

ANALYSIS OF TRENDS AND ANOMALIES IN THE INDUSTRIAL PRODUCTION INDEX IN NORTH MACEDONIA

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Abstract

This research analyzes the monthly trends of the industrial production index in North Macedonia from January 2011 to March 2025, utilizing data from the State Statistical Office. The index, measured relative to the previous year's average, encompasses sectors, industrial divisions, and main industrial groups, categorizing industries by economic activity and the types of goods produced. The analysis reveals a period of stability from 2011 to 2019, followed by a sharp decline in 2020 due to the significant economic disruptions caused by the COVID-19 pandemic. Peaks observed in 2014 and 2018 suggest the influence of external economic dynamics - such as shifts in international demand or investment flows - as well as internal industrial developments. Although the data for 2025 is partial, it is included to capture the continuity of emerging trends. The findings highlight the vulnerability of industrial production to global shocks and underscore the importance of resilient, data-informed economic policies to support sustainable industrial growth in the face of future uncertainties.

Keywords: Industrial production index, North Macedonia, industrial sectors, main industrial groups, pandemic impact

1. Introduction

The Industrial Production Index is one of the most important indicators for measuring the speed and direction of a country's economic development. This reflects changes in the production of goods in major industrial areas and is particularly useful for analyzing both monthly and annual industry performance. The index is widely used by policymakers, economists, investors, and institutions to understand the structural and cyclical trends of industrial production.

The theme of this research is the examination of the Industrial Production Index in North Macedonia for the years 2011-2024. The data have been collected by the State Statistical Office in accordance with the rules of the European Union. The value of the index for each month is compared with the average production of the previous year (base year = 100), which gives a clear vision of seasonal, economic, and political changes that affect the region in the last decade. The objective of this analysis is to examine the development and decline periods in the industry, the factors driving these movements, and an observation of the country's industrial structure. Data will be presented for specific areas such as energy, capital items, durable and non-tricky consumer goods through a comparative approach to better understand their role and dynamics within the national economy.

The analysis begins with the details of the data collection and processing method, followed by an examination of annual and monthly variations, and concludes with a summary of the most significant impacts, including the COVID-19 pandemic, infrastructure investment, and trends in international markets. This comprehensive law aims to create a clear and enduring economic narrative for decision-makers and researchers.

2. Literature Review

The Industrial Production Index (IPI) is one of the major indicators of economic activity, as it measures monthly ups and downs in the amount of production in industrial areas. In terms of North Macedonia, the IPI is regularly published by the State Statistical Office (Makstat), based on the monthly data collected from the selected sample according to international standards. The calculation of the index follows the harmonious functioning of the European Union, as defined in Regulations (EU) 2019/2152 and 2020/1197 [1].

Classification of industrial activities NACE REV. 2 systems (nomenclature sttactique des activités économiques dans la Communauté Européenne), which has a four-level hiered structure:

- **Section (identified by the alphabet),**
- **Division (two-point code),**
- **Group (three-digits code), and**
- **Classes (four-digit code).**

This classification ensures a clear division of industrial areas and facilitates comparative analysis between the European Union member states and countries that align with these standards [2].

The impact of the COVID-19 pandemic on the global and European industries has been substantial. According to the Center for European Policy Studies [3], traditional industrial areas have experienced a significant decline due to disruptions and low demand in the supply chain. In contrast, areas such as technology and pharmaceuticals registered an increase. These developments were also reflected in North Macedonia, where the IPI witnessed a significant decrease in 2020, especially in the energy sector and in the production of durables [3].

The latest report by the OECD in 2024 [4] states that North Macedonia has progressed in trade and energy policies, but is still facing challenges related to digitization and the development of infrastructure. As related to the entertainment industry, it still remains an underexplored topic in North Macedonia [5].

