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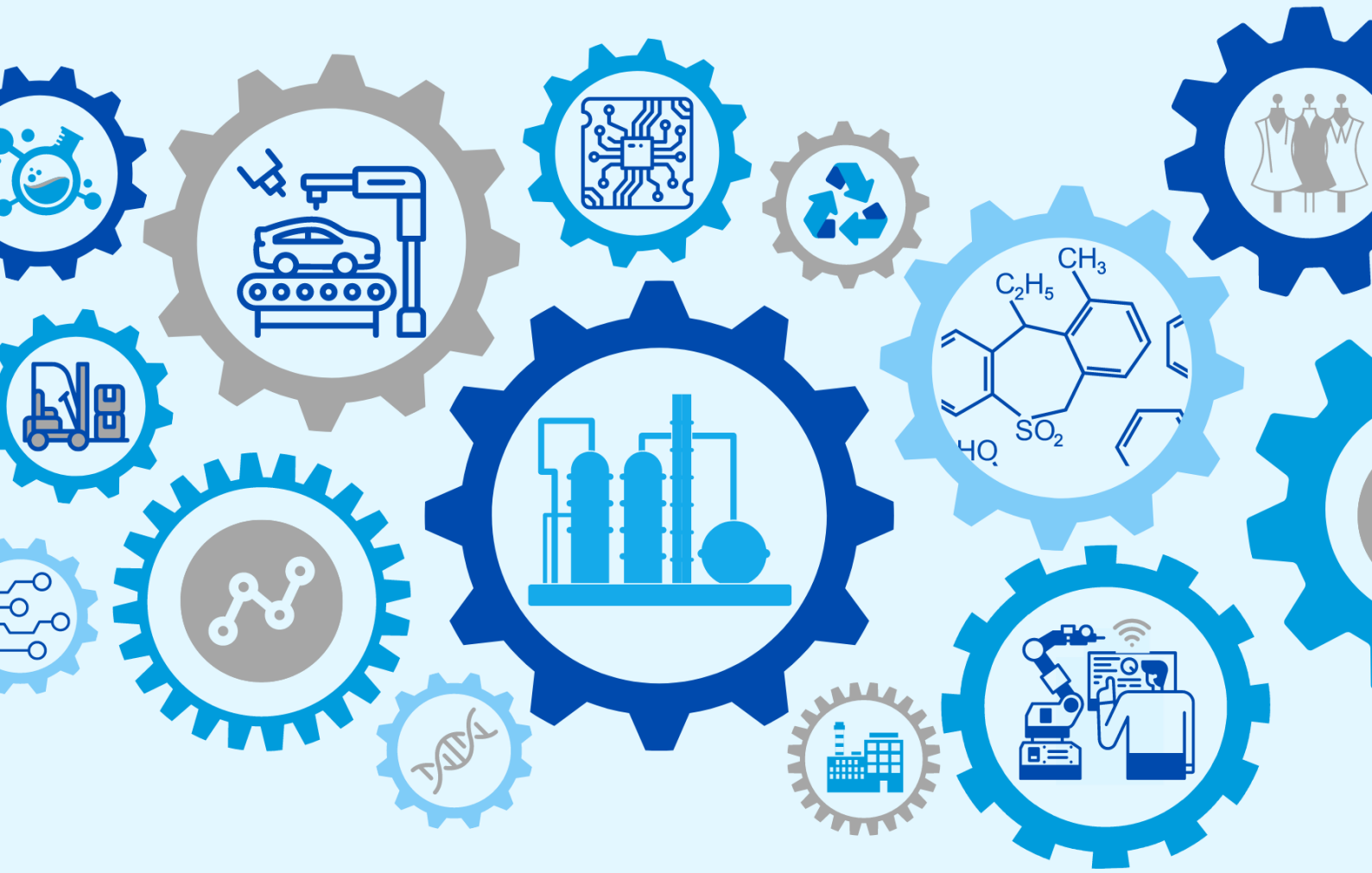

Methodological document

World Manufacturing Production

Edition 2024

Progress by innovation with reliable industrial statistics

Methodological document

World Manufacturing Production

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UNIDO Statistics

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The full report is available online at https://stat.unido.org.

