumption (UNCTAD, 2016).

The literature often considers different metrics interchangeable when documenting resource reallocation between economic activities over time. However, reviews of structural transformation measurement approaches reveal that three important factors and their implications affect these metrics: the classification levels of sectors/activities/industries, the time period, and the kind of price (current or constant).

With regard to classification level, Aggregates can obscure important findings when evaluating structural transformation. Changes in a particular economic sector, driven by increased demand and productivity growth, may be overshadowed by declines in other industries.

With regard to time period, measuring structural transformation at a specific time period can be affected by the impact of cyclical fluctuations on sector performance. Year-to-year comparisons may show volatility due to temporary factors or business cycle effects, which can obscure long-term changes. To address this, it is preferable to compare data over a longer time frame using similar business cycle points. However, studies indicate that business cycles tend to vary across countries. In many studies, the criteria are based on tracking sector quotas as an average of more than four years at the beginning and end of the relevant time period. This provides better evidence of structural transformations, away from the effects of temporary or unusual changes.

With regard to kinds of value-added prices, Many researchers prefer to use current prices when measuring changes/transformations in production quotas, as they consider them to be more accurate for

understanding the dynamics of factors of production and reallocation between different sectors and economic activities. Where Current prices depend on both quantities and relative prices, providing a clear measure of net structural change. On the other hand, some proponents advocate using constant prices, as they enable the measurement of changes in the volume or quantity of production in response to changes in relative prices, offering insight into how industries or activities respond to changes in relative productivity levels. So, both price measures offer valuable information on structural change measurement (Aboshammalah, 2020)

Based on the foregoing and given the limited availability of data, especially for developing and less developed countries (LDCs), the first approach to measuring structural change often relies upon using transformation in supply in terms of value-added quotas.

In this context, a commonly used method for measuring changes in output (and employment) is the rate or magnitude of structural change, often referred to as the "SCI Structural Change Index." This index can be defined as half of the total absolute value of VAT differences between two-time points and can be calculated using the following formula (OECD, 1994, 2014., Lippoldt, 2005)

$$SCI = \frac{1}{2}\Sigma|x_{i\cdot t} - x_{i\cdot t-1}|$$

Where:

(SCI) Structural Change Index

(Xj, t) Value added (%) to sector j at time point

(Xj, t-1 Value Added (%) to sector j at time point t-1

This methodology measures the contributions of economic sectors to GDP for the two periods being measured using absolute values. This ensures that both positive and negative changes in sector quotas are not cancelled out when values are collected across sectors. The value of SCI varies between 0 and 100, where zero expresses no structural change or transformation, while 100 expresses a complete structural change or transformation (complete reversal).

Rodrik (2013) suggests that, according to the catch-up convergence theory, the transition from primary activities to manufacturing activities has been successful in East Asian countries, certain Latin American countries, and others like Turkey. However, there are reasons to believe that this path of structural transformation will be less prominent in the future. One major reason is that many developing countries have initiated their development with much better natural resources than those available during previous experiences of structural transformation, making it difficult for them to specialize or achieve their transition to industrialization.

Rodrik argued that abundant natural resources could lead to diversification through industrialization. Countries with significant animal, agricultural, or fishery resources could utilize them to diversify their products and increase their exports. For example, in the livestock sector, industries related to leather products can be expanded. Subsequently, the value chain can be upgraded to higher stages, such as designing shoes and so on (Rodrik, D. 2013).

The paper considers that there is significant potential in using Rodrik's argument to develop a new global structural transformation index for the world's countries and regions. This would involve improving the traditional structural transformation index to account for the varying structures and resource abundance of different countries and regions at the beginning of structural transformation measurement. The traditional indicator of structural transformation is limited in its ability to assess the comparative performance of structural transformation among the countries and regions of the world simultaneously, as these areas differ in the relative importance of natural resources and primary activities at the start of their structural transformation process.

Based on the foregoing, the paper proposes a methodology to improve the traditional methodology of measuring structural transformation. It aims to expand on Roderick's argument by incorporating the relative importance of natural resources and primary activities at the beginning of the structural transformation process. This is done by assessing the contribution of agricultural activities and extractive activities to the GDP structure. Additionally, the proposed methodology involves averaging this ratio over five years to mitigate the impact of any temporary circumstances that may affect the relative importance of these resources in the GDP structure; this is essential because these resources are more sensitive to price changes than manufactured goods or tradable services.

Proposed methodology for measuring structural transformation:

That methodology suggests weighing the traditional methodology for measuring structural transformation by multiplying inversely the relative contributions of primary activities to GDP, represented in the gross contributions of the agricultural sector and extractive and mining activities, at the beginning of the year or the period of measurement.

The proposed methodology allows for an objective and comparative measurement of structural transformation by considering the uneven initiation of this process across different countries and regions of the world. The transition from primary to industrial activities began in developed countries during the

nineteenth century and has long been completed. According to Rordic and the theory of convergence, this transition will not continue at the same magnitude and pace. In contrast, developing countries began the structural transformation process much later, mainly in the 1960s and 1970s, and also started with a higher relative abundance of natural resources. They also rely more on primary and extractive activities for their GDP compared to the historical structural transformation process in developed countries. This makes it challenging to compare the structural transformation among all countries and regions of the world for a specific period of time, as it needs to be measured for each particular situation. The proposed methodology aims to address these challenges (Rodrik et al., 2016).

The proposed methodology:

$$MSCI = SCI/x_{A,M\cdot t-1}$$

$$MSCI = \left(\frac{1}{2}\Sigma|x_{i\cdot t} - x_{i\cdot t-1}|\right)\frac{1}{x_{A,M\cdot t-1}}$$

Where:

MSCI: The Modified Structural Change Index

SCI: Structural Change Index

$x_{A,M\cdot t-1}$: Total Value Added (%) for Agriculture and Extraction Sectors at Point in Time (t-1) as average for the first period of measurement

III. RESULTS

Based on the foregoing, the paper will apply the traditional methodology for measuring structural transformation (SCI) and the modified methodology for measuring structural transformation (MSCI) to the world's countries and regions from 1970 to 2022, which is considered a suitable period to reflect the realities of structural transformation in the world. The paper selected two measurement periods by calculating the economic sectors' contribution to GDP as an average of 1970-1975 and 2017-2022. In accordance with the proposed methodology (MSCI), the paper will be weighing the structural transformation/change index (SCI) by multiplying inversely the total sectoral contributions of agriculture and extractive activities (as an average) for the first period of measurement (1970-1975).