3. Research Methodology

The study adopts a quantitative research design based on secondary data obtained from the state statistical office of North Macedonia - Makstat. The primary objective is to make a comprehensive analysis of the Industrial Production Index (IPI) from 2011 to 2024, in which NACE REV. 2 is a special focus on regional mobility defined by classification. Traditional association rule mining treats all items equally and doesn't handle duplicates well. But in real-world datasets—like the Industrial Production Index—some sectors (e.g., energy or manufacturing) might be more critical than others [6].

3.1 Data Source and Sample Description: The dataset contains monthly industrial production data from a sample of business institutions operating in the industrial sector. The sample has been constructed based on the following selection criteria:

- Institutions with an annual gross value enhancement (GVA) over 20 million;
- Employment of more than 20 workers.

Between 2021 and 2024, the sample consisted of 450 industrial enterprises, collectively about 80% of the total industrial GVA in the country. The representation of the sample ensures analysis in the interpretation and strengthening of validity in the interpretation of the results.

3.2 Data Collection: Data was extracted from the official Makstat platform in the CSV format. The primary source is the Monthly Industry Report (IND.1), which is presented by the Reporting Units in compliance with the National Law and the European Statistical Rules (European Union Rules 2019/2152 and 2020/1197). Data reporting is based on internal accounting records and official documentation conducted by each reporting unit.

3.3 Data Processing and Analytical Tools: Data processing and analysis were done using the Python Programming Language, using the following libraries:

- **Panda** - for data wrangling and change;
- **Matplotlib and seaborn** - for graphical representation and searching view;
- **Statsmodels** - for time chain decomposition and trend estimate.

The dataset was subject to a **rigorous preprocessing phase**, including handling of missing values, restructuring of time series data, and normalization relative to a **base year (index = 100)**, in accordance with statistical best practices.

3.4 Analytical Framework: The analytical approach incorporates multiple quantitative techniques, including:

- **Descriptive statistics** to summarize central tendencies and dispersion measures;
- **Temporal comparisons**, such as **year-over-year (YoY)** and **month-over-month (MoM)** changes, to detect short- and long-term fluctuations;
- **Time series decomposition** to isolate trend, seasonal, and residual components;
- **Data visualization** to identify structural changes and sector-specific patterns across the 14-year observation period.