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Abbreviations

ARIMA autoregressive integrated moving average

COVID-19 coronavirus disease

IIP index of industrial production
IRIIP International Recommendations for the Index of Industrial Production
ISIC International Standard Industrial Classification of All Economic Activities *(see glossary)*
ISIC Rev. 3 Revision 3 of ISIC
ISIC Rev. 4 Revision 4 of ISIC

MVA manufacturing value added

NSO national statistical offices

SEATS Signal Extraction in ARIMA Time Series

TRAMO Time series Regression with ARIMA noise, Missing values and Outliers

UN United Nations
UNIDO United Nations Industrial Development Organization

1 Introduction

Policymakers, business associations and other international data users rely on information of the most recent industrial trends. To meet these data needs and to highlight UNIDO's position as the specialized United Nations (UN) agency in the field of industrial development, UNIDO Statistics periodically presents the latest trends and growth estimates for the manufacturing sector as a whole as well as for its major industries.

The main highlights are published in the quarterly reports on World Manufacturing Production [1] (since 2011) as well as in the monthly infographics on World Manufacturing Production [2] (since 2020). The main objective of these reports is to provide an overview of the latest growth trends in world manufacturing production by country groups and major sectors. The underlying monthly [3] and quarterly data [4] can be accessed via the UNIDO Statistics Portal.

This document presents a summary of the main methodological aspects in the compilation and production of index of industrial production (IIP) figures in UNIDO, including definitions, classifications, seasonal adjustment, treatment of missing data and aggregation. It serves as a background for the analysis of IIP figures as presented in UNIDO databases and related statistical publications.

2 Definition and data source

2.1 Data definition

To obtain internationally comparable growth estimates from national data, certain methodological standards must be respected and implemented at the national level. These internationally accepted standards are presented in the International Recommendations for the Index of Industrial Production (IRIIP) [5] endorsed by the UN Statistical Commission.

The target variable compiled by UNIDO Statistics would normally be the value added of a reporting country's manufacturing sector. However, information on value added requires detailed information on outputs as well as inputs of each industry. Input data are difficult to estimate from regular surveys. national statistical offices (NSOs) therefore often use output data to measure the approximate developments of value added within a short period of time.

The IIP measures the growth of industrial production in real terms, free from price fluctuations. Users are advised to take note that annual manufacturing growth rates, e.g. from UNIDO's National Accounts Database [6], generally refer to changes in manufacturing value added (MVA)*, i.e. output net of intermediate consumption. However, the sub-annual indices reflect the growth of gross output. Given the temporal nature of estimates, output growth provides the best approximation of value added growth, assuming that the input-output relationship remains relatively stable during the observation period.

The measurement of output volume for constructing the IIP can be conducted in several ways. According to the IRIIP [5], the preferred proxy measure of output volume is generally an output value with the producer price index as the recommended deflator. Another accurate and commonly used proxy measure

* For a description of MVA, see the documentation of UNIDO's National Accounts Database.

is the quantity of output. Value of sales is readily available and is used in practice as a proxy measure for volume of output after the deflation process has been carried out. In special cases, the most suitable approximation of changes in volume of output are input measures, such as labor input or materials consumed, though this approach is less accurate. Indices are usually computed using either a deflation or a volume extrapolation method. IRIIP [5] offers detailed guidance on selecting suitable variables and methods to calculate IIPs for particular sectors of production.

2.2 Data sources

The main data source of UNIDO's quarterly and monthly reports is monthly or quarterly IIPs compiled and disseminated by NSOs through publications or websites. For most European countries, IIP data are obtained from the Eurostat database [7], which contains data reported directly by NSOs.

UNIDO Statistics derives index data from official publications, so that NSOs do not bear any additional respondent burden to report data. This approach does not entail direct interaction with NSOs on the methods used for compiling IIPs. In some cases, UNIDO Statistics takes certain measures to harmonize the data when international standards are not fully met, while preserving the underlying message of nationally published production statistics.

As national data is used to aggregate and derive estimates at the regional and global level, data comparability across countries is crucial. To reduce deviations from internationally recommended methods, UNIDO Statistics urges NSOs to comply with the guidelines presented in the IRIIP [5].