The paper's analysis focused on the countries and regions of the world for which UNCTAD's sectoral contribution data are available at current prices during that period. It excluded most of the Small Island Developing States (SIDS) due to the unique nature of these states, which could affect the credibility of the comparative performance analysis results. Most SIDS suffer from low economic diversification, often characterized by high dependence on the service sector (tourism and remittances) and volatility due to fluctuations in private income flows and raw material prices. Furthermore, SIDS make up two-thirds of the countries that suffer the highest relative losses (1 to 9% of their GDP each year) from natural disasters, and most of them are import-driven economies (OECD, 2024; UNCTAD, 2024a; UN-OHRLLS, 2024).

Firstly, Analysis showed that the highest contributions of agricultural and extractive activities to GDP at the start of structural transformation measurement (1970-1975) were achieved in developing countries (low, medium and high-income) such as Rwanda, Brunei Darussalam, Mali, Nepal, Tajikistan, Kuwait, Qatar, Burundi, Armenia, Georgia, Malawi, Saudi Arabia,... In contrast, developed countries and non-rich natural resource developing countries, including Hong Kong SAR China, Andorra, Singapore, Switzerland, Liechtenstein, Belgium, the United States of America, Malta, the United Kingdom, Denmark, Japan, and France, had the lowest rates of such contributions (See Table 1).

Table 1:The average of primary sectors(Agriculture and Minning) % GDP 1970 – 1975

Rank	Country	Agr and Mining 1970-1975 (%)GDP		Rank	Country	Agr and Mining 1970-1975 (%) GDP
1	Rwanda	76.17		70	Bulgaria	29.40
2	Brunei Darussalam	75.30		71	Burkina Faso	29.13
3	Mali	72.90		72	Honduras	29.12
4	Nepal	71.35		73	Ecuador	28.57
5	Tajikistan	70.32		74	Morocco	28.54
6	Kuwait	67.92		75	El Salvador	28.08
7	Qatar	66.59		76	Germany	27.63
8	Burundi	66.10		77	Hungary	27.41
9	Armenia	64.62		78	Syrian Arab Republic	27.01
10	Georgia	64.44		79	Kenya	26.89
11	Malawi	63.05		80	Nigeria	26.42
12	Saudi Arabia	62.46				

13	Uzbekistan	62.22
14	Mauritania	60.31
15	Libya	59.15
16	Oman	58.79
17	Somalia	56.72
18	Niger	54.71
19	Liberia	54.15
20	Iraq	54.06
21	Albania	53.93
22	Azerbaijan	53.84
23	United Arab Emirates	53.38
24	Ethiopia	52.79
25	Afghanistan	50.62
26	Gabon	49.11
27	Cambodia	48.93
28	Uganda	48.07
29	Sierra Leone	47.58
30	Indonesia	46.58
31	Gambia	46.50
32	Botswana	45.55
33	India	45.04
34	Myanmar	44.89
35	Bangladesh	44.84
36	Bhutan 2008	44.24
37	Iran	43.47
38	Viet Nam	42.62
39	Sudan	41.87
40	China	41.42
41	Togo	41.37
42	Pakistan	41.34
43	Yemen	40.74
44	Russian Federation	40.58
45	Malaysia	40.50
46	Namibia	40.37
47	Angola	40.14
48	Central African Republic	39.08
49	Guinea	38.38
50	Kazakhstan	37.87
51	Mozambique	37.41
52	Latvia	36.92
53	Ghana	36.52
54	Zambia	36.20
55	Madagascar	35.06
56	Bolivia	34.64
57	Benin	34.13
58	Algeria	32.93
59	Chad	32.34
60	Peru	32.22
61	Egypt	31.85
62	Sri Lanka	31.79
63	Korea Republic of	30.47
64	Philippines	30.44
65	Turkey	30.37
66	Thailand	29.96
67	Bahrain	29.67
68	Portugal	29.65
69	Equatorial Guinea	29.64
81	Lesotho	26.06
82	Tunisia	25.28
83	Senegal	24.34
84	Venezuela	23.82
85	Congo	23.75
86	Poland	23.68
87	Cameroon	22.99
88	Panama	22.96
89	Romania	22.24
90	Zimbabwe	21.76
91	Uruguay	21.58
92	Cyprus	20.86
93	Greenland	20.54
94	Guatemala	20.35
95	Mongolia	20.02
96	Paraguay	19.47
97	Colombia	19.36
98	South Africa	19.19
99	Tanzania	19.15
100	Ireland	19.01
101	Chile	18.86
102	Taiwan Province of China	18.06
103	Costa Rica	17.24
104	State of Palestine	16.54
105	Nicaragua	16.12
106	Mexico	15.78
107	Spain	15.32
108	Finland	14.74
109	New Zealand	14.33
110	Australia	14.33
111	Iceland	14.28
112	Brazil	14.19
113	Greece	14.12
114	Lebanon	12.98
115	Argentina	12.47
116	Jordan	12.42
117	Canada	12.07
118	Sweden	11.06
119	Austria	10.68
120	Italy	10.43
121	Luxembourg	9.80
122	Norway	9.64
123	Netherlands	9.15
124	Israel	9.11
125	France	9.08
126	Japan	8.01
127	Denmark	7.50
128	United Kingdom	7.47
129	Malta	7.45
130	United States of America	6.57
131	Belgium	6.22
132	Switzerland, Liechtenstein	5.86
133	Singapore	4.97
134	Andorra	2.71
135	Hong Kong SAR China,	2.51

Source: Author's calculations based on UNCTAD (2024b)

