THE PURCHASING MANAGERS' INDEX AS A TOOL FOR UNDERSTANDING SUPPLY CHAIN DISRUPTIONS

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Abstract:
The study explores the use of the Purchasing Managers' Index (PMI) to predict the impact of economic conditions on supply chain disruptions. By analysing PMI data, we can identify patterns that indicate economic trends and their impact on production, delivery times, inventories and prices. The methodology used involved reviewing PMI indices to gain insights into current and upcoming supply chain disruptions. The results show that the PMI offers early warning signals of potential disruptions, with changes in production, delivery times and inventories reflecting current economic conditions. The importance of the study lies in its ability to provide essential information for formulating strategies to increase the resilience of supply chains, thereby enabling companies to adapt to a dynamic economic environment proactively.

Keywords: *Purchasing Managers' Index (PMI), supply chain, supply chain disruptions*

INTRODUCTION

In recent years, we have witnessed increased public interest in what is happening in the field of procurement and supply. This interest is not unexpected, as disruptions in supply and demand significantly affect the economy and shape our everyday lives. These disruptions, which often occur in supply chains, reveal the vulnerability of companies embedded in global networks and dependent on cooperation with external partners. Globalisation and the interdependence of different markets mean that local events are quickly reflected in global economic movements.

The COVID-19 pandemic has dramatically highlighted these points, with supply chain disruptions increasing by as much as 638% in the first part of 2021, according to data platform Resilinc(*Supply Chain Disruptions- Resilinc's Mid-Year Report*, 2021). Disruptions in supply chains include delivery delays, resource shortages, increased costs and reduced productivity, leading to lost sales, customer dissatisfaction and reputational damage.

Gartner (2021) noted that business leaders are overwhelmingly aware of the need to make their networks more resilient and flexible. At the same time, 60% admit that their supply chains were not designed for resilience but for cost efficiency. Thus, decision-making in the area of procurement and supply chains has become part of the company's strategic decisions.

Effective management and minimisation of the consequences of disruptions require accurate and timely measurement of events in supply chains. A 2023 Deloitte (Narayan et al., 2023)survey of more than 1,000 supply chain managers found that nearly 80% of respondents reported negative supply chain events in the past 12 months.

Research by McKinsey (2022) shows that much effort is being put into improving the visibility of the entire supply chain, scenario-based planning and master data management to increase resilience to disruptions and maintain cost efficiency. Indexes such as the PMI are vital as they allow companies to monitor and analyse critical parameters such as delivery times, production capacity and inventory levels. This allows them to take proactive action and minimise the negative impact of disruptions on their operations.

The Purchasing Managers' Index (PMI) is a key economic indicator that not only assesses the health of the manufacturing sector and reflects global economic trends but also goes beyond traditional economic forecasting with detailed insight into supply chain dynamics, enabling managers and business leaders to adapt their strategies to current and future market conditions.

This study examines the effectiveness of PMI as a predictive tool to signal potential disruptions in supply chains in the context of unforeseen global events such as natural disasters or geopolitical tensions. It aims to improve understanding of its predictive power, which will contribute to better risk management and strategic agility of companies and fill critical gaps in the literature with practical implications for using PMI in strategic planning.

1. LITERATURE REVIEW

The purpose of the indexes is to determine the impact of various events on procurement, OV and economic trends. Index means indicator. These are relative numbers with which we compare two or more data of the same type about the phenomenon under study. Since the indexes are unnamed numbers, it is also possible to compare the indexes of various phenomena, the comparison of which would otherwise not be possible (Mišić, 2022).

One of the most popular economic sentiment measures among economists and governments, published in many countries, is the Purchasing Managers' Index (PMI) (D'Agostino & Schnatz, 2012; Sobko & Klonowska-Matynia, 2021). PMI has emerged as a key indicator of manufacturing activity because it is a broad indicator of various subindexes relating to economic activity in the sector (Harris, 1991).

The PMI is a monthly subjective indicator calculated through structured surveys with company leaders in the field of procurement (Chien & Morris, 2016; Habanabakize & Meyer, 2017; Soni, 2014). Its purpose is to collect information on developments in the field of procurement to provide timely (read fast) insight into changing global business conditions and identify economic trends. This is not about future expectations but actual insight into what is happening in the manufacturing and service sectors.

