

Trade Working Capital Viewpoints

Navigating Global
Uncertainty:
*Perspectives on an
evolving semiconductor
supply chain*

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Treasury and Trade Solutions

Foreword



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As the number of devices that incorporate semiconductors continues to grow, data reviewed by Citi shows semiconductors increasingly at the center of global trade. Additionally, semiconductors are increasingly considered in country specific foreign policy.¹

Remaining focused on working capital is essential for the industry as they navigate this highly complex environment.



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¹The Economic Times, China's semiconductor situation dictated by their foreign policy: Chris Miller, author of Chip Wars, 2023

The Current *Semiconductor Landscape*

Semiconductors can trace their origins back to the 1800s; however, Jack Kilby of Texas Instruments claims to have introduced the world to the first hybrid integrated circuit (IC) in 1958² followed by Robert Noyce's monolithic IC chip in 1959.³ During this time, computers were still large enough to fill an entire room, and the IC chips eventually lead to the microprocessors needed to enable the next generation of commercial and personal use computers.⁴

The rapid proliferation of semiconductors – chips that process digital information – is due in part to the number of devices that use chips, such as: computers, smartphones, military application, and automobiles. As 2024 takes shape, the rise and promise of generative Artificial Intelligence has, in some cases, lifted stock prices of semiconductor chip manufacturers

and created a fast-growing source of demand. Per Deloitte, the market for AI chips is expected to reach \$50 billion in 2024, with forecasts reaching \$400 billion, or roughly half of the chip industry by 2027.⁵

The growing demand for semiconductors is indicative of the ongoing supply chain challenges experienced by the industry. Increasingly, the industry must (i) manage market and geopolitical forces; (ii) protect semiconductor capabilities; and (iii) consider foreign policy while ensuring stable access to semiconductors in many countries. As the industry considers its future amid expansion and the development of new capabilities, careful working capital management can build operational resilience, a capability accretive to realizing current and future aspirations.



² Smithsonian Institute, Jack Kilby's Integrated Circuit, 2023

³ Computer History Museum, 1959: Practical Monolithic Integrated Circuit Concept Patented, 2024

⁴ Britannica, The Personal Computer Revolution, 2024

⁵ Deloitte, 2024 global semiconductor industry outlook, 2024

Global Legislation and Partnerships Impact on *Financing Semiconductor Supply Chains*

The semiconductor industry lays at the center of an on-going conversation regarding reconfiguring certain supply chains as a matter of national interest for governments. Front of mind is the critical role chips play in national security, and their increasingly inherent role across the economy. Securing a reliable supply of both advanced chips and their related ecosystem components will be an important consideration in geopolitical, corporate, and economic policy for years to come.

Growing government interest in semiconductors has potential to be a tailwind for the industry's supply chains. While the potential for policy measures to have negative impact on sales exists, legislation now exists in several countries to incentivize domestic semiconductor manufacturing. Notably, in the U.S., the CHIPS and Science Act appropriated over \$52 billion in subsidies and tax credits with the aim of strengthening supply chain resilience.⁶ And while export agency financing structures may have been more focused on supporting exports, some agencies are now utilizing structures to support domestic capex as well as provide cover for access to critical materials.