3 Methods

Data compilation and presentation methods have regularly been updated since the first quarterly report was released in 2011. This document presents the methods currently implemented for compiling and disseminating the IIPs.

3.1 Base year

The base period of an index is the period against which other periods are compared and for which the index is set equal to 100. The weight reference period is the period whose values serve as weights for the index. When the weight reference period and the index base period are the same, then the index is the Laspeyres index, which is the recommended type of volume index for the compilation of IIP following the IRIIP [5] guidelines. Currently, the chosen base period is the year 2015.

In practice, there could be inconsistencies among countries in terms of the frequency of weight updating and whether a fixed weights or a chain-linked approach is followed to compile the IIP time series. Due to the lack of methodological information and lower stage indices at the country level, UNIDO Statistics cannot control this aspect of the time series.

Consistent time series at least since 2015, but preferably for a longer time period, should be available for the following reasons:

- to ensure that the index in 2015 is equal to 100;
- to carry out a detailed time series analysis and high-quality seasonal adjustment;
- to obtain meaningful comparisons among countries;
- to compile adequate and sufficiently long time series to generate country aggregates.

3.2 Seasonal adjustment

The purpose of seasonal adjustment is to filter out seasonal fluctuations or calendar effects in the time series, which can mask short and long-term movements and impede a clear understanding of underlying phenomena. In this way, the seasonally-adjusted results do not show "regular" and repeating events, but rather help to reveal the "news" contained in the time series [5, p.102].

It is highly recommended to perform seasonal adjustment at the country level. Seasonal adjustment is only carried out by UNIDO Statistics in case original data from national sources show a clear presence of seasonality. UNIDO Statistics may occasionally conduct seasonal adjustments in other special cases, e.g. for now-casting. Further information on the process of seasonal adjustment within UNIDO Statistics can be found in a methodological document [8].

In general, a time series consists of different components:

- Seasonal and calendar effects: Cyclical fluctuations related to the calendar (including moving holidays, working day effects and periodic fluctuations, such as Christmas).
- Trend: Long-term movements at the level of the series, including cyclical fluctuations longer than a year (such as business cycles).
- Irregular: Other random or unpredictable short-term fluctuations (such as strikes or unusual weather situations).

Seasonally-adjusted time series should only contain irregular and trend components.

Since 2017, seasonal adjustment is achieved using the TRAMO[*]/SEATS[†] method in the JDemetra+ software [9] and a partial concurrent (fixed model) revision when a new observation becomes available. A full review of all seasonal adjustment parameters is carried out once a year, usually at the beginning of the production year. Besides the automatic procedures implemented in JDemetra+, model adjustment is often necessary. This is achieved through real-time modeling of unpredictable and unstable events, with the objective of maintaining stable time series. Large economic uncertainties or other unusual events (e.g. the economic crisis of 2020 caused by COVID-19) need to be analyzed carefully and included in the models of the seasonally-adjusted time series as outliers.

One common misconception of seasonal adjustment is that it hides outliers. Outliers are extreme observations that deviate from the trend. These abnormal values may occur for instance as a result of new policies or new types of taxes, extreme natural events or a closure of a significant manufacturer. Outliers remain in the data, but they are identified in order to minimize their effect on the seasonal adjustment process.

[*] Time series Regression with ARIMA noise, Missing values and Outliers (TRAMO).
[†] Signal Extraction in ARIMA Time Series (SEATS).