Many studies find that the PMI is a reliable predictor of changes in manufacturing output and real GDP (Alsu & Mandaci, 2020; Banerjee & Marcellino, 2006; Lombardi & Maier, 2011) and helps forecast industrial production and employment ((Habanabakize & Meyer, 2017; Lindsey & Pavur, 2005; Tsuchiya, 2011). It is also a leading indicator for business users, providing advanced signals of changing economic growth and inflation (Williamson, 2008). However, Herwadkar and Gosh (2020) emphasise the PMI's value as a leading indicator for policymakers. Already in 1991 (1991), Harris analysed the PMI as a reliable tool for forecasting economic activity and found evidence of the usefulness of the index for forecasting economic activity. He also found that the PMI has the characteristics of a leading indicator with a general time lead of about 12 months. All this places the PMI among the publications that most relevantly show the developments in a particular economic market (S&P Global, n.d.).

The benefits of the PMI include its timeliness, reliability, and ability to predict changes in industrial production, gross domestic product (GDP), inventories, sales, the sales/inventory ratio, the federal funds rate, foreign exchange returns, and monetary policy. (Berge & Jordá, 2011; Joseph et al., 2011). Often, PMI data is released months before comparable official data such as GDP, industrial production, employment and inflation. The PMI is also the basis for many other indexes, such as the Global Supply Chain Pressure Index - GSCPI or the Global Supply Chain Volatility Index. Given its advantages, many authors state that the PMI is one of the most followed indexes in the world by economic organisations, including central banks and local companies (Khundrakpam & George, 2012).

Despite its widespread use and recognition, PMI is not without criticism. Thus, Bai and co-authors (2017) point out that the data is problematic, as it is often inferred from changes in transport prices or from the subjective perceptions of interviewees from surveys, which can lead to incorrect interpretations of economic conditions. In addition, as an aggregate of diffusion indexes, the PMI does not reflect the intensity of increases or decreases in the economy and does not consider the economic impact of big companies, which can obscure the true picture of economic changes. However, Lindsey and Pavur (2005) point out that the PMI as a national index may not capture dramatic regional or industry trends. Also, fluctuations in the general business cycle can affect supply chain managers.

Although the existing literature extensively discusses the relationship between the PMI and general economic conditions, there is a notable gap in its use to predict specific disruptions in supply chains, especially during sudden global events such as the financial crisis, the COVID-19 pandemic, the Ukrainian-Russian crisis or conflict in the Middle East. Based on this understanding, this research aims to fill the gap by focusing on PMI's ability to detect economic disruptions that directly affect supply chains early, enabling companies and managers to better prepare and respond to upcoming changes in the economic environment.

2. PMI STRUCTURE

The first calculations of the purchasing managers' index (PMI) date back to World War II in the USA, and the modern form was developed in 1979 by Theodore Turda. PMI is calculated by several organisations, the most important of which are ISM - Institute for Supply Management, formerly known as NAPM and S&P Global (before 2022 Markit Economics) (J-P. Morgan, 2023).

Therefore, the Purchasing Managers' Index is based on a standard, globally identical monthly survey that asks managers to report the change in each variable compared to the previous month, indicating whether the variable increased/improved/decreased/worsened or remained unchanged.

The questions are formulated according to the area the index refers to, which is the manufacturing area - manufacturing PMI, service - service PMI, and construction - PMI for construction. The PMI is also calculated for regions (e.g., the Euro area) or globally for all countries. In this case, we are talking about the global PMI, a manufacturing PMI formed from national PMIs. There is also a composite (composite) PMI at the global level, a weighted average of the manufacturing and service PMI for a specific geographic area. For the euro area, France, Germany, Japan, the USA, Great Britain and Australia, the so-called Flash PMI is an early estimate of the final PMI numbers. With the help of a questionnaire sent to purchasing managers, other sub-indexes that are not included in the manufacturing PMI or the global PMI can be calculated. One such is the price index, which measures whether input prices have risen or fallen. (Williamson, 2019)

PMIs are calculated as diffusion indexes that convert various survey responses into a single-digit value. Indexes thus range between 0 and 100, with levels of 50 indicating no change from the

previous month. Readings above 50 indicate an improvement or increase from the previous month. Readings below 50 indicate a deterioration or decline from the previous month.