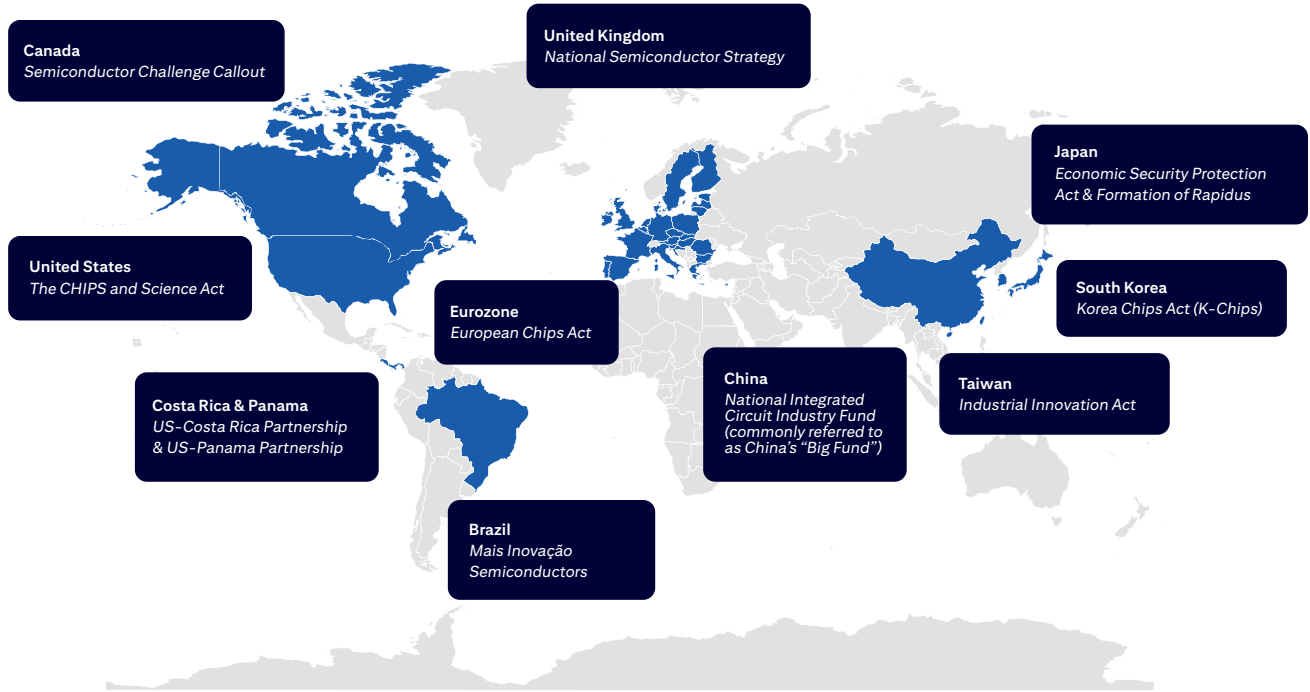
Export Credit Agencies (ECAs) have traditionally played an important role in helping domestic organization expand their sales abroad. In recent years, ECAs have expanded beyond their traditional roles, finding new ways to lend support to businesses within their countries. For Korea's K-SURE, it realized it could support exports by first supporting domestic capex investment.

At the center of the arrangement was a Korea based company with strong chip bumping capabilities. The company was looking for financing to help purchase processing equipment that would help the firm grow its capacity.

Citi, acting as the mandated lead arranger, was able to arrange a K-SURE backed facility in excess of USD \$55mm. And because the borrower was in an industry regarded as a core business of Korea, K-SURE was able to increase its cover to 100%, providing even further benefit to the borrower.

⁶ The White House, FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China, 2022

Figure 1. Summary of Public Support for the Semiconductor Industry



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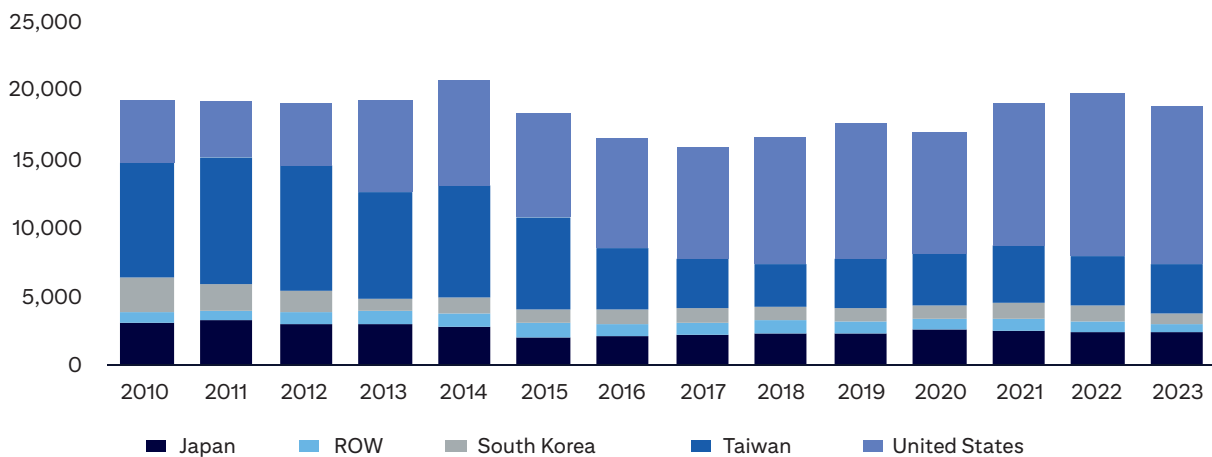
Growing government interest in semiconductors has potential to be a tailwind for the industry's supply chains.

