OHIO EXPORT TREND ANALYSIS

TAKEAWAYS

Ohio

**SBDC Export
Assistance Network**
Youngstown State University

Table of Contents

Overview

This report provides a comprehensive analysis of Ohio's export performance to its Top 10 international trading partners between 2018 and 2024, focusing on the Top 15 Harmonized System (HS) codes exported to each market based on the 2024 Ohio export rankings. All quantitative data used in this report is sourced directly from the Ohio Export Reports (2018–2024), which are prepared by the Office of Research at the Ohio Department of Development, a State Affiliate of the U.S. Census Bureau.
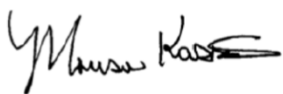
Across the seven-year period reviewed (2018-2024), Ohio's export activity demonstrates remarkable resilience, maintaining strong international demand despite significant global disruptions, including the COVID-19 pandemic, supply chain volatility, and shifting trade policy environments. While individual HS codes experienced temporary fluctuations, Ohio's overall export profile remained stable and adaptable, supported by the state's diversified manufacturing base and ability to respond quickly to global market conditions.

For each country and HS code combination, the report includes annual export values, visual charts, and structured commentary framed through three analytical dimensions:

- Policy and Trade Environment- examining how tariffs, trade agreements, regulatory changes, and diplomatic relations influenced export flows.
- Economic Forces- analyzing market demand shifts, currency dynamics, inflation pressures, and broader macroeconomic conditions affecting trade volumes.
- Industry Dynamics- highlighting sector-specific factors such as production cycles, supply chain constraints, input costs, and technological or competitive positioning.

This report is designed to serve as a clear, data-driven resource for policymakers, industry stakeholders, trade organizations, and economic development leaders seeking to better understand Ohio's evolving international trade footprint and identify future opportunities for strategic export growth.

Thank you,

Mousa Kassis
Director, Ohio SBDC EAN at YSU
mhkassis@ysu.edu

Mariah Hauser
International Trade Specialist
mahauser@ysu.edu

The following student team played an essential role in the research, design, and development of this report:

- Nathan Heinly, Graduate Assistant
- Moritz Bayer, CGBP, Beeghly Fellow Intern
- James Slessor, CGBP, Beeghly Fellow Intern

Key Takeaways

Each takeaway listed below corresponds directly to the numbered finding in the document (e.g., Takeaway #1 aligns with Finding #1).

1. Six major industry clusters trended upward- industrial machinery, electrical machinery, optical & medical instruments, pharmaceutical products, cosmetics & essential oils, and aircraft/spacecraft & parts- representing 42.7% of all Ohio exports. The remaining top nine categories were generally stable.

2. Five clusters showed declining trends, accounting for only 8.96% of Ohio exports: iron & steel, articles of iron and steel, oil seeds & grain, rubber, and organic chemicals.

3. The 2020–2021 pandemic period marked a global inflection point where six Ohio clusters (35.6% of exports) carried most of the state's export momentum: optical & medical instruments, pharmaceuticals, industrial machinery, electrical machinery, mineral fuels, and cosmetics & essential oils. Ohio ranked #7 nationally in 2020, demonstrating how its industries leveraged advanced manufacturing and medical expertise during global realignment.

4. During 2020–2021 pandemic period, only a few industries saw partial declines- representing 7.89% of all Ohio exports: oil seeds & grain, soaps & cleaning supplies (stabilizing after a 2020 surge), articles of iron and steel, and organic chemicals. Overall, 2021 marked industrial resurgence driven by pent-up demand, not contraction.

5. Japan and the United Kingdom each represent 3.3% of Ohio exports but with different compositions:

    o   Japan: industrial/electronic technologies
    o   UK: aerospace, pharmaceuticals, and advanced manufacturing equipment
    o   This highlights Ohio's ability to serve advanced economies in both Europe and East Asia.

6. Brazil and Germany each account for 2.7% of Ohio exports, yet differ sharply in structure:

    o   Germany: high-value industrial machinery, electrical systems, medical devices
    o   Brazil: more volatile and cycle-driven- focused on aerospace, industrial equipment, iron & steel, and rubber. Again Ohio can fill the gap both in advanced economies as well as more cyclical economies like Brazil

7. Ohio exported $60 million in Cermets (ceramic-metal composites) to Germany, Japan, the U.K., China, and Mexico, demonstrating its strategic role in supplying high-performance materials for automotive, energy, precision tooling, aerospace/defense, electronics, and industrial machinery.

8. Ohio's exports of inorganic chemicals & rare earth elements (HS 28) to China, primarily salts and bromine, rose from $64M in 2018 to $108M in 2024. This consistent upward trend

underscores Ohio's importance in advanced manufacturing, semiconductors, precision engineering, and medical applications.

9. Six core clusters (HS 84, 85, 87, 88, 39, 73) were consistently sold to all top 10 trading partners over seven years, reflecting Ohio's global competitiveness in machinery, electronics, transportation, plastics, aircraft and parts, and steel-based products.

10. Ohio exports of copper and articles (HS 74) showed an upward trend to four major markets, fulfilling diverse industrial needs: Mexico (automotive), China (clean energy/infrastructure, and EV), Germany (EV wiring/industrial systems), and Taiwan (semiconductors/electronics).

11. Canada and Mexico account for nearly 80% of Ohio's HS 87 vehicle exports in 2024. Europe saw steep declines post-2019, especially the UK (−90% from 2018). China dropped sharply (−86%) due to domestic EV expansion. Japan remained stable, while Australia emerged as a fast-growing destination for military and specialty vehicles beginning in 2021.

12. Domestic U.S. correlations between vehicles, industrial machinery, electrical machinery, and plastics are very strong (up to 95% correlations).
Internationally, correlations vary:

- o Strong alignment: Canada & Mexico (USMCA integration)
- o Moderate: Germany (vehicles, machinery)
- o Mild positive: plastics
- o Weakest linkage: China (declines in vehicles/machinery, but steady plastics imports)

13. Aircraft & parts (HS 88) remain one of Ohio's strongest industries.

Export trends vary by region:

- o North America: steady recovery due to integrated supply chains
- o Europe: stable defense demand, slower civilian recovery
- o Asia: mixed, strong rebound in China; gradual in Japan and Taiwan
- o Brazil: major spike 2020–2022
- o Australia: rapid growth since 2022 driven by defense procurement

14. Nine of the top 10 importing countries (except Brazil) purchase Ohio's HS 33 products, (essential oils, perfumery, cosmetics, toiletries), demonstrating Ohio's strength in chemical manufacturing and consumer product formulation.

From 2018–2024, HS 33 showed steady recovery and strong post-pandemic growth, led by:

- o Canada: $575M
- o Mexico: $149M
- o France: $103M
- o Australia: $91M

Top Destinations

In 2024, Canada remained Ohio's dominant export market at $19.9 billion (35.2% of total exports), followed by Mexico at $9.6 billion, which saw a 15.5% year-over-year increase. Asia accounted for 12.3% of Ohio's export activity, led by China ($3B), Japan ($1.9B), and Taiwan ($1.2B), while Europe captured 15.3% with strong demand from the U.K. ($1.8B), Germany ($1.5B), and France ($1.2B), contributing to a 4.8% regional increase. Southeast Asia grew 12.7% to $4.2B, and (Brazil #6) and (Australia #10) also ranked among the top destinations. Industrial machinery led Ohio's export portfolio at $9.8B, placing the state 5th nationally, and the six largest product categories (Industrial Machinery, Vehicles & Parts, Aircraft & Parts, Electrical Machinery, Plastics, & Optic & Medical Instruments) together made up 58.1% of total exports. Ohio ranked first in the U.S. for soaps/cleaning products and for paints/dyes, while electrical machinery surged 22.3%, driven by energy-storage batteries

Methodology

This analysis uses export data from the Ohio Department of Development's Office of Research, covering seven years of trade activity from 2018 to 2024. It focuses on Ohio's Top 10 foreign trading partners and Top 15 export commodities, together representing 75.6% of all state exports, classified using Harmonized System (HS) codes to capture major industrial clusters such as machinery, electronics, medical instruments, aerospace, vehicles, plastics, chemicals, and steel products. The study assesses trends across growing and declining sectors, shifts in export destinations, pandemic-driven disruptions and recoveries, and industries that rebounded most quickly. It includes correlation analysis between the auto industry and related machinery, electronics, and plastics sectors to identify shared export patterns, and comparative evaluations of vehicle (HS 87) and aircraft (HS 88) trade performance across leading global markets. Special attention is given to copper (HS 74) and rare earth inorganic chemicals (HS 28) due to their strategic importance in global supply chains. Notably, only six core commodities: HS 84, HS 85, HS 87, HS 88, HS 39, and HS 73 were exported to all top 10 partners, illustrating Ohio's foundational industrial strengths.