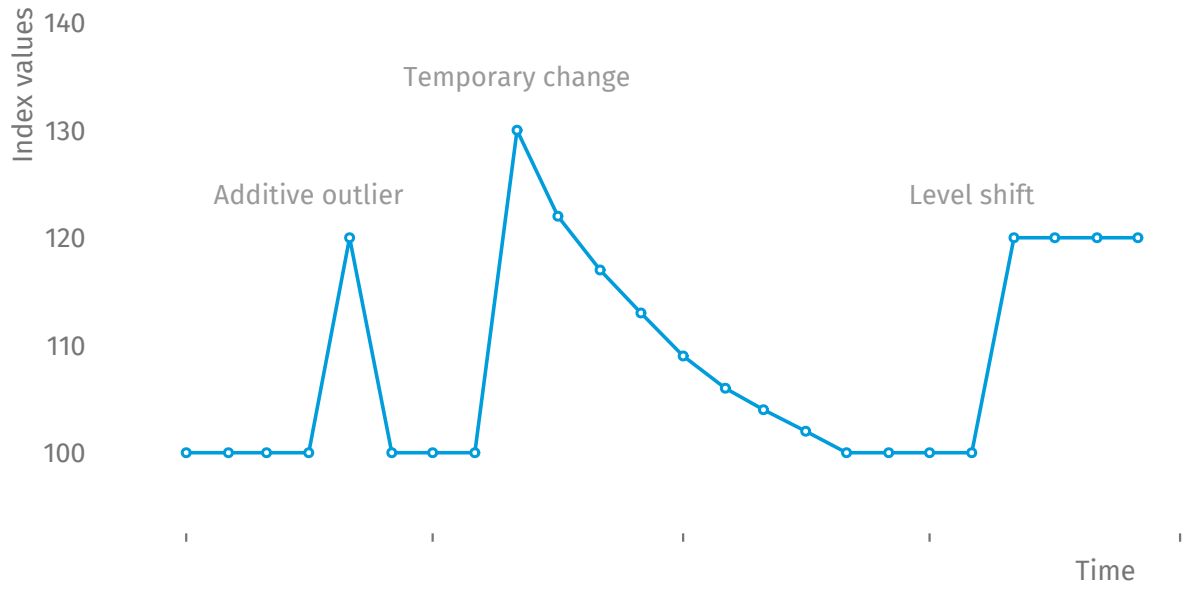

Figure 3.1 | Examples of outliers by type

There are three main outlier types (Figure 3.1):

- Additive outlier (AO): This outlier type affects a single observation caused by a random or short-term effect, such as a strike. After this disruption, the series returns to its normal path as if nothing happened.
- Temporary (transitory) change (TC): This outlier is a spike that takes several periods to disappear exponentially. TC may occur due to deviations from average monthly weather conditions.
- Level shift (LS): It refers to a more permanent change, which may also occur because of changes in economic behavior or in legislation. Level shifts change the level of the time series, but do not modify seasonal behavior.

Regarding the selection of a direct or an indirect (or bottom-up) approach to seasonally-adjust aggregated series, neither theoretical nor empirical evidence uniformly favors one approach over the other. UNIDO Statistics has adopted the indirect approach for country group aggregates to preserve the additive relationship between data. Aggregates published by NSOs are mostly seasonally-adjusted using the direct approach. For other aggregates on the country level created by UNIDO Statistics, a case-by-case study is used to determine the proper approach.

In the seasonal adjustment process, benchmarking entails a procedure in which the annual sums of seasonally-adjusted data are rendered equal to the annual sums of the non-seasonally-adjusted data. Even though this ensures consistency between seasonally-adjusted and raw data over the year, UNIDO Statistics has not implemented this procedure, as it may degrade the quality of the seasonal adjustment and thus produce non-optimal results. Hence, careful consideration is needed when using annual IIP derived from sub-annual IIP with filtered seasonality.

Data revisions need to be carried out as soon as new data or information is accessible. In UNIDO Statistics, the new specification is defined when all sub-annual IIP data become available. The models for seasonal

adjustment are revised based on a partial concurrent revision for each reporting period when new data is included. Besides all the advantages of seasonally-adjusted data for a better understanding of "news" in the time series, users should carefully consider the implications of seasonal adjustment for their analysis (e.g. for econometric modelling).

3.3 Missing data

UNIDO Statistics performs imputations or projections for missing data whenever appropriate. Imputation is conducted for the latest period based on index numbers of earlier periods obtained from national data sources. These projections are based on the Autoregressive Integrated Moving Average (ARIMA) model of the available time series. Such imputations and projections help to maintain the national series as the primary source for the estimation process.

The estimates are replaced as soon as the officially reported values become available in national statistical publications. UNIDO Statistics reports imputed country-level data in its databases with a note ("UNIDO estimate") in the metadata.