The traditional methodology used to measure structural transformation (SCI) shows that most developing countries have achieved high rates of structural transformation and are ranked at the top globally. In contrast, only a few developed and emerging countries have achieved this, while most developed countries have lagged. (See Table 2)

Table 2: Structural transformation in countries worldwide based on the structural transformation index (SCI) for the periods 1970-1975 and 2017-2022 (%)

rank	country	SCI	Income classification	rank	country	SCI	Income classification
1	Georgia	46.79	Upper middle income	70	Hong Kong SAR China,	18.74	High income
2	Liberia	44.80	Low income	71	Andorra	18.60	High income
3	Tajikistan	44.70	Lower middle income	72	Uruguay	18.59	High income
4	Armenia	42.22	Upper middle income	73	Sri Lanka	18.52	Lower middle income
5	Rwanda	39.35	Low income	74	Greece	18.42	High income
6	Luxembourg	38.60	High income	75	Turkey	18.11	Upper middle income
7	Nepal	38.16	Lower middle income	76	Bahrain	18.10	High income
8	Equatorial Guinea	35.05	Upper middle income	77	Malaysia	18.04	Upper middle income
9	Malawi	34.90	Low income	78	Yemen	17.76	Low income
10	Malta	32.89	High income	79	Namibia	17.75	Upper middle income
11	Latvia	32.86	High income	80	Thailand	17.69	High income
12	Romania	31.12	High income	81	Finland	17.69	Upper middle income
13	Sierra Leone	30.40	Low income	82	Japan	17.68	High income
14	Albania	30.07	Upper middle income	83	Austria	17.29	High income
15	Afghanistan	30.01	Low income	84	Togo	17.09	Low income
16	Korea Republic	28.85	High income	85	United Kingdom	17.02	High income
17	Venezuela	28.73	Upper middle income	86	Egypt	16.83	Lower middle income
18	Botswana	28.33	Upper middle income	87	Israel	16.76	High income
19	Myanmar	27.94	Lower middle income	88	France	16.64	High income
20	Oman	27.93	High income	89	Argentina	16.61	Upper middle income
21	Azerbaijan	27.85	Upper middle income	90	Italy	16.51	High income
22	Russian Federation	27.80	Upper middle income	91	Netherlands	16.24	High income
23	Portugal	27.67	High income	92	South Africa	16.09	Upper middle income
24	Mali	27.27	Low income	93	Germany	16.05	High income
25	Norway	27.10	High income	94	Honduras	15.41	Lower middle income
26	Ghana	27.04	Lower middle income	95	Morocco	15.36	Lower middle income
27	China	26.93	Upper middle income	96	Kenya	15.23	Lower middle income
28	Ireland	26.90	High income	97	Colombia	14.73	Upper middle income
29	Brunei Darussalam	26.87	High income	98	Mauritania	14.53	Lower middle income
30	Bulgaria	26.85	Upper middle income	99	Sweden	14.47	High income
31	Burundi	26.65	Low income	100	Burkina Faso	14.23	Low income
32	United Arab Emirates	26.28	High income	101	Iraq	14.22	Upper middle income
33	El Salvador	26.11	Upper middle income	102	Angola	13.87	Lower middle income
34	Bhutan 2008	26.05	Lower middle income	103	Paraguay	13.84	Upper middle income
35	Bangladesh	25.88	Lower middle income	104	United States of America	13.74	High income
36	Poland	25.48	High income	105	Canada	13.54	High income
37	Uzbekistan	25.43	Lower middle income	106	Taiwan Province of China	13.37	High income

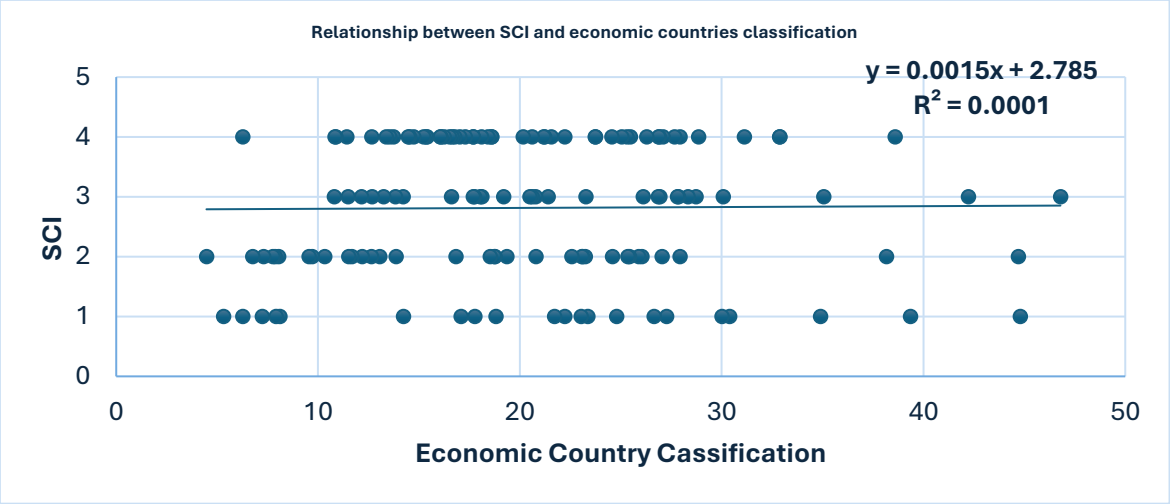
38	Mongolia	25.35	Lower middle income
39	Saudi Arabia	25.30	High income
40	Kuwait	25.04	High income
41	Congo	24.80	Low income
42	Lesotho	24.59	Lower middle income
43	Qatar	24.55	High income
44	Panama	23.75	High income
45	Hungary	23.73	High income
46	Mozambique	23.36	Low income
47	Costa Rica	23.27	Upper middle income
48	Tanzania,	23.24	Lower middle income
49	Philippines	23.10	Lower middle income
50	Viet Nam	23.08	Lower middle income
51	Chad	23.03	Low income
52	Cambodia	22.58	Lower middle income
53	Syrian Arab Republic	22.22	High income
54	Spain	22.22	Low income
55	Gambia	21.72	Low income
56	Cyprus	21.55	High income
57	Iran	21.40	Upper middle income
58	New Zealand	21.22	High income
59	Belgium	21.18	High income
60	India	20.79	Lower middle income
61	Libya	20.78	Upper middle income
62	Iceland	20.61	Upper middle income
63	Brazil	20.61	High income
64	Ecuador	20.49	Upper middle income
65	Australia	20.16	High income
66	Guinea	19.35	Lower middle income
67	Indonesia	19.20	Upper middle income
68	Uganda	18.82	Low income
69	Zambia	18.77	Lower middle income
107	Peru	13.25	Upper middle income
108	Lebanon	13.06	Lower middle income
109	Kazakhstan	12.68	Upper middle income
110	Chile	12.66	High income
111	Pakistan	12.64	Lower middle income
112	State of Palestine	12.18	Lower middle income
113	Guatemala	12.15	Upper middle income
114	Algeria	11.67	Lower middle income
115	Jordan	11.52	Lower middle income
116	Gabon	11.48	Upper middle income
117	Singapore	11.42	High income
118	Denmark	10.88	High income
119	Switzerland, Liechtenstein	10.83	High income
120	Mexico	10.81	Upper middle income
121	Bolivia	10.32	Lower middle income
122	Cameroon	9.71	Lower middle income
123	Nigeria	9.55	Lower middle income
124	Madagascar	8.11	Low income
125	Tunisia	8.05	Lower middle income
126	Niger	7.92	Low income
127	Nicaragua	7.87	Lower middle income
128	Zimbabwe	7.75	Lower middle income
129	Senegal	7.29	Lower middle income
130	Central African Republic	7.24	Low income
131	Benin	6.76	Lower middle income
132	Somalia	6.26	High income
133	Greenland	6.26	Low income
134	Sudan (...2011)	5.31	Low income
135	Ethiopia	4.47	Lower middle income