The Patent *Cluster*

Countries' concerns around stable access to semiconductors are well supported: much of the semiconductor capacity and intellectual property rests within a few specific countries as discovered during the pandemic and in the ensuing global supply chain disruptions.

An analysis conducted by Citi Global Data Insights on global patent data illustrates to what extent semiconductor patents are concentrated within just a few countries. Patent filings related to semiconductors appear to be concentrated in just four countries: the United States, Taiwan, South Korea, and Japan. The US's share of semiconductor patents has been on the rise since 2013. Rest of world (ROW) patent contributions related to semiconductors is roughly one seventh that of the United States.

Figure 2. Patent Breakdown by Country



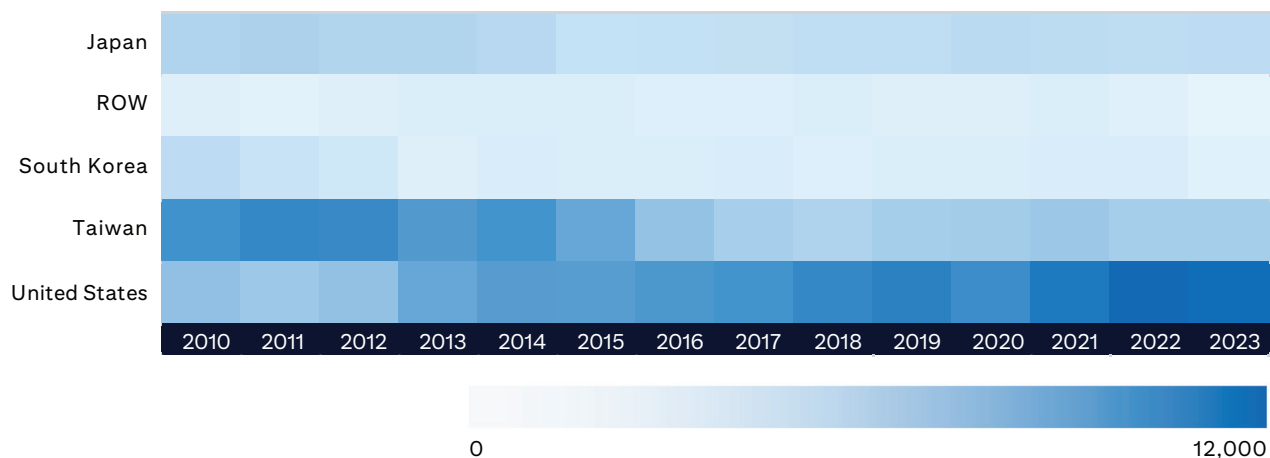
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Source: QuantIP, Citi Global Data Insights

Given the mismatch between the number of countries with meaningful semiconductor production capabilities and the number of downstream users, the global trade of semiconductors has sizeable cross border implications. As such, ensuring stable access to semiconductors, supported by the right trade financing option is critical. For example, standby letters of credit (SBLCs) or demand guarantees provide an important layer of payment risk mitigation in international trade.

Figure 3. Patent Breakdown by Country



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Established trading relationships take time to form and when starting new relationships, corporates often find themselves trading with a counterparty who they are not familiar with.

This was the case for a supplier in the semiconductor industry looking to establish a new relationship with an overseas based buyer. The buyer wanted end-to-end assurance that the supplier would deliver and perform against its obligations.

In this case, the right solution was actually a combination of three solutions: a Letter of Credit (LC) to facilitate the delivery of promised equipment, an LC to guarantee the performance of the equipment, and a warranty bond to guarantee the continued performance of the equipment.

The resulting structure supported a new, and important, business relationship. The new relationship helped the supplier both expand its geographic footprint and diversify revenue sources.



Supporting an Evolving Customer Base *and* *Distribution Channels*

Chips have found a home in an ever-growing list of products that promises to only continue to grow. Corporates are embracing “smart” and connected capabilities in their products. The proliferation of internet of things (IoT) and devices’ ability to “call home” and share data continues to further demand for semiconductors in new places. Sectors that historically had little use for semiconductors are increasingly becoming reliant on semiconductors and the devices that use them (Figure 4).