The manufacturing PMI (and also the global PMI, as the two most important PMI indexes) covers five areas that form independent sub-indexes (the percentages show the weight of each area in the final index): new orders (30%), production (25%), employment (20%), delivery times (of suppliers) (15%) and stocks (10%). The PMI under the indexes reveals the dynamics of economic changes in more detail:

- Indeks Nova naročila predstavlja hitri kazalnik gospodarskih sprememb, z največjo težo v proizvodnem PMI (30%). Rast tega indeksa signalizira povečanje proizvodnje in povpraševanja, kar lahko vodi v optimizem in večje naročilo surovin. Nasprotno, padec pod 50 kaže na zmanjšanje naročil in proizvodnje, kar lahko poveča zaloge in omogoča pogajanja o ceni nabav.
- Indeks Proizvodnja odraža mesečne spremembe v proizvodnji. Vrednost nad 50 kaže na rast proizvodnje, kar zahteva prilagoditve v nabavi in zalogah.
- Indeks Zaposlovanje ponuja vpogled v prihodnje proizvodne kapacitete in pričakovanja podjetij glede gospodarske rasti. Spremembe v tem indeksu so pomemben pokazatelj prihodnje zaposlenosti.
- Indeks Dobavni roki dobaviteljev meri čas, potreben dobaviteljem za izpolnitev naročil. Indeks nad 50 pomeni krajše dobavne roke, obratno pa daljše, kar lahko kaže na pritisk na dobavitelje in morebitno podaljšanje čakalnih dob.
- Indeks Zaloge odseva pričakovano povpraševanje. Nižji indeks od 50 lahko pomeni nepričakovan porast povpraševanja, kar zahteva hitro prilagoditev zalog.

• The New Orders Index represents a rapid indicator of economic changes, with the most significant weight in the manufacturing PMI (30%). The growth of this index signals an increase in production and demand, which can lead to optimism and higher orders for raw materials. Conversely, a drop below 50 indicates reduced orders and production, which can increase inventories and allow procurement price negotiations.
• The Production Index reflects monthly changes in production. A value above 50 indicates production growth, which requires adjustments in procurement and inventory.
• The Employment Index offers insight into future production capacities and companies' expectations regarding economic growth. Changes in this index are an important indicator of future employment.
• The Supplier Delivery Time Index measures the time required for suppliers to fulfil orders. An index above 50 means shorter delivery times and, conversely, longer, which may indicate pressure on suppliers and a possible extension of waiting times.
• The Inventory Index reflects expected demand. An index below 50 may indicate an unexpected surge in demand, requiring rapid inventory adjustments.

Together, these indexes provide a comprehensive overview of economic trends and enable companies to adjust their strategies in a timely manner based on actual market trends.

3. PMI AND SUPPLY CHAIN DISRUPTIONS

In addition to showing economic trends, the PMI index can be used to interpret significant unexpected fluctuations resulting from unforeseen events and disruptions. Examples of such fluctuations are the global financial crisis in 2009 and the tsunami in Japan in 2011, which caused a drop in demand and production and extended delivery times. During the financial crisis, difficulties in obtaining financing caused delays in fulfilling obligations to suppliers and customers, which reduced orders and production. The tsunami in Japan, however, caused the destruction of manufacturing facilities and ports, interrupting supplies of critical raw materials and products and resulting in delays and shortages in the market. While the financial crisis had global consequences, the tsunami did not cause a global recession, as evidenced by the PMI data, which, in this case, did not fall below 50, as shown in Figure 6. The chart also illustrates a significant disruption in 2020 due to the COVID-19 pandemic, which led to a sharp spike in delivery times and input prices due to global supply chain shutdowns.