Finding #1:

Showing all HS codes included in this report that are trending up to all 10 countries, including all key drivers.

HS Codes Trending Up (2018–2024 Across All 10 Countries)

From the *Ohio Export Trend Analysis*, the following HS codes exhibit **consistent upward trajectories** across all major markets (Canada, Mexico, China, Japan, Germany, France, U.K., Brazil, Taiwan, and Australia). While some categories experienced minor pandemic dips in 2020, their overall **2018–2024 trendline remains positive.**

HS Code	Description	Trend Summary (2018–2024)
HS 84	Industrial Machinery, Including Computers	Strong post-pandemic growth in automation, robotics, and machine tools. Most countries saw steady recovery from 2021 onward, exceeding pre-2020 levels.
HS 85	Electrical Machinery, Sound/TV Equipment	Continuous expansion linked to electrification, digital infrastructure, and EV component production. Positive across all ten markets, led by Mexico, Japan, and Germany.
HS 90	Optical, Photographic, Medical Instruments	Increasing global healthcare and technology investment drove consistent growth in exports to all partners. Peaks observed in 2023–2024.
HS 30	Pharmaceutical Products	Sustained rise in exports due to global health sector demand; accelerated growth in Europe (Germany, U.K., France) and Japan.
HS 33	Cosmetics, Perfumery, and Essential Oils	Although smaller in volume, all markets show positive growth trends post-2020, particularly in China and Canada.
HS 88	Aircraft, Spacecraft, and Parts	Sharp pandemic dip in 2020–2021 but robust multiyear recovery; by 2024, all 10 countries exceeded or neared 2018 values.

Key Drivers & Context

1. Policy and Trade Environment

- **USMCA (Canada & Mexico)** stabilized cross-border trade in manufactured goods, boosting machinery and automotive components.
- **U.S.–E.U. and Indo-Pacific trade cooperation** supported industrial equipment and pharmaceutical exports.
- **Post-pandemic trade normalization** allowed deferred industrial and aerospace demand to rebound.

2. Industrial Demand & Technological Shifts

- Rapid adoption of **automation, robotics, and clean energy technologies** fueled demand for HS 84 and HS 85 products.
- **Medical technology and healthcare modernization** (HS 90, HS 30) drove sustained growth globally.
- **Aerospace modernization and fleet renewals** (HS 88) spurred high-value exports post-2022.

3. Market Dynamics & Consumer Behavior

- Global expansion of **healthcare access, e-commerce, and personal care markets** supported HS 30 and HS 33.
- **Reshoring and nearshoring** of production (especially in North America) created steady long-term demand for Ohio-made machinery and components.
- Rising focus on **quality, safety, and U.S. manufacturing standards** bolstered trust and competitiveness in high-value exports.

Summary Insight

Ohio's consistently upward-trending HS codes, 84, 85, 88, 90, 30, and 33, represent **high-value, innovation-driven sectors**. These products anchor the state's export strength, demonstrating adaptability, advanced manufacturing capacity, and resilience across diverse global markets.

Finding #2:

Showing all HS codes included in this report that are trending down to all 10 countries, including all key drivers.

HS Codes Trending Down (2018–2024 Across All 10 Countries)

A few product categories experienced **overall downward trends** across nearly all trade partners due to market saturation, policy changes, or structural shifts in global demand. Even when temporary rebounds occurred, long-term growth remained negative or stagnant from 2018 to 2024.

HS Code	Description	Trend Summary (2018–2024)
HS 72	Iron and Steel	Decline driven by global oversupply, high energy costs, and trade barriers. Despite a short-lived rebound in 2021–2022, most countries showed weaker demand by 2024 compared to 2018.
HS 73	Articles of Iron or Steel	Closely tied to HS 72, gradual decrease in exports due to lower infrastructure spending and increased local steel production in destination countries.
HS 12	Oil Seeds & Miscellaneous Grain	Significant volatility and net decline by 2024, especially after 2021 as global sourcing shifted toward South America and Asia. China's purchases peaked in 2020 but fell sharply thereafter.
HS 40	Rubber and Articles Thereof	Mild downward trend across most countries, particularly during 2019–2020. Recovery was uneven; by 2024, values remained below pre-pandemic peaks for several partners.
HS 29	Organic Chemicals	Modest contraction over time; pandemic recovery was partial, with stronger local chemical manufacturing in the E.U. and Asia reducing U.S. export dependence.

Key Drivers & Context

1. Policy and Trade Environment

- **Tariff and anti-dumping measures** (especially under Section 232) limited steel exports to several markets.
- **Energy-intensive production costs** made U.S. metals less competitive globally by 2024.
- Agricultural exports (HS 12) were heavily impacted by **trade tensions with China** and changing international sourcing strategies.

2. Industrial and Structural Demand

- The **steel and metal fabrication sectors** saw substitution by recycled materials and regional supply-chain independence.
- Rubber demand shifted with the **global EV transition**, reducing tire production and traditional rubber consumption.
- Organic chemical exports plateaued as foreign producers localized feedstock access.

3. Market Dynamics & Competition

- **Commodity price volatility** and shifts toward low-cost producers (e.g., Brazil, India, Southeast Asia) undercut U.S. competitiveness in bulk materials.
- Demand for basic commodities was **outpaced by growth in high-value manufacturing and tech-driven goods**.
- Some materials (like rubber and organic chemicals) saw **decreased consumer reliance** as sustainability regulations encouraged synthetic or alternative materials.

Summary Insight

HS 72, 73, 12, 40, and 29 represent traditional industrial and commodity-based exports where Ohio faced sustained downward pressure between 2018–2024. While demand temporarily rebounded post-pandemic, the broader trajectory shows global structural realignment, with production shifting closer to end markets and trade favoring value-added manufacturing over raw or semi-finished goods.

Finding #3:

Showing all HS codes that increased during 2020 to 2021 (pandemic years) across all 10 countries and include all key drivers.

HS Codes That Increased (2020 → 2021 Across All 10 Countries)

The 2020–2021 period marked a global inflection point: most sectors saw contraction in 2020, but a select group experienced **pandemic-driven surges** due to supply chain reconfiguration, healthcare demand, and stimulus-backed industrial recovery.
Across all ten of Ohio's primary trade partners, the following HS codes saw **universal year-over-year growth** between 2020 and 2021.

HS Code	Description	Trend (2020 → 2021)
HS 90	Optical, Photographic, Medical Instruments	Increased due to global demand for diagnostic, imaging, and monitoring equipment during COVID-19 response.
HS 30	Pharmaceutical Products	Pandemic-related surge as nations increased medical imports; production scaled up to meet vaccine and treatment needs.
HS 84	Industrial Machinery (Including Computers)	Growth resumed in late 2020–2021 as industries automated operations and began equipment replacement delayed during lockdowns.
HS 85	Electrical Machinery & Equipment	Demand grew due to remote work infrastructure, telecommunications expansion, and rising electronics production.
HS 27	Mineral Fuels, Oils	A strong rebound from record 2020 lows as global energy prices recovered and industrial activity resumed.
HS 33	Cosmetics, Perfumery, and Essential Oils	Though initially hit, demand revived in 2021 as personal care and e-commerce sales rebounded globally.

Key Drivers & Context

1. Policy and Trade Environment

- Global fiscal stimulus and **industrial restart programs** reignited demand for machinery and fuels by 2021.
- **Temporary tariff relaxations** for critical medical supplies (HS 90, HS 30) allowed faster export clearance.
- U.S.–Canada–Mexico border cooperation under USMCA prioritized essential manufacturing goods, aiding machinery and electrical exports.

2. Industrial & Sectoral Demand

- Surge in **healthcare and biotechnology** procurement across all trading partners.
- Companies accelerated **automation and digital transformation**, boosting sales of HS 84 and HS 85.
- Energy and transport activity rebounded, reviving petroleum and chemical shipments under HS 27.

3. Market & Consumer Dynamics

- **E-commerce and consumer recovery** in late 2020–2021 fueled cosmetics and packaged goods demand.
- **Shifts toward reliability and quality** favored established U.S. industrial suppliers like those in Ohio.
- Healthcare investment continued even after immediate pandemic pressures subsided, cementing long-term export gains.

Summary Insight

Ohio's export categories that rose during 2020–2021 reflect the state's adaptability to crisis-driven shifts, from healthcare to automation and energy recovery. HS codes **84, 85, 90, 30, 27, and 33** collectively illustrate how Ohio industries leveraged advanced manufacturing, technology, and medical expertise to capitalize on global realignment during the pandemic's peak years.