Source: Author's calculations based on UNCTAD (2024b)

Overall, the list reveals significant asymmetry between structural transformation and economic progress according to the income criterion.

Figure 1 clearly shows a very low correlation (R^2) between structural transformation (SCI) in the world's countries and the economic country classification based on average income, with this coefficient only reaching 0.01%. The paper used a dummy variable ranging from 1 to 4 for subcategories of income level classification. Specifically, (1) denotes low income, (2) denotes lower middle income, (3) denotes upper middle income, and (4) denotes high income.

.Figure 1: Relationship between SCI and the economic classification of countries worldwide for the periods (1970-1975) and (2017-2022).



Source: Author's calculations based on UNCTAD (2024b)

On the other hand, when the paper applied the proposed methodology to measure structural transformation, the "Modified Structural Transformation Index - MSCI" results showed that most developed and emerging countries achieved higher rates of structural transformation. The majority of the European Union, the United States, Hong Kong, and Singapore are ranked as the most advanced countries in the world. Following them were high-income developing countries, upper-middle-income countries, and most low and low-middle-income countries. High-income developing countries rich in natural resources and extractive activities came in the last order on that list. (See Table 3).

Table 3: Structural transformation in countries worldwide based on the Modified Structural Transformation Index – MSCI for the periods 1970-1975 and 2017-2022 (%)

rank	country	MSCI	income Classification		rank	country	MSCI	income Classification
1	Hong Kong SAR China,	7.48	High income		69	Myanmar	0.62	Lower middle income
2	Andorra	6.86	High income		70	Mozambique	0.62	Low income
3	Malta	4.42	High income		71	Bahrain	0.61	High income
4	Luxembourg	3.94	High income		72	Turkey	0.6	Upper middle income
5	Belgium	3.4	High income		73	Guatemala	0.6	Upper middle income
6	Norway	2.81	High income		74	Afghanistan	0.59	Low income
7	Singapore	2.3	High income		75	Bhutan	0.59	Lower middle income
8	United Kingdom	2.28	High income		76	Thailand	0.59	Upper middle income
9	Japan	2.21	High income		77	Bangladesh	0.58	Lower middle income
10	United States of America	2.09	High income		78	Sri Lanka	0.58	Lower middle income
11	Switzerland, Liechtenstein	1.85	High income		79	Germany	0.58	High income
12	Israel	1.84	High income		80	Kenya	0.57	Lower middle income
13	France	1.83	High income		81	Albania	0.56	Upper middle income
14	Netherlands	1.78	High income		82	Malawi	0.55	Low income
15	Austria	1.62	High income		83	Viet Nam	0.54	Lower middle income
16	Italy	1.58	High income		84	Morocco	0.54	Lower middle income
17	New Zealand	1.48	High income		85	Nepal	0.53	Lower middle income
18	Spain	1.45	High income		86	Egypt	0.53	Lower middle income
19	Brazil	1.45	Upper middle income		87	Honduras	0.53	Lower middle income