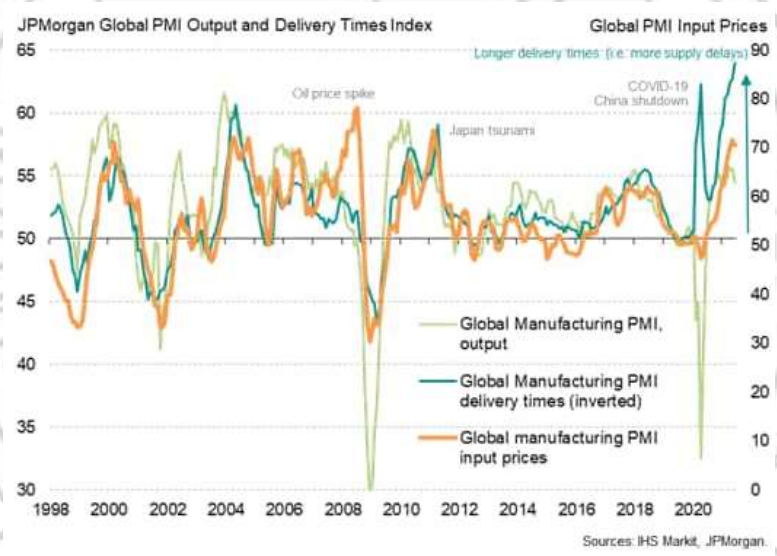

Figure 6: Global manufacturing PMI index, PMI of Delivery Times and Input Prices (Source: IHS Markit Ltd, 2021)

4. USE OF THE DELIVERY TIME INDEX TO DETERMINE SUPPLY DISRUPTIONS

Typically, an increase in production is associated with longer delivery times and a decrease in inventories, as the Manufacturing PMI and New Orders PMI rise while the Delivery Times PMI declines. In ideal conditions, globalisation and efficient allocation of resources would enable faster delivery processes and shorter waiting times.

However, some periods indicate exceptions to such events and suggest disturbances on the supply side as well. For example, during COVID-19, in connection with the New Orders PMI, we noticed that both indexes were below 50 (in Figure 2: the period after the beginning of 2019, the Delivery Time PMI date is reversed). At first, there was a decrease in demand and a deterioration in delivery times due to the known closure restrictions (lockdown). However, with increased demand, companies faced limited capacities and resources to meet the demand.
The disruption then continued with a combination of solid demand (New Orders PMI rising mainly on work-from-home products) but limited production options. Adding to this disruption, such as the Suez Canal disaster, fires, earthquakes or labour shortages on the supply side, the disruptions have further increased the persistence of the Delivery Time Index at an extremely high level (inverse of the PMI) (De Santis, 2022). When things seemed to be calming down, the situation worsened again with the Russian-Ukrainian crisis and shutdowns due to COVID-19 (lockdown) in China (Figure 2b).

These dynamics highlight that the longer delivery times were not simply the result of higher demand but were crucial constraints on the supply side. When the PMI for New Orders and Manufacturing PMI declines, but the Delivery Time PMI remains high, it indicates persistent supply-side disruptions impacting operational efficiency.

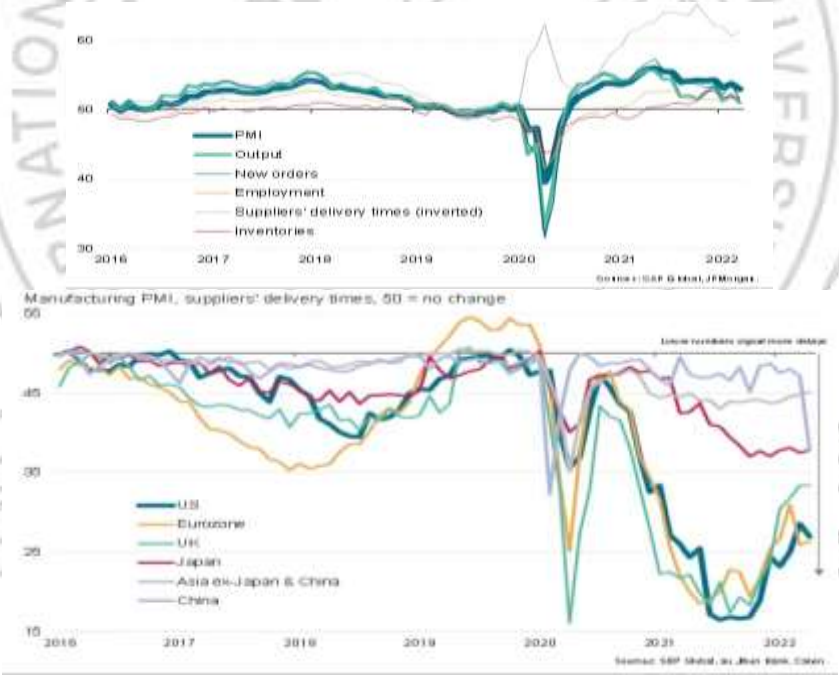

Figure 2: a) PMI indexes during the epidemic b) Delivery Tine PMI during the Ukrainian-Russian crisis (Source Williamson, 2022)