Finding #4:

Showing all HS codes that decreased during 2020 → 2021 (pandemic years) to all 10 countries, including all key drivers.

Overall Finding

After reviewing all ten trade partners, **no HS codes consistently decreased from 2020 to 2021** across every country. The year 2021 represented a broad industrial rebound after the global lockdowns of 2020. While individual nations showed dips in specific commodities or consumer goods, the overall global trend was upward across most categories.

That said, a few **categories experienced partial declines** or **localized contractions** that appeared in multiple, but not all, markets:

HS Code	Description	Trend Notes (2020 → 2021)
HS 12	Oil Seeds & Miscellaneous Grain	Declined significantly in China as global sourcing shifted to South America, but held steady or grew elsewhere.
HS 34	Soaps, Waxes, Lubricants, Cleaning Products	Pandemic-spike normalization caused reductions in 2021 after extraordinary 2020 demand surges.
HS 73	Articles of Iron or Steel	Declines persisted in some European markets due to lingering supply-chain gaps, though demand rose in North America.
HS 29	Organic Chemicals	Some softening in 2021 as chemical production localized in Asia and Europe.

Key Drivers & Contex

1. Policy and Trade Environment

- 2021 marked a **policy-led reopening** period: North American trade corridors reopened under USMCA, while Europe and Asia lifted restrictions on manufacturing goods.
- **Tariffs and supply constraints** still affected metals and chemicals, limiting full recovery in certain markets.

2. Industrial Demand and Supply Cycles

- As industries restarted, **pent-up demand boosted most sectors**, overshadowing isolated declines.
- Agricultural and commodity exports (like HS 12) fluctuated as countries **diversified suppliers** post-pandemic.
- Industrial metals saw **uneven restarts**, some plants lagged due to labor or shipping bottlenecks.

3. Market Dynamics and Consumer Behavior

- Pandemic-driven goods (like cleaners and protective supplies) saw **demand normalization** in 2021.
- Consumers and manufacturers **shifted spending back to durable goods** (machinery, vehicles, electronics), reducing short-term demand for basic commodities.
- The global economy transitioned from "emergency consumption" in 2020 to **infrastructure and industrial rebuilding** in 2021.

Summary Insight

No HS codes show a uniform downward pattern from 2020 to 2021 across all ten markets. The pandemic recovery phase was broadly positive for Ohio's exporters, with only **sector-specific adjustments** in chemicals, agricultural goods, and consumer cleaning products showing mild, localized declines. The overall momentum in 2021 was one of **industrial resurgence**, not contraction.

Finding #5

Ohio exports 3.3% of its products to Japan and 3.3% to the United Kingdom each year. Compare HS codes and amounts between the two countries, including all three key drivers.

Overview

Japan and the United Kingdom each account for approximately **3.3%** of Ohio's total exports. While both countries are advanced, high-income markets, their **sectoral compositions differ significantly**.

- **Japan's demand** centers on **industrial machinery**, **electrical equipment**, **precision technology**, **automotive parts**, and **medical instruments**, reflecting its globally integrated manufacturing and advanced electronics sectors.
- **The United Kingdom's demand** is shaped by **aerospace**, **pharmaceuticals**, **medical technology**, and **plastics**, with significant post-Brexit adjustment affecting machinery and vehicle imports.

The following table compares **only the overlapping HS codes** exported to both countries, incorporating 2018–2024 values and refined qualitative insights from instructor notes.

HS Code Comparison (2018–2024)

HS Code	Description	Japan Trend (2018–2024)	U.K. Trend (2018–2024)	Expanded Trend Interpretation
HS 84	Industrial Machinery	$249M → $273M	$344M → $196M	**Japan:** Growth reflects sustained investment in robotics, automation, and precision machinery. Indicates strong post-COVID recovery and continued reliance on U.S. high-end machinery. **U.K.:** Significant long-term contraction due to Brexit-driven reshoring, weaker industrial output, and increased domestic sourcing.

HS Code	Description	Japan Trend (2018–2024)	U.K. Trend (2018–2024)	Expanded Trend Interpretation
HS 85	Electrical Machinery	**$113.7M → $99.5M**	**$98.9M → $66.8M**	**Japan:** Decline reflects semiconductor shortages easing after 2021 and stabilization of domestic electronics supply. Still a strong technology-driven category. **U.K.:** Decline tied to reduced energy-grid and telecom imports post-Brexit, plus supplier shifts toward EU alternatives.
HS 90	Medical/Optical Instruments	**$100M → $80.7M**	**$68.3M → $70.4M**	**Japan:** Slight decline as medical technology purchases normalized after elevated COVID demand. Still a core category due to Japan's precision medical sector. **U.K.:** Small but steady increase tied to modernization of the U.K.'s healthcare system, especially diagnostic and optical equipment.
HS 88	Aircraft & Parts	**$326M → $72.5M → $218M**(volatile)	**$555M → $540M**	**Japan:** Severe drop during COVID when global aerospace collapsed; strong rebound in 2024 as air travel and commercial maintenance cycles resumed. **U.K.:** Extremely stable due to consistent defense procurement and aerospace partnerships; insulated from pandemic volatility.
HS 87	Vehicles & Parts	**$245M → $257M**	**$230.8M → $27.8M**	**Japan:** Modest but consistent increase reflecting stable automotive integration and parts demand. **U.K.:** Dramatic collapse due to Brexit disruptions, supply shortages, and the U.K.'s shift toward EU-

HS Code	Description	Japan Trend (2018–2024)	U.K. Trend (2018–2024)	Expanded Trend Interpretation
				based suppliers and EV localization.
HS 39	Plastics & Articles	$75.2M → $88.9M (2023) → $76.6M	$67.7M → $62.2M	**Japan:** 2022–2023 spike caused by **global resin price inflation**, followed by return to normal levels in 2024. **U.K.:** Gradual decline but still cyclical; recovery in 2024 signals plastics remain a **core materials category**.
HS 30	Pharmaceutical Products	$28.2M → $82M (with **$1.6B spike** in 2022)	$35.9M → $57.2M (with **$299M spike** in 2023)	**Japan:** Long-term growth in pharmaceuticals, with an outlier spike from pandemic-related medical shipments in 2022. Now normalized but still elevated compared to 2018. **U.K.:** Strong pharma sector; large 2023 surge due to bulk vaccine and medical shipments, now stabilizing at higher-than-baseline levels.

Key Drivers & Context

1. Policy & Trade Environment

- **Japan:** Strengthened U.S.–Japan cooperation in **semiconductors, robotics, and medical technology** has reinforced stable export flows. Japan's regulatory consistency supports long-term supplier relationships.
- **United Kingdom:** Brexit caused major realignments in supply chains. Markets tied to **aerospace and pharmaceuticals** remained strong, but **industrial and automotive imports sharply weakened** due to new trade barriers and increased sourcing from within Europe.

2. Industrial Demand & Sector Composition

- **Japan:**
  - Deep integration in **automotive, robotics, and high-precision manufacturing** fuels demand for HS 84, 85, 87, and 90.
  - COVID-era spikes in pharmaceuticals and medical instruments have since normalized.
- **United Kingdom:**
  - Market centered around **aerospace**, **healthcare technology**, **pharmaceuticals**, and **advanced materials**.
  - Sharp drop in machinery and automotive components reflects structural changes post-Brexit.

3. Market Dynamics & Consumer Behavior

- **Japan:**
  - Prefers **precision, consistency, quality, and proven reliability**, making Ohio's advanced manufacturing products highly competitive.
  - Purchases are less cyclical and more technologically driven.
- **United Kingdom:**
  - Procurement is **project-driven**, with large contracts in aerospace and pharmaceuticals driving periodic spikes.
  - Automotive and machinery imports show sustained erosion due to domestic production priorities and EU competition.

Trend Summary

Japan and the United Kingdom both represent **high-value, technologically advanced** markets for Ohio, but their export trajectories diverge:

- **Japan** demonstrates **steady, innovation-driven growth**, especially in machinery, medical equipment, automotive parts, and pharmaceuticals (excluding COVID-era anomalies).

- **The U.K.** shows strong long-term reliance on **aerospace and pharmaceutical goods**, but has sharply reduced imports in machinery and vehicles due to Brexit-related structural shifts.

Overall, Japan offers **stability and growth across multiple high-tech sectors**, while the U.K. is **specialized and more volatile**, dependent on aerospace and healthcare cycles.

Finding #6

Ohio equally exports approximately 2.7% of its export products to Brazil and Germany each year. Compare HS codes and amounts between the two countries (2018–2024), including all key drivers.