20	Denmark	1.45	High income	88	Rwanda	0.52	Low income
21	Iceland	1.44	High income	89	Azerbaijan	0.52	Upper middle income
22	Ireland	1.42	High income	90	Zambia	0.52	Lower middle income
23	Australia	1.41	High income	91	Guinea	0.5	Lower middle income
24	Romania	1.4	High income	92	United Arab Emirates	0.49	High income
25	Costa Rica	1.35	Upper middle income	93	Iran	0.49	Upper middle income
26	Argentina	1.33	Upper middle income	94	Burkina Faso	0.49	Low income
27	Sweden	1.31	High income	95	Nicaragua	0.49	Lower middle income
28	Greece	1.3	High income	96	Oman	0.48	High income
29	Mongolia	1.27	Lower middle income	97	Gambia	0.47	Low income
30	Venezuela	1.21	Upper middle income	98	Cambodia	0.46	Lower middle income
31	Tanzania	1.21	Lower middle income	99	India	0.46	Lower middle income
32	Finland	1.2	High income	100	Malaysia	0.45	Upper middle income
33	Equatorial Guinea	1.18	Upper middle income	101	Yemen	0.44	Low income
34	Canada	1.12	High income	102	Namibia	0.44	Upper middle income
35	Poland	1.08	High income	103	Cameroon	0.42	Lower middle income
36	Congo	1.04	Low income	104	Uzbekistan	0.41	Lower middle income
37	Panama	1.03	High income	105	Indonesia	0.41	Upper middle income
38	Cyprus	1.03	High income	106	Togo	0.41	Low income
39	Lebanon	1.01	Lower middle income	107	Peru	0.41	Upper middle income
40	Republic of Korea	0.95	High income	108	Burundi	0.4	Low income
41	Lesotho	0.94	Lower middle income	109	Saudi Arabia	0.4	High income
42	Portugal	0.93	High income	110	Uganda	0.39	Low income
43	El Salvador	0.93	Upper middle income	111	Mali	0.37	Low income
44	Jordan	0.93	Lower middle income	112	Kuwait	0.37	High income
45	Bulgaria	0.91	Upper middle income	113	Qatar	0.37	High income
46	Latvia	0.89	High income	114	Brunei Darussalam	0.36	High income
47	Hungary	0.87	High income	115	Nigeria	0.36	Lower middle income
48	Uruguay	0.86	High income	116	Zimbabwe	0.36	Lower middle income
49	South Africa	0.84	Upper middle income	117	Libya	0.35	Upper middle income
50	Liberia	0.83	Low income	118	Angola	0.35	Lower middle income
51	Syrian Arab Republic	0.82	Low income	119	Algeria	0.35	Lower middle income
52	Philippines	0.76	Lower middle income	120	Kazakhstan	0.33	Upper middle income
53	Colombia	0.76	Upper middle income	121	Tunisia	0.32	Lower middle income
54	Ghana	0.74	Lower middle income	122	Pakistan	0.31	Lower middle income

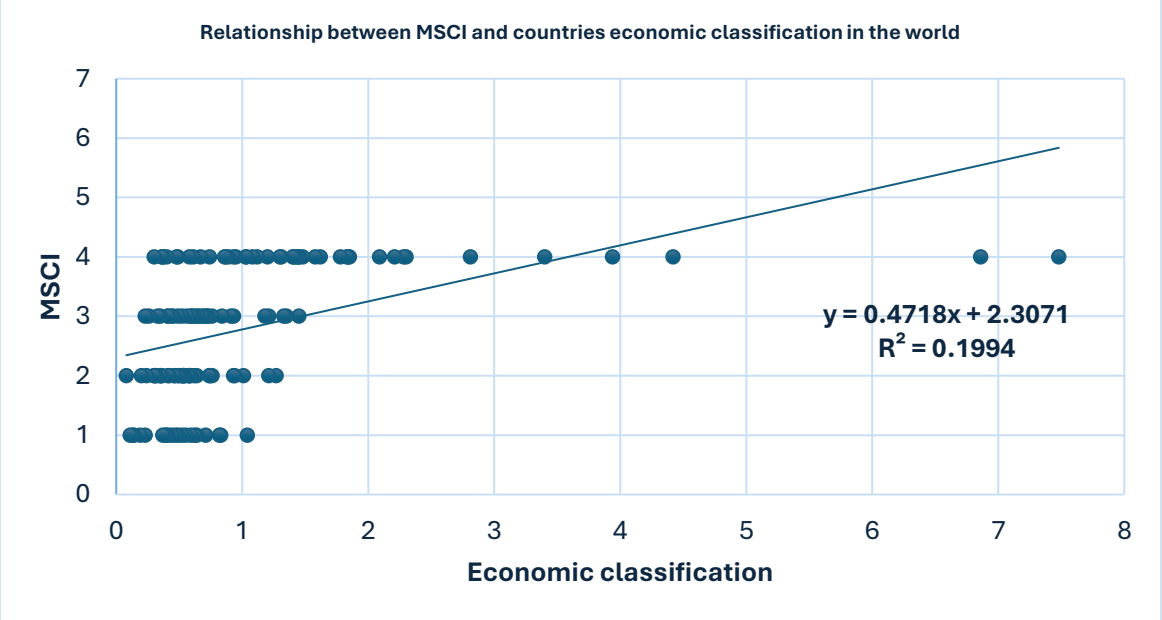
55	Taiwan Province of China	0.74	High income	123	Bolivia	0.3	Lower middle income
56	State of Palestine	0.74	Lower middle income	124	Senegal	0.3	Lower middle income
57	Georgia	0.73	Upper middle income	125	Greenland	0.3	High income
58	Ecuador	0.72	Upper middle income	126	Iraq	0.26	Upper middle income
59	Chad	0.71	Low income	127	Mauritania	0.24	Lower middle income
60	Paraguay	0.71	Upper middle income	128	Gabon	0.23	Upper middle income
61	Russian Federation	0.69	Upper middle income	129	Madagascar	0.23	Low income
62	Mexico	0.68	Upper middle income	130	Benin	0.2	Lower middle income
63	Chile	0.67	High income	131	Central African Republic	0.19	Low income
64	Armenia	0.65	Upper middle income	132	Niger	0.14	Low income
65	China	0.65	Upper middle income	133	Sudan (...2011)	0.13	Low income
66	Tajikistan	0.64	Lower middle income	134	Somalia	0.11	Low income
67	Sierra Leone	0.64	Low income	135	Ethiopia	0.08	Lower middle income
68	Botswana	0.62	Upper middle income				

Source: Author's calculations based on UNCTAD (2024b)

This demonstrates the high levels of compatibility and harmonization between the rate of structural transformation achieved and economic progress as indicated by average income, especially when compared with the outcomes of the structural transformation index (SCI).

Figure 2 shows a higher rate of correlation between the modified structural transformation (MSCI) in the world's countries and the economic country classification based on average income, with this coefficient reaching 19.9%.

Figure 2: Relationship between MSCI and the economic classification of countries worldwide for the periods 1970-1975 and 2017-2022.



Source: Author's calculations based on UNCTAD (2024b)

In the same context, the proposed methodology for measuring structural transformation (MSCI) has been applied to the five main regions of the world for the periods 1970-1975 and 2017-2022. The results indicate that the proposed methodology aligns (MSCI) more closely with the economic classification of those regions based on average income than the traditional methodology (SCI) (Table 4).