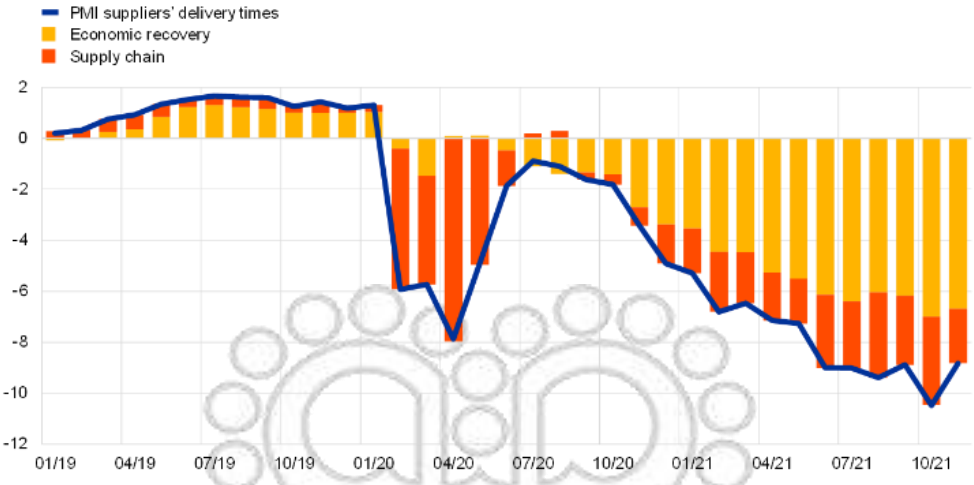

Figure 3: Breakdown of PMI Supplier Delivery Time (Source: Attinasi et al., 2022)

Authors from the European Central Bank conducted an empirical analysis showing that supply-side disruptions during the COVID-19 pandemic contributed about one-third to the impact on global output (Attinasi idr., 2022). The analysis revealed that while demand factors played a crucial role in determining the overall level of the Delivery Time PMI, supply chain disruptions on the supply side accounted for about one-third of all delivery delays. During periods of economic recovery, when new orders are increasing, the impact of such disruptions is usually less (Figure 3).

The link between supply chain disruptions and PMI can also be identified through the recent incidents in the Red Sea. These events caused logistical disruptions reflected in extended delivery times, increased costs, and changes in production and demand (Williamson, 2024).

Delivery Time PMI analysis shows (Figure 4) that due to the need to bypass trade routes around the Cape of Good Hope, delivery times for European manufacturers have grown significantly, which added up to two weeks to standard delivery times (Williamson, 2024). This extension increased transport and logistics costs, passed on to final product prices, increasing inflationary pressures. In addition, due to the uncertainty brought about by longer delivery times and higher prices, new orders have decreased, which indicates a slowdown in production activity. This situation has caused some companies to start increasing inventories or looking for alternative supply routes to mitigate the impact of the disruption.

From Figure 5, we can see how the prices of input raw materials in production also increased during this period due to increased delays and disruptions in the supply chain, which is shown by the increasing trend of the blue line for the prices of input materials.