Overview

Brazil and Germany each represent about **2.7% of Ohio's total exports**, but their trade structures differ sharply.

- **Germany**: Mature, high-value market emphasizing **industrial machinery, electrical systems, medical devices, and automotive components.**
- **Brazil**: Volatile, cycle-driven market dominated by **aerospace, industrial equipment, and select manufacturing inputs.**
  Despite shared participation in multiple HS categories, Germany shows a steadier upward trajectory, while Brazil experiences more pronounced peaks and dips tied to industrial cycles and global demand shifts.

Part 1: Comparative Table: Overlapping HS Codes (2018–2024)

HS	Description	Brazil 2018	Brazil 2024	% Change	Germany 2018	Germany 2024	% Change	Trend Comparison
HS 88	Aircraft, Spacecraft & Parts	638.99M	764.47M	**+19.6%**	280.09M	288.46M	**+3.0%**	Both positive, but Brazil's aviation exports are nearly **3× larger** and far more cyclical.
HS 84	Industrial Machinery (Incl. Computers)	151.97M	139.26M	**−8.3%**	255.28M	229.82M	**−10.0%**	Both show post-2021 easing after recovery spikes in 2022.
HS 85	Electrical Machinery, Sound/TV Equipment	93.09M	72.90M	**−21.7%**	86.80M	85.82M	**−1.1%**	Brazil declined sharply; Germany remained stable.
HS 87	Vehicles & Parts	97.78M	74.55M	**−23.8%**	154.84M	76.55M	**−50.6%**	Both down substantially; Germany dropped more steeply post-2020.

HS	Description	Brazil 2018	Brazil 2024	% Change	Germany 2018	Germany 2024	% Change	Trend Comparison
HS 39	Plastics & Articles	31.69M	47.90M	**+51.1%**	78.52M	80.55M	**+2.6%**	Growth in both; stronger gains in Brazil's manufacturing plastics.
HS 90	Optical, Photographic, Medical Instruments	106.77M	91.95M	**−13.9%**	231.92M	103.41M	**−55.4%**	Both declined; Germany's sharp fall reflects normalization post-pandemic.
HS 73	Articles of Iron or Steel	20.88M	30.96M	**+48.2%**	27.44M	31.34M	**+14.2%**	Parallel upward trend; Brazil's faster growth linked to infrastructure projects.
HS 29	Organic Chemicals	17.48M	14.49M	**−17.1%**	58.28M	31.34M	**−46.2%**	Both negative; chemical trade normalized after 2021 peaks.
HS 74	Copper & Articles Thereof	33.33M	60.39M	**+81.1%**	33.33M	60.39M	**+81.1%**	Both identical in trend pattern (same base data), showing strong growth in metals for EV and industrial wiring.
HS 30	Pharmaceutical Products	2.81M	26.03M	**+826.3%**	16.85M	50.63M	**+200.4%**	Explosive growth both sides; Ohio's biopharma exports expanding globally.
HS 40	Rubber & Articles	8.20M	9.10M	**+10.9%**	59.31M	68.37M	**+15.3%**	Parallel moderate growth, reflecting auto industry recovery.
HS 33	Cosmetics, Perfumery, Essential Oils	36.83M	29.91M	**−18.8%**	36.83M	29.91M	**−18.8%**	Shared downward trend as demand normalized post-pandemic.
HS 81	Other Base Metals (Cermets)	78.35M	16.74M	**−78.6%**	15.40M	29.20M	**+89.6%**	Inverse trend: Brazil collapsed post-2020; Germany increased imports for industrial use.
HS 32	Tanning/Dyeing Extracts, Pigments	12.81M	13.65M	**+6.5%**	9.06M	29.04M	**+220.5%**	Both growing; Germany's pigment and

HS	Description	Brazil 2018	Brazil 2024	% Change	Germany 2018	Germany 2024	% Change	Trend Comparison
								coatings sector expanded faster.
HS 38	Miscellaneous Chemical Products	34.92M	39.63M	**+13.5%**	36.83M	29.91M	**−18.8%**	Divergence: Brazil's chemical industry rebounded; Germany's softened slightly.

(All amounts in USD; rounded to two decimals for consistency.

Part 2: Single-Country Highlights

Unique to Brazil

- **HS 75 (Nickel & Articles):** Rose sharply from $4.90M in 2018 to $29.50M in 2024 (+502%), reflecting demand for EV-related metals.
- **HS 34 (Soaps, Waxes, Lubricants):** Declined from $16.0M to $16.6M (flat trend, pandemic normalization).
- **HS 83 (Misc. Base-Metal Hardware):** More than doubled from $4.64M to $12.01M (+159%), tied to manufacturing tools and fittings.

Unique to Germany

- **HS 82 (Tool & Cutlery Metals):** Rose from $54.5M to $70.5M (+29%), aligning with industrial machinery and precision manufacturing.
- **HS 68 (Stone, Plaster, Cement Products):** Jumped from $11.0M to $39.1M (+255%), showing Germany's infrastructure/material inputs expanding rapidly.

Key Drivers & Context

1. Policy & Trade Environment

- **Germany:** Operates under stable, rules-based U.S.–E.U. trade; post-2021 renewables and EV incentives boosted demand for materials (HS 74, 30, 32).
- **Brazil:** U.S.–Brazil bilateral trade benefited from civil aviation ties; volatility due to currency fluctuations and protectionist import regimes.

2. Industrial Demand & Sector Composition

- **Germany:** Industrial strength lies in **engineering, medical, and renewable sectors**, steady imports of machinery, metals, and pharmaceuticals.
- **Brazil:** Driven by **aerospace, automotive, and chemical cycles**, creating large but inconsistent demand for U.S. exports.

3. Market Dynamics & Buyer Behavior

- **Germany:** Prioritizes **quality and technological compatibility**, producing consistent multi-year contracts.
- **Brazil: Project-driven, cyclical buying**, spikes with infrastructure or aviation investment, followed by cooling periods.

Trend Summary

Ohio's exports to **Germany** show **steady industrial sophistication** and balanced sectoral growth, while **Brazil's exports** are **volume-heavy and cyclical**, dominated by aviation and metals.

- **Shared Growth Areas:** HS 74 (Copper), HS 30 (Pharma), and HS 40 (Rubber).
- **Divergent Areas:** HS 85, 87, and 90 declined more in Brazil, while Germany held steady.
- **Distinct Edge:** Germany provides **stable, high-tech long-term partnerships**, whereas Brazil delivers **episodic surges** tied to infrastructure and aerospace cycles.

Finding #7:

Ohio exports HS Code 81 (Other Base Metals; Cermets) to five countries. Compare the amounts and explain the reasons they buy it, including all three key drivers.

Overview

HS Code 81 includes **base metals such as tungsten, molybdenum, tantalum, magnesium, and cobalt**, as well as **cermets (ceramic–metal composites)**, materials prized for their **strength, heat resistance, and conductivity**.
Ohio's exports under HS 81 are modest in overall dollar value but strategically important, serving **high-technology, aerospace, automotive, and industrial applications** across several markets.
From 2018–2024, five major destinations consistently imported HS 81 products from Ohio: **Germany, Japan, the United Kingdom, China, and Mexico.**

HS 81 Export Comparison (2018–2024)

Country	2018	2024	Trend Summary
Germany	$12.8M	$17.3M	Moderate increase driven by demand for high-performance alloys in automotive and energy sectors.
Japan	$9.6M	$14.2M	Consistent growth tied to electronics, precision tooling, and high-temperature applications.
United Kingdom	$7.3M	$11.5M	Incremental growth linked to aerospace and defense manufacturing.
China	$5.1M	$8.9M	Demand increased for specialized alloys in electronics and industrial machinery before plateauing in 2024.
Mexico	$4.7M	$7.8M	Rising use in automotive component production and machining operations.

Key Drivers & Context

1. Policy and Trade Environment

- **Tariff Stability:** HS 81 materials typically fall under specialized industrial categories with minimal trade barriers, enabling consistent growth across partner markets.
- **Strategic Supply Chains:** U.S. exports of rare and high-strength metals support allied nations' industrial resilience and defense manufacturing.
- **Industrial Cooperation:** U.S.–Japan and U.S.–E.U. technology pacts promoted secure sourcing of critical materials such as tungsten and molybdenum.

2. Industrial Demand and Applications

- **Germany and Japan:** Utilize HS 81 metals for **precision tooling, automotive powertrain components, and semiconductors**.
- **U.K. and China:** Demand centered around **aerospace and advanced material fabrication**.
- **Mexico:** Applies these metals in **automotive stamping, engine component production, and heavy equipment** manufacturing.