4. Analysis and Results

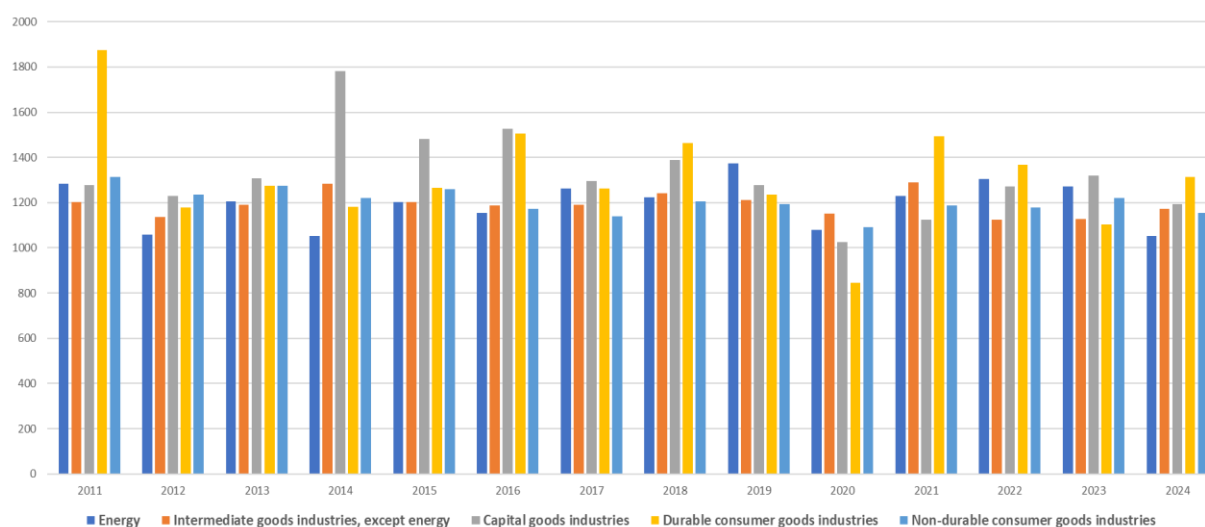


Figure 3. Presentation of Main Industrial Groups (MIGs) over the years

The chart in figure 1 presenting main industrial groups (MIGs) shows the difference with sector and time from 2011 to 2024. The yield was the highest product of energy and durable consumer goods from 2011 and 2024. In 2014, there was a huge increase in capital goods, which marked a significant turn in the change of the structure of the industrial area. Almost all regions had relative equality for periods from 2015 to 2017 as the gaps were quite modest. In 2018 and 2021, there was a strong growth for sustainable consumer goods. Non-tricolor goods and intermediate accessories performed continuously in this period with only slight fluctuations around the performance of these items. Finally, in the most recent period (2023 to 2024), almost

all industrial categories have a broad-based recession, however, were able to maintain the current level of sustainable goods production, which could not follow these other areas. These medium-term trends will highlight various effects of a large number of factors that affect the level of industrialization, which can vary greatly from the region to the region with geographical and macroeconomics effects over a certain time period.

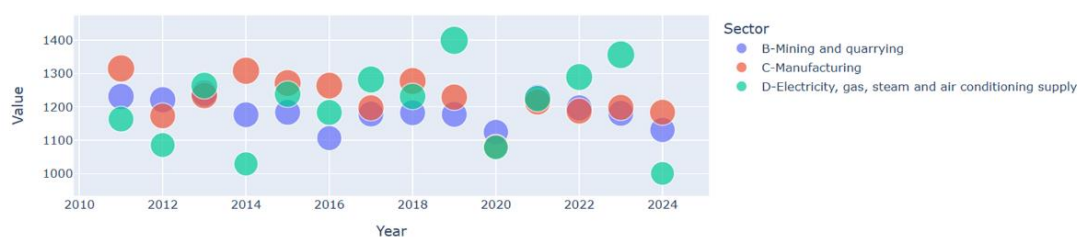


Figure 4. Overview of Subsectors

- Sector A - Agriculture, forestry and fishing are not published by Makstat just like other areas, as it is examined through agricultural survey or agricultural census and with various functioning.
- Sector B - Mining and mine data, based on the value of the chain index (2016 base year), gradually decreased from 2016 (the lowest value of 1106.5) to 2024 (1131.1) (1131.1), which is not being reduced in compared to a resource in this economic sector or less.
- Sector C-construction has been more unstable, with high values in 2011 and 2014, while after slow recovery has not been recovered from time to time to previous levels.
- Sector D - Electricity supply 2019 (1399.5) has been the most unstable with the highest peak and is the most reduced in 2024 (1000.8), possibly associated with the results of energy crisis and structural factors.