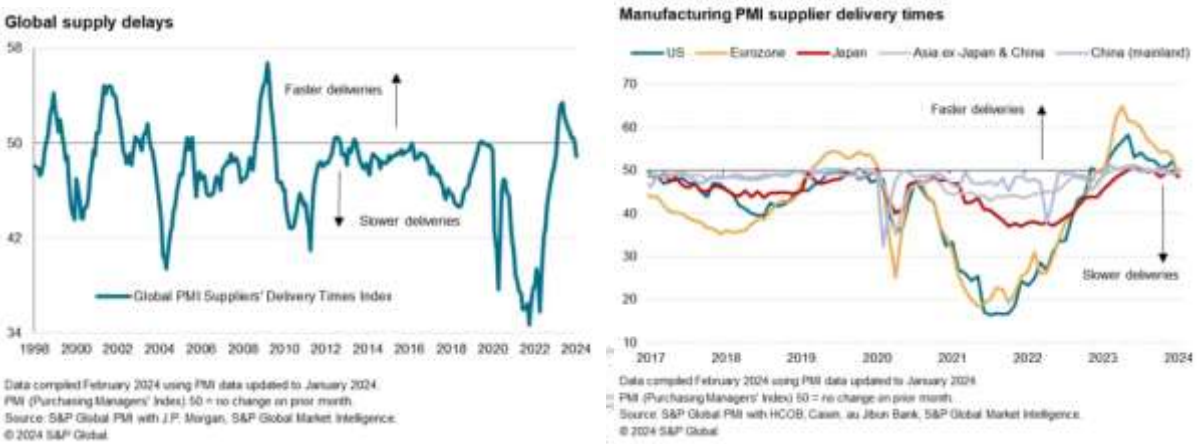

Figure 4: PMI and events in the Red Sea (Source: Williamson, 2024)

Figure 5: Global manufacturing supply conditions and prices (Source: Williamson, 2024)

CONCLUSION

This study successfully highlights and validates the role of the Purchasing Managers' Index (PMI) as a tool for early detection and understanding of disruptions in supply chains. Analysis of PMI

components such as lead times, production and inventories revealed how these indicators predict economic trends affecting supply chains and logistics. This study clearly shows that changes in the PMI can serve as early warning signals for upcoming disruptions and allow companies to respond effectively to changing economic conditions.

Based on the key findings, further research could explore how companies practically use PMI data to shape their future business strategies and operational tactics. Understanding how companies incorporate PMI analysis into their strategic decisions could offer more profound insight into their ability to adapt and innovate in response to economic challenges. This could include an analysis of how different industry sectors adjust their supply chains and production processes based on PMI forecasts, further enriching the understanding of the impact of economic indicators on business practices.

REFERENCES

Alsu, E., & Mandaci, P. E. (2020). Is purchasing managers' index (PMI) a leading indicator for stock, bond and foreign exchange markets in turkey? *Dokuz Eylül Üniversitesi İşletme Fakültesi Dergisi*, *21*(1), 219–233. https://doi.org/10.24889/ifede.605338

Attinasi, M. G., Balatti, M., Mancini, M., & Metelli, L. (2022). *Supply chain disruptions and the effects on the global economy*. https://www.ecb.europa.eu/pub/economic-bulletin/focus/2022/html/ecb.ebbox202108_01~e8ceebe51f.en.html

Bai, C., Rezaei, J., & Sarkis, J. (2017). Multicriteria Green Supplier Segmentation. *IEEE Transactions on Engineering Management*, *64*(4), 515–528. https://doi.org/10.1109/TEM.2017.2723639

Banerjee, A., & Marcellino, M. (2006). Are there any reliable leading indicators for US inflation and GDP growth? *International Journal of Forecasting*, *22*(1), 137–151. https://doi.org/10.1016/j.ijforecast.2005.03.005

Berge, T. J., & Jordá, Ó. (2011). Evaluating the Classification of Economic Activity into Recessions and Expansions. *American Economic Journal: Macroeconomics*, *3*(2), 246–277. https://doi.org/10.1257/mac.3.2.246

Chien, Y., & Morris, P. (2016). *PMI and GDP: Do They Correlate for the United States? For China?* https://doi.org/10.20955/es.2016.6

D'Agostino, A., & Schnatz, B. (2012). *Survey-based nowcasting of US growth: A real-time forecast comparison over more than 40 years* (Working Paper 1455). ECB Working Paper. https://www.econstor.eu/handle/10419/153888

De Santis, R. A. (2022). Sources of supply chain disruptions and their impact on euro area manufacturing. *ECB Economic Bulletin*, *2021*(8). https://www.ecb.europa.eu/pub/economic-bulletin/focus/2022/html/ecb.ebbox202108_07~e6aad7d32f.en.html

Habanabakize, T., & Meyer, D. F. (2017). AN ANALYSIS OF THE RELATIONSHIPS BETWEEN THE PURCHASING MANAGERS' INDEX (PMI), ECONOMIC GROWTH

AND EMPLOYMENT IN THE MANUFACTURING SECTOR IN SOUTH AFRICA. *International Journal of Economics and Finance Studies*, *9*(2), Article 2.

Harris, E. S. (1991). Tracking the Economy with Purchasing Managers' Index. *Quarterly Review. Federal Reserve Bank of New York*, 61–69.