As a result, there is a global supply and demand imbalance and pressure on the semiconductor industry to meet customer demands. To better understand how the semiconductor industry has evolved and what industries are reliant on semiconductors, Citi Global Data Insights (GDI) in partnership with Citi Global Trade Working Capital Advisory (TWCA), examined a range of data sources gathered in 2023 to better understand the unique attributes of

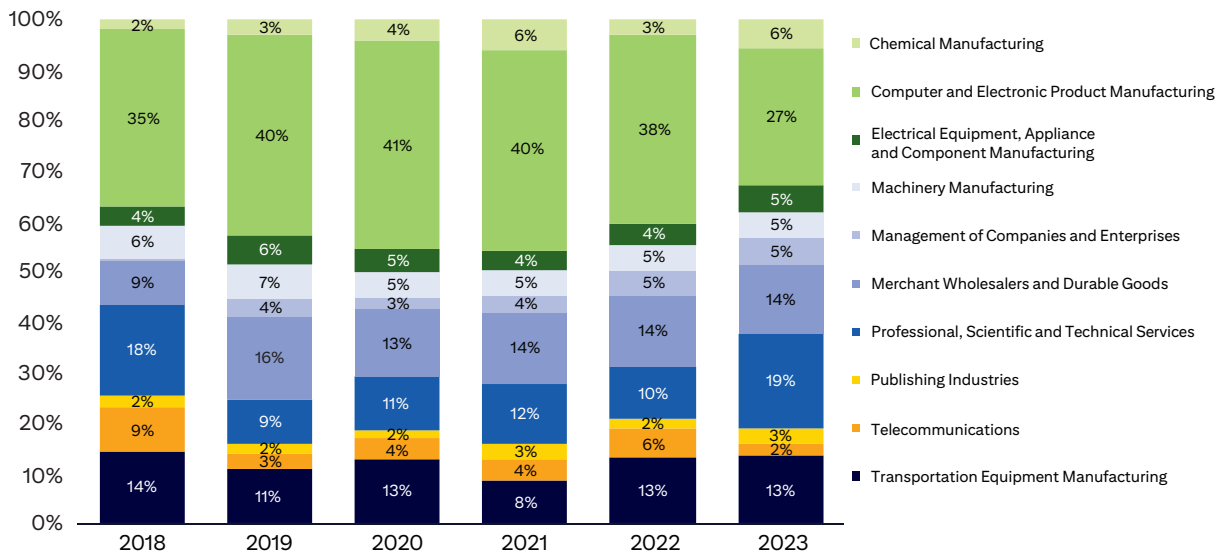
the global semiconductor supply chain. While the resulting analysis is robust, it is important to note that it is limited to the extent to which data is available.

Understanding End-User Demand *on Semiconductors*

Based on customer data, computer and electronic product manufacturing firms still represent the majority of semiconductor manufacturers’ customers with a 27% share in 2023; however, other industries figure into the picture as well.

Professional, Scientific, and Technical Services accounted for the next largest share at 19%, followed by ‘Merchant wholesalers, durable goods’ at 14%. The mobility industry, during a transformation from internal combustion engine vehicles (ICE) to electric vehicles (EVs), continues to heavily rely on semiconductors. The size of the mobility industry’s relationship with the semiconductor industry is telling as it continues to grapple with ongoing supply challenges of its own.

Figure 4. Customer Breakdown by Sector



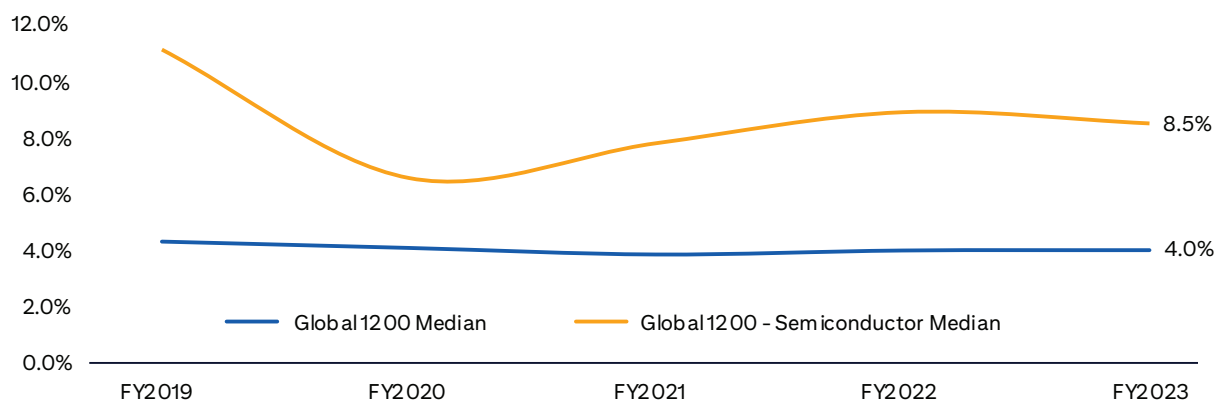
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Forecasted AI chip demand presents new challenges for chip manufacturers as increased demand may be short lived. Enterprise software companies are securing chip orders to meet this anticipated demand. Any weakness in demand, may create inventory build-up, similar to the post-COVID chip inventory build-up as PC demand softened. Chip manufacturers can utilize receivables financing tools to accelerate days sales outstanding (DSO), thereby improving inventory turnover.