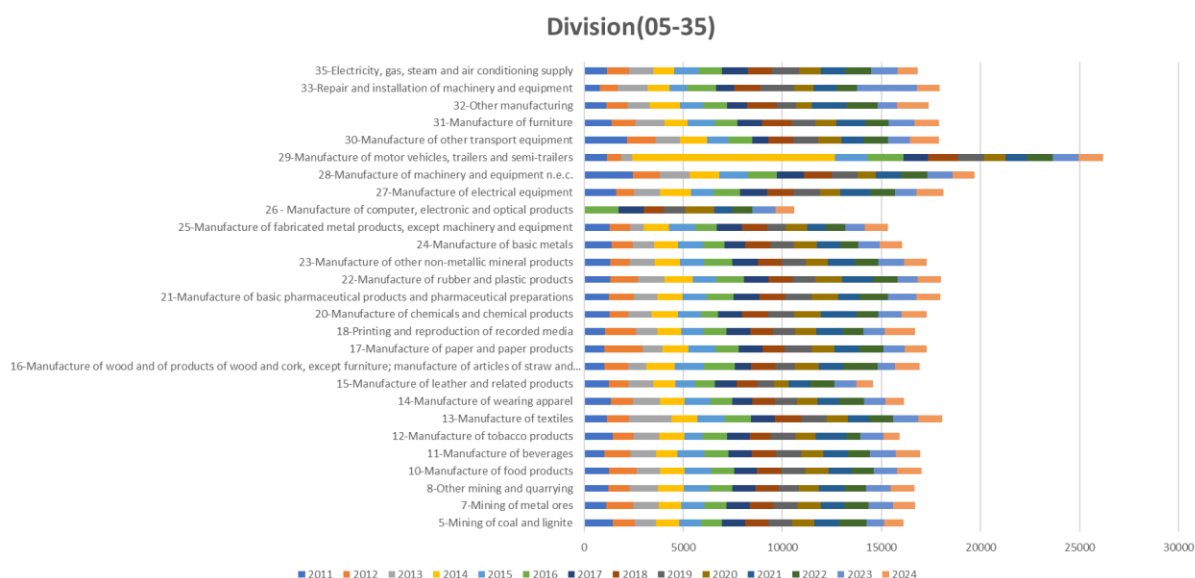


Figure 5. Divisions of Subsectors

The sector of automotive manufacturing in North Macedonia has experienced blazing increase as a result of the opening of foreign investments and new factories such as Johnson Controls and Lear Corporation, which have contributed positively to economic growth. On another note, the metal product industry and both rubber and plastic industry have increased to all as a result of high demand in construction and exports. The production of computers and electronic devices

has declined for the first time and has been stabilized since then; This reflects technical changes and effects of global competition. Mining and energy sector are characterized by low levels of activity, but with a significant increase in power generation amidst the energy crisis of stable activity, 2021-2022. In addition, a steady increase in chemical, plastic and drug production has been observed, rapidly intensified between epidemic with medical products and more demand for disinfectant; On the other hand, the textile and clothing industry is facing important threats as a result of strong international competition and already facing lack of labor.

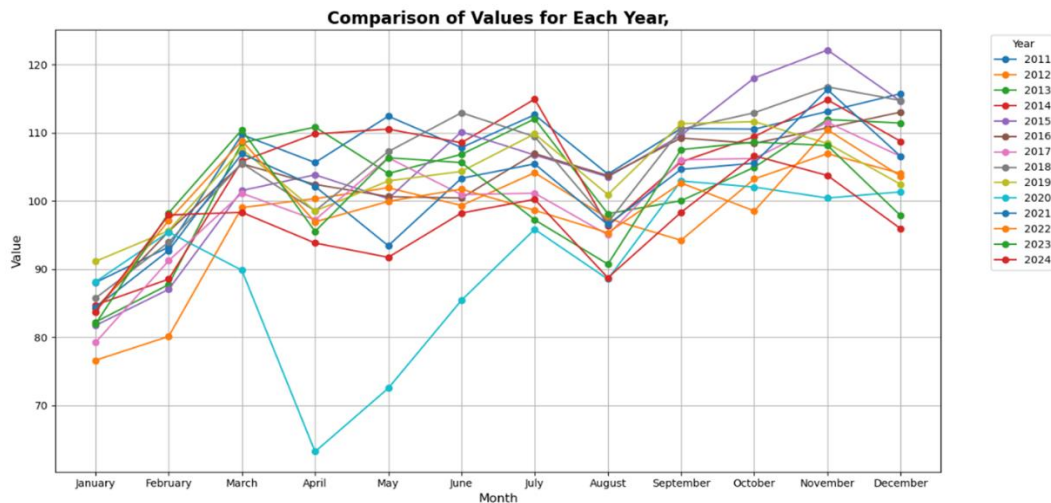


Figure 6. Comparison of values for each year

This graph increases at the end of March, June and the year as a result of seasonal activity and infrastructure projects, and declines in April and August as a result of holidays and low activity. The clear digital dip in April 2020 clearly belongs to the Covid-19 epidemic, and the duration of 2021–2023 is a period of recovery and stabilization through government support and recovery in the economical aspect.