3.4 Classification of industries

Since 2016, the monthly and quarterly data have implemented Revision 4 of International Standard Industrial Classification of All Economic Activities (ISIC) (Rev. 4 ISIC) [10]. For countries that publish index numbers based on ISIC Rev. 4, national data from the sections mining and quarrying (ISIC Section B), manufacturing (ISIC Section C, including the 2-digit division levels), electricity, gas, steam and air-conditioning supply (ISIC Section D) and water supply, sewerage, waste management and remediation activities (ISIC Section E) are used in their original form. For countries that still produce index numbers based on ISIC Rev. 3 or another classification system, growth figures are estimated at the 2-digit level of ISIC Rev. 4 using correspondence tables.

3.5 Country groups

UNIDO Statistics relies on country groups in terms of economic territories rather than political boundaries. Economies are classified according to a combination of their stage of industrialization (industrial or industrializing) and income level (high income, middle income and low income). This classification is particularly useful for presenting growth estimates by country aggregates at different levels of structural transformation.

In addition, the report includes information on the group of emerging industrial economies, which includes the most dynamic middle- and low-income economies within both industrial and industrializing economies. Finally, regional groups based on the M49 classification [11] are also presented. A comparative picture of growth trends in different parts of the world is provided based on these country groups. The full list of economies in the country groupings is available in UNIDO's latest country classification report [12].

A disaggregation of the data into these groups ensures better representativeness. The country classification is particularly useful for presenting aggregated growth estimates by country group at different levels of industrialization.

3.6 Aggregation

As already mentioned, country data are aggregated by stage of industrial development as well as by income groups and geographical region. The averages for country groups as well as the world are calculated using the relative contribution (weight) of the given countries to their group's or the world's total MVA. These indices are computed according to the Laspeyres fixed-base method. The base weights refer to the value added figures for 2015. The country weight is further disaggregated to the manufacturing weights at the 2-digit level of ISIC Rev. 4. The distribution of weights is consistent across both countries and manufacturing industries. Overall manufacturing output growth can be computed by aggregating either all country indices or all industry indices. However, these two results may differ slightly due to the non-additivity caused by direct seasonal adjustment of national aggregates.

Let w_0 and I_q denote the base weights and indices of industrial production for quarter q, which are available by manufacturing industry i and by country j. Subsequently, the overall index for country group J and industry i in quarter q is calculated as:

$$I_{q,i,J} = \sum_{j \in J} w_{0,i,j} I_{q,i,j}$$

where

$I_{q,i,J}$ is the overall aggregated index for the i-th industry and the J-th country group in the q-th quarter,

$w_{0,i,j}$ is the base weight for the i-th industry of country j and

$I_{q,i,j}$ is the production index for the i-th industry of country j in the q-th quarter.

The compilation process involves aggregating the division level indices to the national level and further aggregating to the country group level as well as the world aggregate. The weights of the base year are updated annually, with the latest available weighting data (including all data revisions for the chosen base year published by the countries) drawn primarily from the Industrial Statistics Databases (INDSTAT) [13] (currently in ISIC Rev. 4) and from the latest UNIDO National Accounts Database [6], both available from the UNIDO Statistics Portal.

3.7 Requested features of national data

To summarize the compilation of internationally comparable IIP data, it is highly desirable for national data to exhibit the features summarized in the box below.

Requested features of national data

- Classification: ISIC Rev. 4
- Scope
  - Mining and quarrying (ISIC Section B)
  - Manufacturing (ISIC Section C)
  - Electricity, gas, steam and air-conditioning supply (ISIC Section D)
  - Water supply, sewerage, waste management and remediation activities (ISIC Section E)
- Level for manufacturing: 2-digit
- Base year: 2015
- Time lag: no more than two quarters/months
- Original as well as seasonally and calendar adjusted data
- IIP time series consistent over time, preferably since 2005

4 Results

As of 2024, UNIDO compiles quarterly IIP data of 117 countries, accounting for 97.2 per cent of world MVA. These results are presented in the quarterly report and published in their original form as well as seasonally-adjusted time series in UNIDO's Quarterly IIP database [4]. Figure 4.1 and Figure 4.1 give overviews of the coverage of quarterly and monthly IIP data, respectively. Additionally, monthly IIP data of 81 countries, representing 92.9 per cent of global MVA, are published in UNIDO's Monthly IIP database [3] and summarized in the monthly infographic.