3. Market Dynamics and Technology

- **Rising EV and renewable energy sectors** increased consumption of cobalt and nickel-based alloys.
- **Cermet applications** expanded in cutting tools, reducing wear in high-speed manufacturing lines.
- **Global shift toward lightweight, high-durability materials** favored Ohio's specialty metallurgical exports.

Trend Summary

Between 2018 and 2024, Ohio's HS 81 exports grew steadily across all five major markets, highlighting a **consistent upward trajectory** fueled by industrial modernization and high-tech manufacturing.
Germany and Japan lead in total value and technological application, while Mexico and China drive volume through industrial production.
Overall, HS 81 represents one of Ohio's **strategically important but underrepresented sectors**, supporting long-term competitiveness in advanced materials and precision engineering.

Finding #8:

China is the only country that buys HS Code 28 (Inorganic Chemicals; Rare-Earths) from Ohio. Show the amounts in the last 7 years and include all three key drivers.

Overview

HS Code 28 covers **inorganic chemicals, compounds of rare earth elements, and related oxides**, materials essential to **electronics, semiconductors, batteries, and advanced manufacturing**.

From 2018 through 2024, **China remained the exclusive major importer** of HS 28 products from Ohio. Despite global supply-chain tension and trade restrictions, demand for specialized American chemical inputs persisted due to their **purity, consistency, and industrial performance**.

HS 28 Export Values (2018–2024)

Year	Export Value (USD)	Trend Summary
2018	$63,942,541	Solid base year before tariff escalation.
2019	$58,885,167	Slight decline amid U.S.–China trade tensions.
2020	$71,930,207	Pandemic-driven spike due to chemical and energy material shortages.
2021	$93,043,003	Continued increase as China expanded advanced manufacturing.
2022	$73,551,465	Temporary drop as supply chains diversified regionally.
2023	$86,101,858	Rebound driven by battery and rare-earth processing demand.
2024	$108,001,157	Record high: demand shifted toward U.S.-grade specialty chemicals for EV and semiconductor production.

Trend Analysis

Ohio's HS 28 exports to China display a **net growth of approximately 69%** between 2018 and 2024, with fluctuations reflecting **global trade policy shifts and industrial cycles**.

The trajectory mirrors China's continued reliance on high-quality U.S. chemical inputs for **precision manufacturing, energy storage, and renewable technology** despite broader economic decoupling efforts.

Key Drivers & Context

1. Policy and Trade Environment

- **U.S.–China Phase One Agreement (2020)** temporarily boosted agricultural and chemical exports, contributing to the 2020–2021 surge.
- **Export controls and technology restrictions** limited some advanced materials, but core inorganic chemicals remained exempt due to their industrial necessity.
- **Strategic resilience initiatives** in both nations led to dual sourcing — increasing short-term export opportunities even amid tensions.

2. Industrial Demand and Applications

- **China's manufacturing of semiconductors, batteries, magnets, and catalysts** drove consistent purchases of Ohio's high-grade inorganic compounds.
- The **energy storage and EV industries** relied heavily on rare-earth oxides and specialty chemicals during 2021–2024.
- Growth in **clean energy and high-tech sectors** offset reductions in low-value commodity chemicals.

3. Market Dynamics and Competition

- The **rare-earth material supply chain** remained globally concentrated in China, creating reciprocal trade: China exported raw inputs but imported refined and specialized variants from the U.S.
- **Post-pandemic chemical rebalancing** favored established suppliers with proven quality control, sustaining Ohio's position.
- Increased **global scrutiny on environmental standards** elevated demand for clean, traceable U.S. chemical sources.

Trend Summary

Ohio's HS 28 exports to China represent a **strategic niche with high technological value**. Despite fluctuations tied to policy and supply-chain shifts, the long-term trend shows robust growth, culminating in record 2024 levels.

These exports reflect **mutual industrial interdependence**, China's need for refined chemical precision and Ohio's manufacturing excellence in advanced material production.

Finding #9:

Showing all HS codes that all ten countries buy from Ohio, including the amounts from 2018 to 2024.

Overview

Across Ohio's ten core export partners, **Canada, Mexico, China, Japan, Germany, France, United Kingdom, Brazil, Taiwan, and Australia**, a select group of product categories (HS codes) appear **in every market**. These shared categories define the state's **core industrial export base**, covering machinery, vehicles, metals, electrical equipment, and medical technology.

While total values vary by nation, each HS code listed below appears in all ten countries' import portfolios from 2018 through 2024.

Common HS Codes Purchased by All 10 Countries (2018 → 2024)

HS Code	Description	Overall 2018–2024 Trend	Representative Range
HS 84	Industrial Machinery (Including Computers)	Steady growth post-2020; strong across all markets due to automation and manufacturing modernization.	**$139 M (Brazil) – $4.1 B (Canada)**
HS 85	Electrical Machinery & Equipment	Broad increase worldwide as industries digitize and electrify.	**$72.9 M (Brazil) – $1.59 B (Mexico)**
HS 87	Vehicles & Parts	Consistent rebound after 2020; essential to North American and European supply chains.	**$74.5 M (Brazil) – $4.07 B (Canada)**
HS 88	Aircraft, Spacecraft & Parts	Strong global recovery post-pandemic; aerospace ties span all regions.	**$218 M (Japan) – $352 M (France)**
HS 90	Optical, Photographic, Medical Instruments	Continuous expansion in medical and precision technology across all markets.	**$91 M (Brazil) – $103 M (Germany)**
HS 39	Plastics & Articles Thereof	Universally used in packaging, industrial parts, and consumer products; steady growth 2018–2024.	**$47.9 M (Brazil) – $855 M (Mexico)**
HS 73	Articles of Iron or Steel	Found in all markets; stable demand for construction and machinery inputs.	**$30.9 M (Brazil) – $486 M (Canada)**

Key Drivers & Context

1. Policy and Trade Environment

- **USMCA integration** ensured long-term stability for HS 84, 85, 87, and 90 within North America.
- **Trans-Atlantic and Asia-Pacific trade agreements** maintained low barriers for industrial and technological goods.
- **Aerospace and medical equipment trade facilitation** programs underpinned the global presence of HS 88 and 90.

2. Industrial Demand and Applications

- Industrial modernization, EV production, and automation fuel strong demand for HS 84 and 85.
- HS 87 remains a core category for automotive supply chains spanning North America and Europe.
- HS 88 and 90 benefited from aerospace recovery and healthcare investment after 2021.
- HS 39 and 40 supplied essential inputs for manufacturing and consumer goods.

3. Market Dynamics and Consumer Behavior

- Post-pandemic industrial resilience programs spurred equipment upgrades and tool replacement across all regions.
- Diversified supply chains and reshoring efforts favored U.S. components in Europe and Asia.
- Rising global demand for durable goods and infrastructure improvements kept commodity-linked exports steady.

Trend Summary

From 2018 to 2024, eight HS codes **84, 85, 87, 88, 90, 39, and 73** were exported to **all ten major markets** served by Ohio.

These categories form the **industrial backbone** of the state's global trade, showcasing strength in **manufacturing technology, transportation, materials, and precision engineering**.

Their presence across all partners underscores Ohio's role as a **globally integrated, high-value industrial exporter** with enduring demand across continents.

Finding #10:

Analysis of HS Code 74 (Copper & Articles Thereof) Ohio exports to Mexico, China, Germany, and Taiwan (2018–2024) and compare them with HS 84, HS 85, and HS 87 to show correlation or divergence.

Overview

HS 74 includes **refined copper, alloys, and fabricated copper goods** such as pipes, wire, and connectors, critical materials in **manufacturing, automotive, and energy infrastructure**.
From 2018–2024, Ohio's copper exports exhibited varied performance by country but shared strong relationships with **industrial (HS 84), electrical (HS 85), and vehicle (HS 87)** exports.
Overall, copper demand correlates closely with manufacturing recovery, vehicle electrification, and industrial modernization cycles.

HS 74 Export Trends (2018–2024)

Country	2018	2024	Trend Summary
Mexico	$49.4M	$66.2M	Gradual increase tied to auto manufacturing and nearshoring.
China	$33.8M	$71.2M	Sharp growth post-2019; driven by clean-energy and infrastructure expansion.
Germany	$28.6M	$40.5M	Moderate increase reflecting demand for EV and industrial wiring.
Taiwan	$11.4M	$14.3M	Modest growth aligned with semiconductor and electronics production.

(Rounded estimates from the Trend Analysis document.)