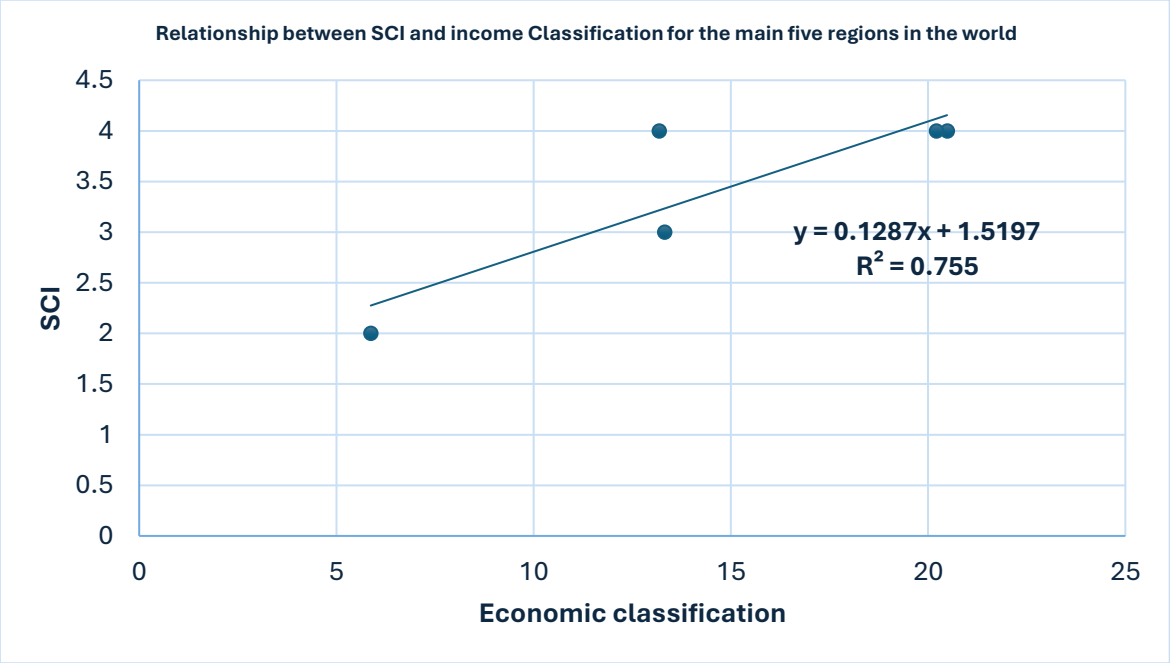
Table 4: SCI and MSCI for the main five regions in the world for the periods 1970 – 1975), (2017 – 2022)

SCI (1970-1975), (2017-2022)					MSCI (1970-1975), (2017-2022)			
Rank	**Region**	**SCI**	**income Classification**		**Rank**	**Region**	**MSCI**	**income Classification**
1	Europe	20.48	High income		1	Europe	1.76	High income
2	Oceania	20.21	High income		2	Americas	1.55	High income
3	Asia	13.32	Upper middle income		3	Oceania	1.37	High income
4	Americas	13.18	High income		4	Asia	0.52	Upper middle income
5	Africa	5.87	Lower middle income		5	Africa	0.19	Lower middle income

Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

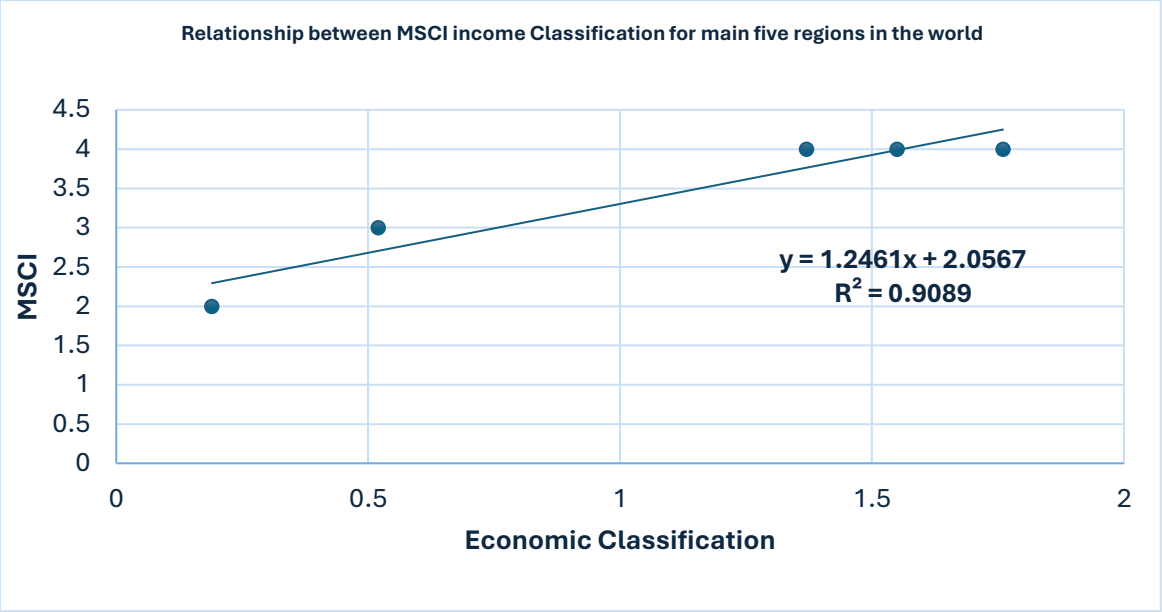
This is confirmed by the high correlation (R^2) between structural transformation variables and the regions' economic classification, which increased from 0.75.5% of (SCI) to 90.9% of (MSCI), as shown in figures (3) and (4).