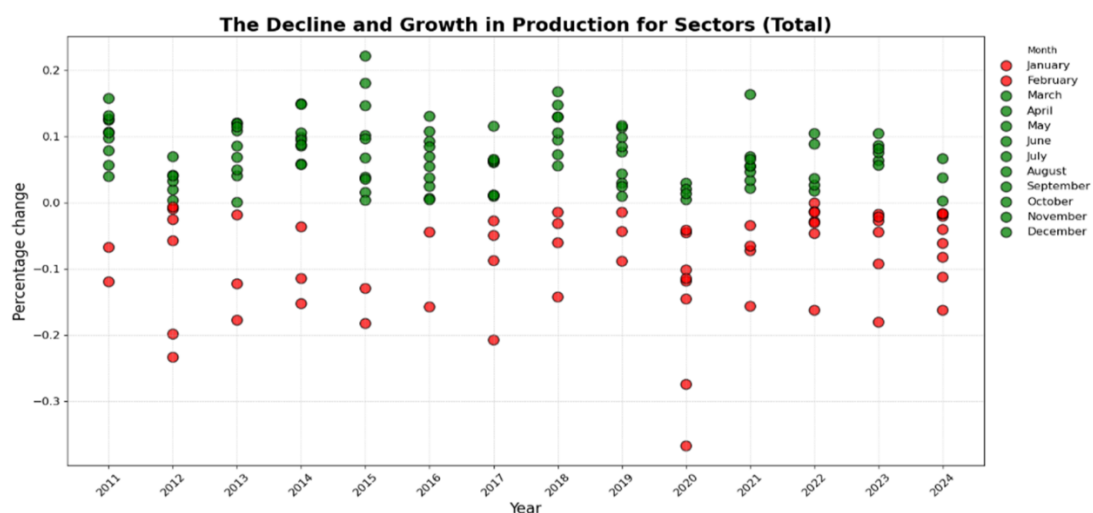


Figure 5. Monthly-based decline and growth

Figure 5 above displays the seasonal rhythm of production over the years. In general terms, we want to note a consistent and recognizable pattern: cold months, such as January and December, indicate a decline in production, while warm months, like April and July, indicate improvement. In this way, this seasonal rhythm remains stable, regardless of recent economic events, although there is a notable decline in 2020–2021 that may be related to the COVID-19 pandemic.