The reports and infographics contain two sets of growth indicators for world manufacturing output:

- the reference period compared to the previous period
- the reference period compared to the same period of the previous year.

These growth figures refer to the change in MVA or more precisely, to the change in production (as measured by IIP). For the quarterly report, the growth figures therefore refer to either the growth percentage of a quarter-on-quarter comparison:

$$G_q^{QoQ} = \left(\frac{I_q}{I_{q-1}} - 1\right) \times 100$$

or a year-on-year comparison:

$$G_q^{YoY} = \left(\frac{I_q}{I_{q-4}} - 1\right) \times 100.$$

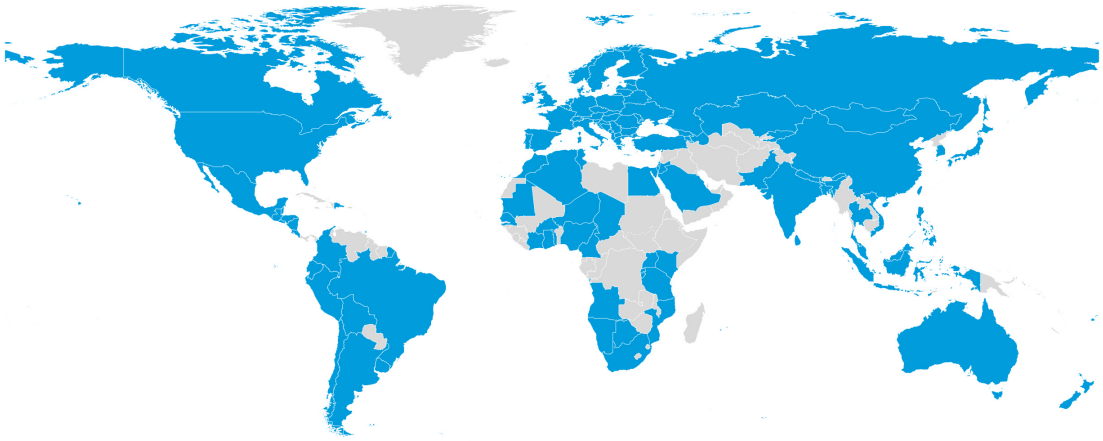

Figure 4.1 | Data availability of quarterly IIP indices, Q4 2023

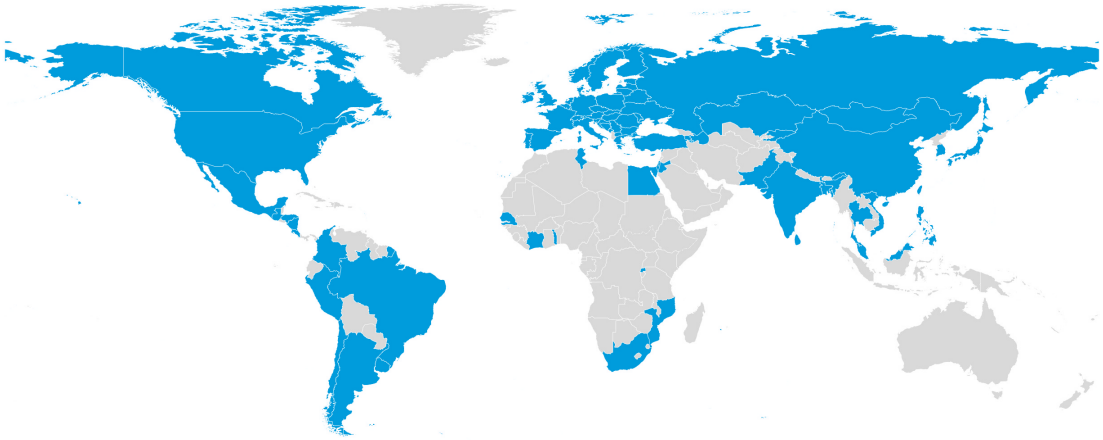

Figure 4.2 | Data availability of monthly IIP indices, January 2024

For the monthly infographic, the growth figures refer to either the growth percentage of a month-on-month comparison:

$$G_m^{MoM} = \left(\frac{I_m}{I_{m-1}} - 1\right) \times 100$$

or a year-on-year comparison:

$$G_m^{YoY} = \left(\frac{I_m}{I_{m-12}} - 1\right) \times 100.$$

While the first set of growth indices represents more recent growth trends and allow to study short-term developments, the second set provides more stable estimates for analysing a country's manufactur-

ing performance, as year-on-year comparisons might help mitigate undetected seasonal or calendar variations.

The reports [1] and infographics [2] focus on period-on-period comparisons to highlight latest short-term movements. Nevertheless, the user should be aware that national data are not always seasonally-adjusted and country-specific national holidays or other particularities could lead to hidden seasonal or calendar patterns in the adjusted series when carrying out seasonal adjustment at the international level.

Table 4.1 presents a summary of the main indicators for the fourth quarter of 2023, which is also included in the Quarterly Reports on World Manufacturing Production [1] covering that quarter.

Table 4.1 | Main indicators of manufacturing output by region and industrial group, Q4 2023

	Share in world MVA (2015, percentage)	Index (2015=100)	Growth compared to previous quarter (percentage)	Growth compared to same period of previous year (percentage)
Development groups				
World	100.0	124.1	1.0	1.5
Industrial economies	93.1	123.9	1.0	1.4
Industrializing economies	6.9	126.9	0.3	2.6
Regions				
Africa	1.9	108.2	-0.1	-0.7
Asia & Oceania	50.8	141.1	1.5	3.4
Europe	22.7	112.7	1.2	-1.3
Latin America and the Caribbean	5.4	105.3	-0.4	-1.5
Northern America	19.3	99.7	-0.5	-0.5
Industrial economies				
High-income industrial	53.4	105.4	0.8	-0.9
Middle-income industrial (excl. China)	12.7	118.1	-0.3	0.3
China	27.0	163.3	1.9	4.9
Industrializing economies				
High-income industrializing	1.9	118.0	2.6	2.1
Middle-income industrializing	5.0	130.2	-0.4	2.7
Low-income	0.1	126.7	0.1	7.0

5 Limitations

Growth estimates published in quarterly and monthly reports are based on a sound methodology, best practices and thoroughly validated data. Nevertheless, aggregated index figures have some limitations, which are described here to clarify the technical process of treatment of national indices. Users should consider these limitations when conducting economic analysis and interpreting results.

The main purpose of the reports is presenting the short-term growth trends of manufacturing production. The reports therefore present growth figures as well as IIP in levels, where appropriate. Index numbers are presented in UNIDO's quarterly [4] as well as monthly [3] IIP databases. It should be considered

that not all countries publish harmonized and long time series. The national data source may revise the index series whenever new data is collected. The reports and databases are based on the latest data releases. As soon as new releases from national sources are available, UNIDO Statistics revises the figures in its databases, which may result in some disparities with respect to the figures published in preceding reports.

Index figures for a significant number of countries are not seasonally-adjusted, which has implications for comparability over time as well as for the imputation of missing values. Even though UNIDO Statistics carries out seasonal adjustment whenever necessary or appropriate, it is recommended that countries themselves perform seasonal adjustments on their own data.

The national IIP data was converted from various classifications of industrial activities to the 2-digit level of ISIC Rev. 4. Even though these classifications are mostly compatible with ISIC Rev. 4, there is not always a one-to-one match for all industries. Occasionally, national sources publish data at a more aggregated level, which requires a disaggregation of the index numbers to the 2-digit level of ISIC. Since there is no effective way to properly disaggregate these data, UNIDO Statistics uses the aggregated time series either for all industries included therein or only selects one or some of them according to their MVA contribution to total manufacturing.

Despite these limitations, the figures presented in the quarterly report are highly reliable and adequately reflect the growth trends in global manufacturing.

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