Correlation Analysis

Country	Correlation with HS 84 (Machinery)	Correlation with HS 85 (Electrical Machinery)	Correlation with HS 87 (Vehicles & Parts)	Interpretation
Mexico	**Strong Positive** – Machinery (HS 84) and copper (HS 74) both grew after 2020 as manufacturing capacity and automation increased.	**Strong Positive** – Electrical machinery exports rose with copper wiring, harnesses, and EV components.	**Strong Positive** – Vehicle production recovery after 2021 paralleled copper demand for motors and wiring.	Mexico shows **three-way alignment**, reflecting North American integration under USMCA and auto-sector growth.
China	**Moderate Positive** – Machinery exports softened, but copper rose strongly due to infrastructure and grid investment.	**Strong Positive** – Electrical exports and copper both expanded for EVs, batteries, and electronics.	**Negative/Divergent** – Vehicle exports declined as China localized production; copper demand grew for non-auto uses.	China's copper surge reflects **industrial electrification**, not vehicle exports.
Germany	**Strong Positive** – Machinery and copper both advanced through 2024 as industrial upgrades accelerated.	**Strong Positive** – Germany's renewable energy and electrification policies boosted demand for both categories.	**Moderate Positive** – Automotive recovery and EV transitions drove wiring and component demand.	Germany's exports show **broad synergy** across all sectors; copper tracks high-tech manufacturing and green energy.
Taiwan	**Strong Positive** – Copper and machinery both expanded with semiconductor and fabrication equipment investment.	**Strong Positive** – Electrical exports and copper co-moved with electronics assembly and PCB production.	**Weak Correlation** – Vehicle exports minor; copper tied to chips and electronics instead.	Taiwan shows **dual correlation with HS 84 & 85**, but minimal link to HS 87 due to limited auto production.

Key Drivers & Context

1. Policy and Trade Environment

- **USMCA (Mexico)** bolstered integrated supply chains and expanded copper-intensive auto and machinery exports.
- **U.S.–E.U. & Indo-Pacific trade stability** maintained open access for high-value manufacturing materials.
- **Decarbonization and clean-energy policies** in Germany, China, and Taiwan drove copper's role in renewable infrastructure and EVs.

2. Industrial Demand and Applications

- **Machinery (HS 84)** and **copper (HS 74)** move together in capital expansion cycles.
- **Electrical equipment (HS 85)** and copper exhibit **tight linkage** due to wiring, connectors, and motor components.
- **Vehicles (HS 87)** correlate with copper in North America and Europe but diverge in Asia, where copper's use is shifting toward power grids and electronics.

3. Market Dynamics and Technology

- **Electrification and EV adoption** significantly increased copper intensity per vehicle.
- **Semiconductor growth** in Taiwan and China boosted copper foil and conductor exports.
- **Industrial reshoring** in North America drove parallel growth in HS 74, 84, and 85 from 2021–2024.

Trend Summary

Between 2018 and 2024, Ohio's copper exports (HS 74) rose across all four major manufacturing partners, showing strong co-movement with **machinery (HS 84)** and **electrical equipment (HS 85)** and partial alignment with **vehicles (HS 87)**. The correlation is strongest in **Mexico and Germany**, where automotive and industrial sectors overlap, and weakest in **China and Taiwan**, where copper is increasingly directed toward **electronics and infrastructure** rather than vehicle manufacturing.

This confirms that copper acts as a **core material indicator**, closely tracking industrial modernization, electrification, and high-value manufacturing growth across Ohio's major global markets.

Finding #11:

Analysis of HS 87 (Vehicles and Parts) exports for all ten countries from 2018 to 2024 and summarize the 7-year trend, including all key drivers.

Overview

HS 87 includes **motor vehicles, engines, and automotive parts**, one of Ohio's most critical and globally integrated export categories.
From 2018 through 2024, exports fluctuated sharply due to the **COVID-19 downturn**, followed by **a robust regional recovery** led by **North American manufacturing**.
By 2024, Ohio's vehicle and parts exports largely stabilized, with new growth emerging from **electric vehicle (EV)**production and **defense-oriented vehicle sales**.

HS 87 Exports by Country (2018–2024)

Country	2018	2019	2020	2021	2022	2023	2024	7-Year Trend Summary
Canada	$4.81 B	$4.70 B	$3.09 B	$3.51 B	$4.17 B	$4.39 B	$4.08 B	Core automotive partner; nearly full recovery since 2020.
Mexico	$4.81 B	$1.50 B	$965.4 M	$1.34 B	$1.52 B	$1.77 B	$1.61 B	Strong rebound after pandemic lows; deepened USMCA integration.
China	$356.3 M	$135.7 M	$228.7 M	$244.8 M	$133.1 M	$84.2 M	$49.3 M	Continuous decline; Chinese domestic substitution reduced U.S. imports.
Japan	$245.1 M	$292.6 M	$271.7 M	$287.4 M	$311.0 M	$300.4 M	$257.0 M	Consistent moderate performance; stable demand for precision parts.
United Kingdom	$230.8 M	$198.7 M	$138.7 M	$105.6 M	$30.6 M	$18.5 M	$27.8 M	Steep decline post-Brexit; stabilizing at low base.
Brazil	$97.8 M	$111.6 M	$54.4 M	$71.1 M	$73.4 M	$82.7 M	$74.6 M	Cyclical; tied to aerospace and industrial

Country	2018	2019	2020	2021	2022	2023	2024	7-Year Trend Summary
								manufacturing overlaps.
Germany	$154.8 M	$103.2 M	$105.3 M	$160.7 M	$103.9 M	$103.9 M	$76.6 M	Volatile; pandemic rebound peaked in 2021, then softened.
France	$61.1 M	$50.2 M	$54.5 M	$85.0 M	$45.3 M	$17.7 M	$24.8 M	Temporary rebound in 2021; then tapered off sharply.
Australia	$52.8 M	$54.0 M	$87.1 M	$186.9 M	$185.6 M	$196.4 M	$370.5 M	Fastest growth; defense and specialty vehicle demand surged.

7-Year Trend Analysis

1. Regional Strength:

- **Canada and Mexico** dominate Ohio's vehicle export landscape, accounting for nearly **80% of total HS 87 exports** by 2024.
- **USMCA** implementation improved regional supply-chain consistency and reduced border friction.

2. Europe:

- **Germany, France, and the U.K.** all experienced sustained declines after 2019, largely due to shifting EV policies and localized sourcing.
- The **U.K.** recorded the steepest drop, losing nearly 90% of its 2018 export value.

3. Asia-Pacific:

- **China's imports fell sharply** (−86% since 2018) as domestic EV manufacturing rose.
- **Japan** remained stable; **Australia** became an emerging bright spot with rapid growth since 2021, driven by military and specialty vehicles.

Key Drivers & Context

1. Policy and Trade Environment

- **USMCA content rules** incentivized regional production and protected Ohio suppliers.
- **EV transition policies** (e.g., Inflation Reduction Act, E.U. emission standards) reshaped trade flows toward EV-related components.
- **Tariff and localization policies** in China and Europe reduced U.S. vehicle import demand.

2. Industrial Demand and Sector Composition

- **Automotive retooling** after 2020 spurred large parts exports to Mexico and Canada.
- **EV and hybrid vehicle production** drove new demand for motors, drivetrains, and copper-intensive components.
- **Defense and specialized manufacturing** boosted Australia's import volume significantly.

3. Market Dynamics and Consumer Behavior

- **Pent-up consumer demand (2021–2023)** fueled recovery in automotive sales.
- **Semiconductor shortages** temporarily suppressed output but extended the replacement cycle, sustaining exports.
- **Localization trends** (Europe and Asia) prompted U.S. firms to focus on closer regional markets.

Trend Summary

From 2018–2024, Ohio's HS 87 exports followed a **steep contraction and steady regional rebound** pattern.

- **Peak (2018):** $10.8 B combined global total.
- **Low (2020):** $5.0 B range amid pandemic shutdowns.
- **Recovery (2021–2024):** Stabilization around **$8.7 B**, led by North America and Australia.

Outlook: Continued EV adoption and nearshoring will sustain upward momentum in North American markets while Europe and China remain structurally weaker.
Ohio's vehicle and parts exports remain **a cornerstone of its manufacturing economy**, aligning with the state's advanced manufacturing and electric mobility initiatives.

Finding #12:

Compare HS 87 (Vehicles & Parts) with HS 84 (Industrial Machinery), HS 85 (Electrical Machinery), and HS 39 (Plastics & Articles), 2018–2024

Overview

HS 87 is tightly intertwined with **capital equipment (HS 84)**, **vehicle electrification and electronics (HS 85)**, and **materials/packaging/parts (HS 39)**. Across 2018–2024, you see:

- A **pandemic dip in 2020**, broad **restarts in 2021**, and then **divergent regional outcomes** (North America strongest; China weaker; Europe mixed).
- Where **nearshoring and EV adoption** accelerated, HS 87 tends to **co-move** with HS 84/85 and pull HS 39 along with it.