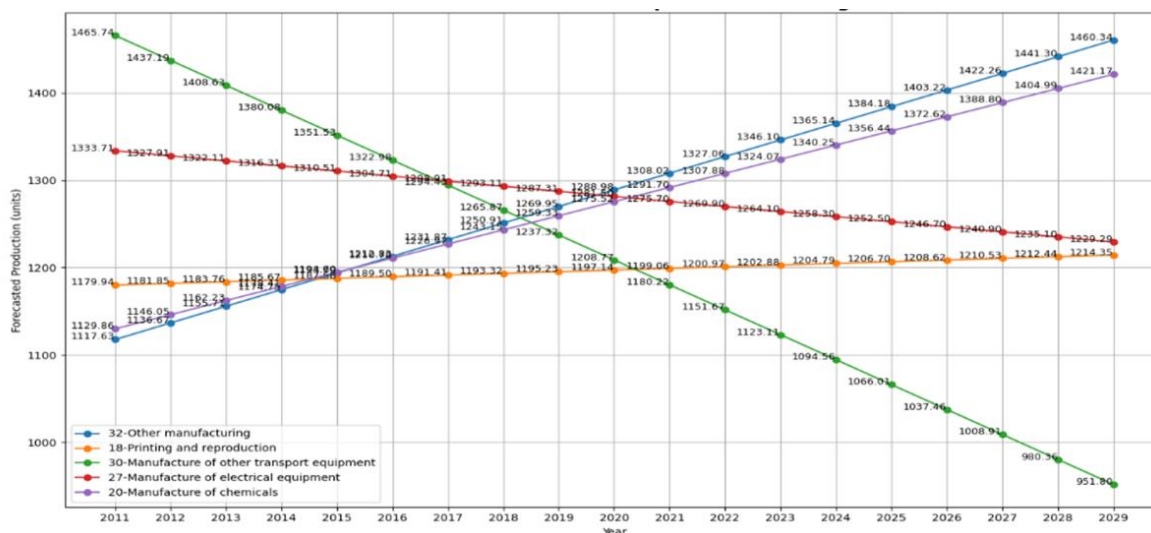


Figure 6. Forecast of production for the Top 5 Sectors Through 2029

Figure 6 shows the forecast of production until 2029 for five main industrial areas. "Other manufacturing" (NACE 32) and "Construction of Chemicals" (NACE 20) are predicted to achieve important levels of production growth, reflecting capacity expansion and market demand; However, the "NCE 30) sector is estimated to show a significant production to the" NCE 30) sector, which is the lowest in 2011 to 2029 that may indicate the underlying structural issues or increased competition. The "printing and breeding" (NACE 18) sector is estimated to be almost unchanged, indicating stability in the market, there is no mobility in development, while "manufacturing electrical equipment" (NACE 27) estimates a gradual decline. These trends reflect the need for targeted policy that supports declining areas and accelerates the growth of growing areas.

5. Conclusions

The duration from 2011 to 2024 exhibits a holistic tendency characteristic of global events, such as the significant fluctuations caused by the COVID-19 pandemic. After a sharp decline in 2020-areas such as energy and durable consumer goods experienced adequate effects - majors exhibited a gradual recovery between 2021 and 2023, crossing the level of pre-mahamari. By 2024, the market will have reached a state of relative stability, with close to 100. Energy and capital goods, such as areas that faced failures in 2020, have shown signs of recovery in the Pandemic period. Meanwhile, industries such as motor vehicle manufacturing and pharmaceuticals have exceptionally well performed, reflecting flexibility and development during the time of health and economic crises. This period highlights the overall flexibility of the economy and its industrial sectors, as they try to overcome significant external shocks.

References

- [1] State Statistical Office of the Republic of North Macedonia. (2024). Indices of industrial production, monthly, previous year = 100. Retrieved from https://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/MakStat_Industrija_Bazna2021/325_Ind_mk_preth100_21_ml.px/
- [2] Eurostat. (2008). NACE Rev. 2 – Statistical classification of economic activities in the European Community. ISBN: 978-92-79-04733-1.
- [3] CEPS. (2021). Impacts of the COVID-19 pandemic on EU industries. Retrieved from <https://www.ceps.eu/ceps-projects/impacts-of-the-covid-19-pandemic-on-eu-industries/>
- [4] OECD. (2024). Western Balkans Competitiveness Outlook 2024: North Macedonia. OECD Publishing. <https://doi.org/10.1787/8207326d-en>

- [5] Hasani, A., Rasheed, J., Alsubai, S., Luma-Osmani, S.: Personal rights and intellectual properties in the upcoming Era: the rise of deepfake technologies. *Lecture Notes in Networks and Systems*, 1036 LNNS, pp. 379–391 (2024). https://doi.org/10.1007/978-3-031-62881-8_32
- [6] Parashu Ram Pal, Pankaj Pathak, and Shkurte Luma Osmani. 2021. IHAC: Incorporating Heuristics for Efficient Rule Generation & Rule Selection in Associative Classification. *J. Inf. Knowl. Manag.*, Vol. 20, 1 (2021), 2150010.