Herwadkar, S. S., & Ghosh, S. (2020). Is PMI a good leading indicator of industrial production? Evidence from India. *MPRA Paper*.

IHS Markit Ltd. (2021). *Focus on… Suppliers' delivery times*.

Joseph, A., Larrain, M., & Turnerc, C. (2011). Forecasting Purchasing Managers' Index with Compressed Interest Rates and Past Values. *Procedia Computer Science*, *6*, 213–218. https://doi.org/10.1016/j.procs.2011.08.040

J-P. Morgan. (2023). *Global manufacturing output returns to growth as supply chain constraints ease and mainland China reopens*. JPMorgan.

Khundrakpam, J. K., & George, A. T. (2012). An Empirical Analysis of the Relationship between WPI and PMI-Manufacturing Price Indexes in India. *MPRA Paper*, Article 50929. https://ideas.repec.org//p/pra/mprapa/50929.html

Lindsey, M. D., & Pavur, R. J. (2005). As the PMI Turns: A Tool for Supply Chain Managers. *Journal of Supply Chain Management*, *41*(1), 30–39. https://doi.org/10.1111/j.1745-493X.2005.tb00182.x

Lombardi, M. J., & Maier, P. (2011). Forecasting Economic Growth in the Euro Area During the Great Moderation and the Great Recession. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2281792

McKinsey & Company. (2022). *Taking the pulse of shifting supply chains*. https://www.mckinsey.com/capabilities/operations/our-insights/taking-the-pulse-of-shifting-supply-chains

Mišić, E. (2022). *Indeksna števila in indeksiranje. Splošno metodološko pojasnilo*. Statistični urad RS.

Narayan, A., Murphy, T., & Marquard, B. (2023). *Looking to make your supply chain more resilient? Measure it.* Deloitte Insights. https://www2.deloitte.com/us/en/insights/focus/supply-chain/supply-chain-resilience-measurement.html

Sobko, R., & Klonowska-Matynia, M. (2021). The Relationship between the Purchasing Managers' Index (PMI) and Economic Growth: The Case for Poland. *EUROPEAN RESEARCH STUDIES JOURNAL*, *XXIV*(Special Issue 1), 198–219. https://doi.org/10.35808/ersj/2038

Soni, P. (2014). *Why do key purchasing managers' index readings move markets?* Yahoo Finance. https://finance.yahoo.com/news/why-key-purchasing-managers-index-190325269.html

S&P Global. (n.d.). *Use the Purchasing Managers' Index (PMI) for accurate and timely insight into the health of the global economy*. S&P Global. Retrieved 18 March 2023, from https://www.spglobal.com/marketintelligence/en/mi/products/pmi.html

Supply Chain Disruptions- Resilinc's Mid-Year Report. (2021). Resilinc. https://www.resilinc.com/in-the-news/supply-chain-disruptions-resilincs-mid-year-report/

Tsuchiya, Y. (2011). Is the Purchasing Managers' Index Useful for Assessing the Economy's Strength? A Directional Analysis. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1766380

Williamson, C. (2008). The Purchasing Managers' Index as a Leading Indicator for Business Users. In Bundesverband Materialwirtschaft, Einkauf und Logistik (Ed.), *Best Practice in Einkauf und Logistik* (pp. 467–479). Gabler. https://doi.org/10.1007/978-3-8349-9581-0_30

Williamson, C. (2019, October 3). *Explaining US manufacturing PMI survey divergences*. S&P Global. https://www.spglobal.com/marketintelligence/en/mi/research-analysis/explaining-us-manufacturing-pmi-survey-divergences-oct19.html

Williamson, C. (2022, April 4). *PMI at 18-month low as manufacturing disrupted by Ukraine war and Omicron wave*. S&P Global. https://www.spglobal.com/marketintelligence/en/mi/research-analysis/pmi-at-18month-low-as-manufacturing-disrupted-by-ukraine-war-and-omicron-wave-apr22.html

Williamson, C. (2024, February 1). *Worldwide manufacturing confidence improves as factories shrug off Red Sea concerns*. IHS Markit. https://www.spglobal.com/marketintelligence/en/mi/research-analysis/worldwide-manufacturing-confidence-improves-as-factories-shrug-off-red-sea-concerns-feb24.html