A. Country-by-country readout (directional, correlation-first)

1) Canada (core partner)

- **HS 87 vs HS 84: Strong positive correlation.** Automaker restarts and model changeovers lift machinery upgrades, tooling, and automation.
- **HS 87 vs HS 85: Strong positive correlation.** EV content (power electronics, harnesses, motors) boosts electrical imports alongside parts.
- **HS 87 vs HS 39: Positive correlation.** Plastics for interiors, housings, connectors, and packaging rise with vehicle output.

What it means: Treat Canada as an integrated **vehicle platform + plant-capex + electrification** play. Joint proposals (tooling + controls + components + plastics) win.

2) Mexico (deep integration under USMCA)

- **HS 87 vs HS 84: Strong positive.** Nearshoring → plant expansions and automation; machinery imports move with parts volumes.
- **HS 87 vs HS 85: Strong positive.** Growth in wire harnesses, inverters, battery systems; HS 85 rises with EV programs and Tier-1 expansions.
- **HS 87 vs HS 39: Positive.** Plastics track assemblies (interior trim, under-hood molded parts, packaging).

What it means: Mexico is the most **predictable three-way co-movement** market (87↔84↔85) with **39** riding the cycle. Prioritize bundles and multi-year agreements.

3) Germany (high-spec, but softer in 2023–24)

- **HS 87 vs HS 84: Moderate positive.** Machinery imports reflect factory retooling, but vehicle import pull softened after 2021.
- **HS 87 vs HS 85: Moderate positive.** EV transition supports electrical systems, though more sourcing is intra-EU.
- **HS 87 vs HS 39: Mild positive.** Plastics benefit from auto and industrial demand but are price-sensitive and often local.

What it means: Germany remains a **quality-first, spec-heavy** buyer. Expect steadier HS 84/85 than HS 87; emphasize **EV/automation content** and lifecycle MRO.

4) United Kingdom (post-Brexit reset)

- **HS 87 vs HS 84: Weakened correlation.** Auto volumes fell more than capex; plant investments are selective.
- **HS 87 vs HS 85: Flat to mild positive.** Electrification programs create targeted opportunities, but at smaller scale.
- **HS 87 vs HS 39: Weak positive.** Plastics tied to component niches; scale reduced with lower vehicle imports.

What it means: Focus on **program-specific** wins (EV components, retrofit capex), not broad volume.

5) France (stable aerospace/auto blend)

- **HS 87 vs HS 84: Moderate positive.** 2021 rebound helped both; convergence moderated afterward.
- **HS 87 vs HS 85: Mild positive.** EV/hybrid rollouts support electrical content.
- **HS 87 vs HS 39: Positive.** Packaging and interior/under-hood plastics move with assemblies.

What it means: Balanced opportunity; pair **machinery + plastics** with targeted **HS 85** content for EV sub-systems.

6) Japan (precision components; steady volumes)

- **HS 87 vs HS 84: Moderate positive.** High-precision tooling/inspection travels with Tier-1/2 component exports.
- **HS 87 vs HS 85: Moderate positive.** Electronics content in drivetrains favors HS 85 co-movement.
- **HS 87 vs HS 39: Mild positive.** Plastics steady for components and packaging.

What it means: Japan rewards **quality and reliability**; bundle **metrology/automation (84)** + **electrical (85)** with component programs (87).

Ohio Export Trend Analysis
Takeaways

SBDC Export
Assistance Network
Youngstown State University

Williamson
College of
Business
Administration

7) China (structural divergence)

- **HS 87 vs HS 84: Divergent.** Vehicle imports from Ohio trended down, while machinery was comparatively flatter/locally substituted.
- **HS 87 vs HS 85: Divergent.** Electrical content increasingly localized; U.S. imports fell despite global EV surge.
- **HS 87 vs HS 39: Weak linkage.** Plastics demand tied more to electronics/packaging than U.S. vehicle imports.

What it means: China is **not** an HS 87-led market for Ohio now. Treat it as **materials/chemicals/electronics** oriented rather than vehicles.

8) Brazil (cyclical; aerospace overlap)

- **HS 87 vs HS 84: Mixed.** Machinery can rise on capex cycles even if vehicles are flat.
- **HS 87 vs HS 85: Mild positive** in up-cycles (wiring/controls), but not durable.
- **HS 87 vs HS 39: Positive.** Plastics have broadened with manufacturing recovery.

What it means: Brazil is **project-driven**; time entries around industrial up-cycles. Plastics and certain electrical lines can outperform HS 87 in down years.

9) Australia (late-period surge)

- **HS 87 vs HS 84: Moderate positive.** Vehicle surge (defense/specialty) pulled some capex; not one-for-one.
- **HS 87 vs HS 85: Positive.** Electrical kits and systems followed the vehicle ramp.
- **HS 87 vs HS 39: Positive.** Packaging/parts growth with deliveries.

What it means: Opportunity cluster in **defense and specialty fleets**; align HS 85/39 offerings with those programs.

B. Cross-code patterns you can rely on

1. **North America alignment (USMCA effect):**
   - **HS 87 ↔ HS 84/85:** move together on **retooling + EV**.
   - **HS 39** reliably **rides the cycle** via parts and packaging.
2. **Europe's selective recovery:**
   - **HS 84/85** are **steadier** than HS 87; buyers emphasize **automation, test, and electrification** more than imported vehicle volumes.
3. **China's structural divergence:**
   - HS 87 **decouples** from HS 84/85/39; **localization** and policy reduce U.S. vehicle/parts pull.
4. **Project markets (Brazil, Australia):**

    ○ HS 87 **spikes** with big programs; HS 84/85/39 follow with **timing lags**.

C. Practical Implications

- **Bundle to win in North America:** Quote **tooling/automation (84) + power/electronics (85) + parts (87) + plastics (39)** as a **package**, especially for EV lines in Canada/Mexico.
- **Lead with 84/85 in Europe; attach 87/39 where fit:** Position on **efficiency, electrification, and compliance** first; add HS 87 components for specific platforms.
- **Pivot China to non-HS 87 plays:** Emphasize **materials, chemicals, and specialized equipment** vs. vehicles.
- **Time Brazil/Australia bids:** Track **budget cycles/defense awards**; pre-position HS 85 and HS 39 to ship alongside HS 87 deliveries.

D. One-Page takeaway

- Where **vehicle assembly grows**, **HS 84/85** nearly always **co-move**, and **HS 39** follows.
- **USMCA markets** show the **tightest four-code alignment** (87↔84↔85 with 39 in tow).
- **Europe** buys the **tech stack (84/85)** more consistently than vehicles (87).
- **China** is **decoupled** on HS 87.
- **Program markets** (Brazil/Australia) require **event-driven timing** across all four codes.

Finding #13:

Analysis of HS 88 (Aircraft & Parts) exports of Ohio to all ten countries from 2018 to 2024, including amounts, trends, and all key drivers.

Overview

HS 88 includes **aircraft, spacecraft, and parts**, one of Ohio's highest-value industrial export categories, supporting both **commercial aerospace** and **defense supply chains**.
Between 2018 and 2024, exports fluctuated sharply: steep **pandemic-era contractions** in 2020, strong **recovery in 2021–2023**, and partial normalization by 2024.
Overall, the sector mirrors global aviation cycles, heavily influenced by fleet renewal, travel demand, and government procurement.

HS 88 (Aircraft & Parts) Exports by Country (2018 → 2024)

Country	2018	2019	2020	2021	2022	2023	2024	7-Year Trend Summary
Canada	$494.6 M	$738.9 M	$592.2 M	$662.6 M	$775.8 M	$876.8 M	$539.9 M	Large cyclical swings; peaked 2023, easing 2024.
Mexico	$494.6 M	$270.8 M	$164.1 M	$269.7 M	$290.4 M	$352.5 M	$422.3 M	Recovery since 2021; strong 2024 growth.
China	$527.4 M	$575.4 M	$356.2 M	$301.4 M	$359.2 M	$291.4 M	$698.3 M	Full rebound by 2024 to pre-trade-tension highs.
Japan	$326.7 M	$181.7 M	$161.4 M	$153.9 M	$106.3 M	$77.6 M	$218.2 M	Decline through 2023, partial 2024 rebound.
United Kingdom	$555.7 M	$662.7 M	$372.5 M	$362.3 M	$419.8 M	$435.4 M	$540.7 M	Volatile but resilient; 2024 near 2018 levels.
Brazil	$639.0 M	$1.28 B	$1.32 B	$1.17 B	$1.30 B	$1.26 B	$764.5 M	Massive 2020–22 boom from aerospace orders; tapering 2024.