Figure 3. Relationship between SCI and income Classification for the main five regions in the world



Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

Figure 4. Relationship between MSCI income Classification for the main five regions in the world



Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

These findings are also observed when applying the proposed methodology to the broader geographical classifications of 18 Regions worldwide (UNTAD, 2024). The results demonstrate a stronger alignment with the economic classification of those regions based on average income compared to the traditional methodology (See Table 5)

That is also consistent with the application of that methodology to the more expansive geographical classifications of 18 regions worldwide (UNTAD,2024), where the results showed a higher alignment of the results of the proposed/adjusted methodology for measuring structural transformation (MSCI) in those regions worldwide with the economic classification of those regions according to the average income criterion, compared to the results of the application of the traditional methodology (SC) (See Table 5).

Table 5: SCI and MSCI for the different regions in the world for the periods (1970 – 1975) and (2017 – 2022)

SCI (1970-1975), (2017-2022)			
Rank	**Region**	**SCI**	**income Classification**
1	Eastern Europe	27.05	Upper middle income
2	Southern Europe	19	High income
3	Southern Asia	18.53	Lower middle income
4	South-eastern Asia	16.68	Upper middle income
5	South America	16.67	Upper middle income
6	Western Europe	16.34	High income
7	Southern Africa	15.62	Upper middle income

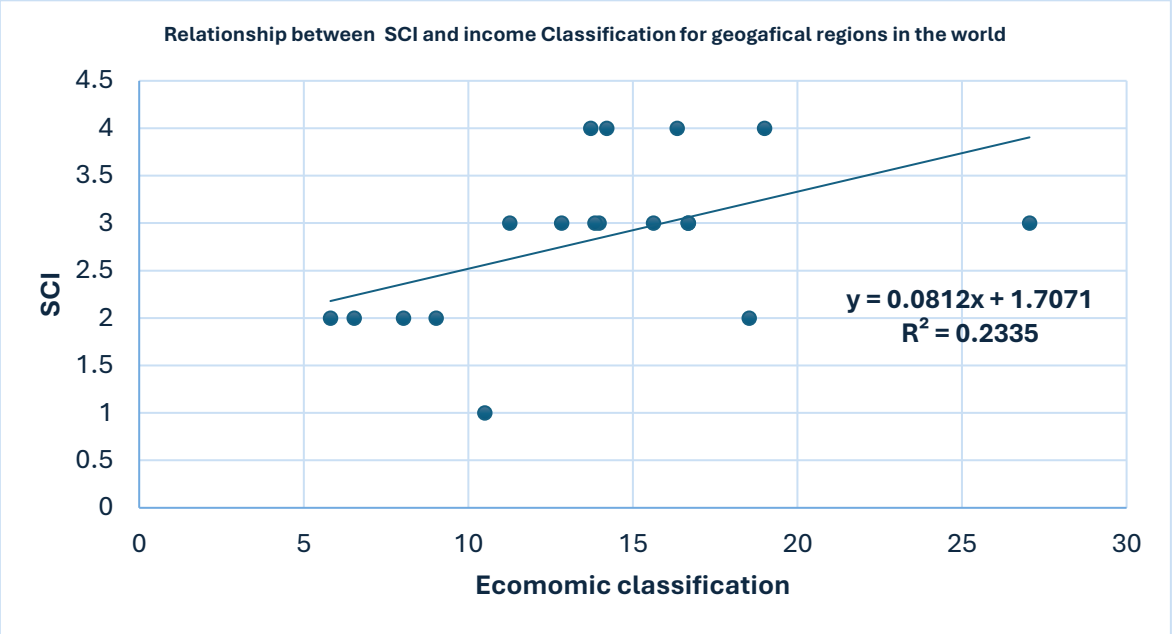
MSCI (1970-1975), (2017-2022)			
Rank	**Region**	**MSCI**	**income Classification**
1	Western Europe	2.01	High income
2	Northern America	1.96	High income
3	Eastern Europe	1.74	Upper middle income
4	Northern Europe	1.61	High income
5	Southern Europe	1.36	High income
6	South America	0.96	Upper middle income
7	Latin America and	0.82	Upper middle income

					the Caribbean		
8	Northern Europe	14.2	High income	8	Eastern Asia	0.8	Upper middle income
9	Latin America and the Caribbean	13.97	Upper middle income	9	Southern Africa	0.78	Upper middle income
10	Eastern Asia	13.84	Upper middle income	10	Central America	0.69	Upper middle income
11	Northern America	13.72	High income	11	South-eastern Asia	0.45	Upper middle income
12	Western Asia	12.83	Upper middle income	12	Southern Asia	0.41	Lower middle income
13	Central America	11.26	Upper middle income	13	Western Asia	0.32	Upper middle income
14	Eastern Africa	10.5	Low income	14	Eastern Africa	0.29	Low income
15	Northern Africa	9.02	Lower middle income	15	Northern Africa	0.24	Lower middle income
16	Middle Africa	8.03	Lower middle income	16	Middle Africa	0.22	Lower middle income
17	Western Africa	6.53	Lower middle income	17	Western Africa	0.22	Lower middle income
18	Sub-Saharan Africa	5.81	Lower middle income	18	Sub-Saharan Africa	0.2	Lower middle income

Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

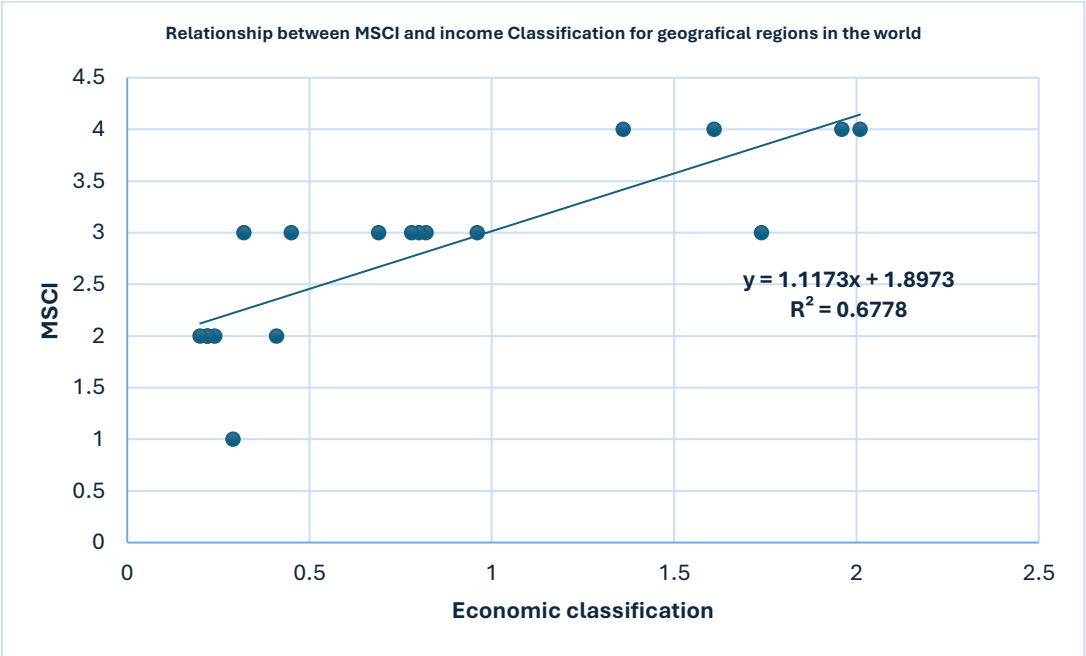
In the same contest, it is clear that there is a higher correlation (R^2) between the regions' economic classification and the modified structural transformation index (MSCI), where it was 67.8% in comparison with (SCI) which was only 23.3%. as shown in figures (5) and (6).

Figure 5. Relationship between SCI and income Classification for geographical regions in the world for the periods (1970 – 1975) and (2017 – 2022)



Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

Figure 6. Relationship between MSCI and income Classification for geographical regions in the world



Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

Goodness-of-Fit Tests:

Two goodness-of-fit tests were employed to ensure the quality and reliability of the statistical analysis results. These tests aim to verify the distributional characteristics of the data or the relationship between variables, thereby enhancing confidence in the research findings.

Chi-Squared Test: The Chi-Squared test was utilized to assess whether observed frequency distributions differ significantly from expected frequency distributions, or to evaluate the independence between two categorical variables. In this study, the test was applied to assess the relationship between the Structural Transformation Index (SCI) and the Modified Structural Transformation Index (MSCI) across different world regions and for two specified periods (1970 – 1975) and (2017 – 2022).

The results, presented in Table 6, indicate a Chi-Squared statistic value of 0.3125. This low value suggests a minimal level of deviation between the observed and expected frequencies. More importantly, the p-value was 0.5762, which is substantially higher than the commonly accepted statistical significance level of $\alpha=0.05$. Based on this result, there is insufficient evidence to reject the null hypothesis, which assumes no

statistically significant relationship between the variables. The test has 1 degree of freedom, which is typical for a 2x2 contingency table.

Table 6: Chi-Squared Statistic for SCI and MSCI for the different regions in the world for the periods (1970 – 1975) and (2017 – 2022)

Statistic	Value
Chi-Squared Statistic	0.3125
p-value	0.57615
Degrees of Freedom	1

Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

These findings suggest that there is no statistically significant relationship between the Structural Transformation Index (SCI) and the Modified Structural Transformation Index (MSCI) across the two analyzed periods. The high p-value indicates that any observed differences in the indices are likely due to random chance rather than a true effect (Pallant, 2016; Field, 2018).

Kolmogorov-Smirnov Test:

The Kolmogorov-Smirnov test was applied to compare the empirical cumulative distribution function of data samples with a reference probability distribution, or, in this case, to compare the empirical cumulative distributions of two different samples (SCI and MSCI) (Sheskin, 2011). This test determines whether two samples are drawn from the same population distribution.

Table 7 presents the results of the Kolmogorov-Smirnov test. The Kolmogorov-Smirnov statistic was approximately 0.368. This value represents the maximum absolute difference between the empirical cumulative distribution functions of the two groups; a higher value indicates a greater disparity between the distributions. Crucially, the p-value was extremely small (approximately 1.3 ×10-60).

Table 7: Results of the Kolmogorov-Smirnov Test

Statistic	P- Value
0.368	**1.2990993761208528e-60**

Source: Author's calculations based on UNCTAD (2024b) and WDI (2024).

This exceedingly small p-value indicates a firm rejection of the null hypothesis, which posits that the two samples originate from the same distribution. In practical terms, this implies a statistically significant difference between the distributions of SCI and MSCI within this dataset. Based on these results, it can be concluded that the SCI and MSCI values exhibit substantial distributional differences, necessitating further analysis of these disparities (Siegel & Castellan, 1988).

IV. CONCLUSION

The criteria for evaluating development performance have significantly expanded. Economic progress and sustainability are now assessed using various indicators and dimensions. This expansion is supported by the expansion and diversification of databases and performance measurement indicators.

It is widely recognized in economic and development literature, as well as in the experiences of various countries, that a key factor in achieving economic progress is the successful accomplishment of structural transformation. This has been observed in both developed countries and those that have emerged more recently. In light of this, the paper aims to present a methodology for classifying and ranking countries and regions worldwide based on their degree of success in achieving structural transformation, regardless of the historical context or timing of this transformation.

The paper attempted to develop the traditional structural change/transformation index (SCI), which is based on factors of production shifting between economic sectors by weighting it with the Multiplicative inverse of the primary sectors contributing to the GDP at the beginning of measurement. The results of this proposed methodology, which is called The modified structural change/transformation index – MSCI, demonstrated a strong correlation with the actual economic progress of countries and regions compared to the results of the traditional Methodology (SCI).

Finally, The paper suggests launching a research project that involves universities, international development institutions, and researchers to conduct applied research. This project will integrate the aspects of development and sustainable growth in measuring and evaluating structural transformation. The aspects to be considered include institutional quality, human capital, economic complexity, carbon dioxide emissions, climate risk, and other institutional and social dimensions. The objective is to develop an indicator that can measure and assess structural transformation, ensuring that its results align more with the actual economic progress and development performance of countries and regions worldwide.

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