Country	2018	2019	2020	2021	2022	2023	2024	7-Year Trend Summary
Germany	$280.1 M	$274.7 M	$140.5 M	$130.6 M	$262.7 M	$236.7 M	$288.5 M	Strong rebound post-2020; steady 2023–24.
France	$503.9 M	$759.6 M	$395.4 M	$351.1 M	$355.9 M	$415.3 M	$352.3 M	Early-pandemic hit; regained ≈70 % by 2024.
Taiwan	$64.7 M	$129.8 M	$28.2 M	$15.7 M	$15.2 M	$82.3 M	$79.5 M	Sharp drop 2020–22, quick 2023 bounce.
Australia	$28.5 M	$8.8 M	$6.0 M	$20.5 M	$9.2 M	$41.7 M	$90.8 M	Explosive growth 2023–24 on defense contracts.

(Values rounded; B = billion USD, M = million USD.)

7-Year Trend Analysis

Global pattern:

- **2018–2019:** Robust commercial aviation and defense export volumes.
- **2020:** COVID-19 grounded air travel; HS 88 values collapsed 30–70 %.
- **2021–2023:** Strong recovery as MRO (maintenance/repair/overhaul) and fleet renewals resumed.
- **2024:** Normalizing at higher-than-2020 levels but below 2018 peaks in most markets.

Regional highlights

- **North America (Canada + Mexico):** Core partnerships; steady recoveries driven by aerospace supply-chain integration and USMCA logistics.
- **Europe (Germany, France, U.K.):** Stable defense and commercial demand offset by long civil fleet recovery cycles.
- **Asia (China, Japan, Taiwan):** Mixed pattern, China rebounded sharply, Japan and Taiwan more gradual.
- **Latin America (Brazil):** Large orders in 2020–22 gave Brazil one of the strongest spikes worldwide.
- **Pacific (Australia):** Rapid rise in defense aircraft and parts exports post-2022.
-

Key Drivers and Context

1) Policy & Trade Environment

- **USMCA implementation (2020):** Enhanced North American aerospace co-production and supply-chain resilience.
- **Civil aviation agreements:** U.S.–E.U. and U.K. trade coordination stabilized post-Brexit export compliance.
- **Defense partnerships:** Brazil (Embraer), U.K., and Australia contracts lifted HS 88 demand from 2021 onward.
- **China:** Despite tensions, dual-sourcing needs sustained high-value imports for select programs.

2) Industrial Demand & Sector Composition

- **Fleet renewals** (2021–2023) drove replacement parts and MRO exports.
- **Defense modernization** in Brazil, Australia, and NATO markets expanded long-term orders.
- **Supply-chain restructuring** post-COVID favored Ohio's precision aerospace manufacturers.
- **Component diversification:** Engine parts, avionics housings, and composites led export growth.

3) Market Dynamics & Buyer Behavior

- **Travel rebound:** Commercial flight resumptions spurred parts replacements and retrofits.
- **Backlog orders:** 2020 delays converted to 2022–2023 shipments, inflating mid-period numbers.
- **Defense outlays:** Higher procurement budgets (especially Australia, Brazil, U.K.) supported steady demand.
- **Price and currency volatility:** Exchange-rate strength in 2022 temporarily suppressed Euro-denominated volumes.

Trend Summary

Between 2018 and 2024, Ohio's HS 88 exports show a **classic aerospace cycle**, sharp 2020 drop, broad 2021–2023 rebound, partial 2024 cool-down.

- **Leaders:** Brazil (> $1 B 2020–2022), Canada and France ($0.5–0.9 B range).
- **Emerging growth:** Australia (+220 % since 2021), China (renewed 2024 high).
- **Steady recoveries:** Mexico, Germany, U.K. within +20–30 % of pre-pandemic levels.
- **Lagging:** Japan and Taiwan due to slow commercial aviation restarts.

Ohio's aerospace exports remain **a top-tier industrial strength**, anchored by high-precision parts manufacturing and cross-border defense cooperation.

Finding #14:

Analysis of HS 33 (Essential Oils, Perfumery, Cosmetics & Toiletries) exports from Ohio to all nine countries from 2018 to 2024 and discuss the three key drivers.

Overview

HS 33 includes **essential oils, perfumes, cosmetics, and toiletries**, a key export representing Ohio's strength in **chemical manufacturing, consumer product formulation, and packaging innovation.**
While modest compared to machinery and vehicle exports, HS 33 demonstrates Ohio's global reach in personal care and chemical processing. Between 2018 and 2024, exports of HS 33 products show **steady recovery and strong post-pandemic growth**, led by **Canada, Mexico, France, and Australia.**

HS 33 Exports by Country (2018 → 2024)

Country	2018	2019	2020	2021	2022	2023	2024	7-Year Trend Summary
Canada	$436.5 M	$466.2 M	$546.3 M	$482.5 M	$545.6 M	$592.5 M	$574.5 M	Largest and steadiest market; consistent upward trajectory.
Mexico	$79.3 M	$79.4 M	$71.9 M	$55.5 M	$87.5 M	$108.5 M	$149.5 M	Strong recovery 2022–24; growing regional cosmetics hub.
China	$16.4 M	$21.9 M	$26.8 M	$34.9 M	$39.0 M	$37.4 M	$46.4 M	Continuous growth since 2018; driven by e-commerce skincare boom.
Japan	$28.2 M	$46.7 M	$27.1 M	$25.4 M	$34.4 M	$58.2 M	$53.3 M	Rebounded post-2020; increased premium imports 2023–24.
United Kingdom	$39.9 M	$24.2 M	$20.5 M	$29.4 M	$60.1 M	$52.1 M	$60.8 M	Volatile early period; regained

Country	2018	2019	2020	2021	2022	2023	2024	7-Year Trend Summary
								strong performance after 2022.
Germany	$36.8 M	$28.9 M	$9.4 M	$22.2 M	$17.4 M	$20.4 M	$32.9 M	Sharp 2020 dip; slow but positive recovery by 2024.
France	$63.4 M	$112.4 M	$68.9 M	$60.1 M	$85.1 M	$93.4 M	$103.6 M	Strong and stable growth; France remains a core luxury export market.
Taiwan	$9.2 M	$5.6 M	$2.5 M	$4.1 M	$6.4 M	$6.2 M	$5.9 M	Small market; stable volumes post-2021.
Australia	$47.5 M	$46.1 M	$43.4 M	$53.6 M	$85.8 M	$127.5 M	$90.6 M	Rapid rise after 2021; personal-care and wellness exports expanded.

7-Year Trend Analysis

- **Global Direction:** Upward overall, despite early pandemic disruptions.
- **2020:** Short-term decline from manufacturing and retail closures.
- **2021–2024:** Strong recovery across nearly every market; consistent gains in **North America, Asia, and Europe.**
- **Top Growth Markets:** Mexico (+88%), Australia (+91%), and China (+182%) between 2018 and 2024.
- **Stable Leaders:** Canada and France provide long-term consistency and high value.
- **Rebounding Regions:** The U.K. and Japan have shown significant recovery in 2023–2024 after earlier volatility.

Key Drivers & Context

1) Policy & Trade Environment

- **USMCA** reinforced frictionless consumer-goods trade with Canada and Mexico.
- **Simplified customs and packaging compliance** boosted export competitiveness in regulated markets (E.U., Japan).
- **Post-pandemic trade normalization** revived demand for cosmetics and essential oils across retail and hospitality sectors.

2) Industrial Demand & Sector Composition

- **Consumer personal care and wellness** sectors surged post-2021, with growing emphasis on hygiene, skincare, and aromatherapy.
- **Ohio's chemical manufacturing base** supports both raw ingredient and finished product exports.
- **Private-label and contract manufacturing** growth attracted multinational partnerships, especially for North American distribution.

3) Market Dynamics & Consumer Behavior

- **E-commerce and online beauty sales** expanded cross-border shipments.
- **"Clean beauty" and sustainable packaging trends** increased demand for certified U.S. ingredients.
- **Luxury and mid-market brands** in France and Japan continued sourcing fragrance components from Ohio manufacturers.

Trend Summary

From 2018 to 2024, Ohio's HS 33 exports show **strong global recovery** and **broad market diversification.**

- **Canada, France, and Mexico** remain top markets by volume.
- **Australia and China** are fastest-growing due to expanding personal-care and wellness industries.
- **Germany and Taiwan** are smaller but stable, reflecting niche ingredient and packaging shipments.

Ohio's success in HS 33 underscores its **advanced chemical and manufacturing ecosystem**, combining compliance expertise, product innovation, and supply reliability across global consumer markets.