Manufacturing semiconductors is particularly capital intensive compared to other industries as illustrated in Figure 5. To help fortify customer channels and support capex while managing DSO, semiconductor manufacturers may consider adopting an accounts receivable (AR) finance solution to inject liquidity into sales distribution channels. The addition of credit enhancement may also help.

AR finance has the added benefit of offering qualified corporates with additional liquidity. In a structured AR finance solution, AR finance providers aim to support a corporate’s desire to monetize accounts receivables, providing liquidity due to them on a single name or portfolio basis. The addition of credit enhancement may further a supplier’s ability to offer customers more flexible terms. Citi’s Distribution Finance offering is designed to help clients increase sales with its existing portfolio of distributors and can be structured to meet a corporate’s unique needs. Additionally, buyers do not have to be existing Citi clients, however, please inquire about terms and conditions that apply.

Figure 5. Capex as % of Total Revenue



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“Generative AI technology has the potential to be transformational in many industries in the coming years. More sophisticated and efficient microchips are crucial to deliver the ambitions of AI technology, enabling faster processing speeds and improved computational power. And in turn as financiers, our call to action is to provide more sophisticated and efficient working capital solutions that are required to fuel the growth and investment in chip production.”

Ankit Pahuja

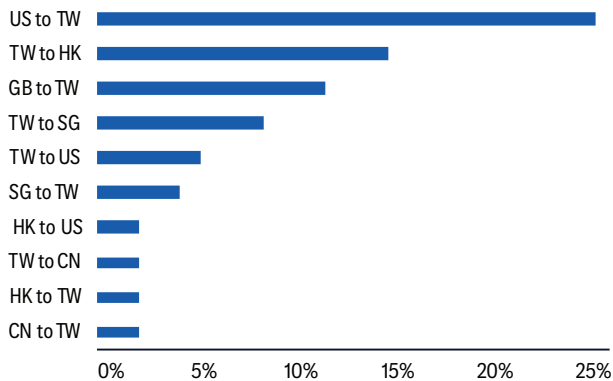
Global Sector Lead — E-commerce, Technology, and Communications,
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The Role of *Electronic Manufacturing Services*

The electronic manufacturing services ecosystem comprises value chain inputs required to manufacture a chip. These process inputs include design automation, specialized materials, wafer fab production, and outsourced semiconductor assembly and test (OSAT). Taken collectively, these Electronic Manufacturing Services (EMS) play a critical role in the overall semiconductor supply chain. Customers in other industries are largely reliant upon EMS firms, especially those not hailing from other technology related industries, to fill their needs as it relates to semiconductors. Given how EMS corporates factor into the overall semiconductor supply chain, EMSs are major facilitators in the overall global trade of semiconductors and may have substantial working capital needs.

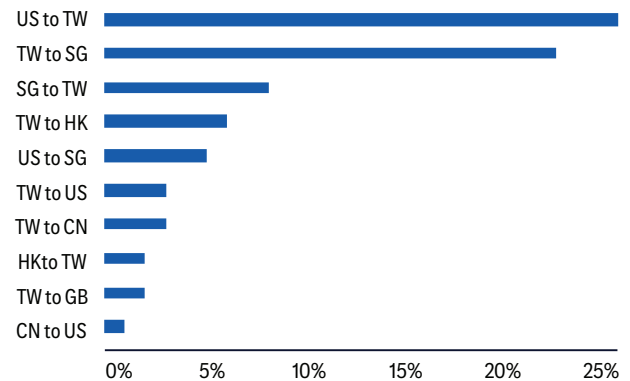
To better understand the global theater of semiconductor trade as it relates to EMS firms, Citi Global Data Insights in partnership with Citi Trade Working Capital Advisory conducted an analysis based on Citi Services global payments data. Figures 5 and 6 show the 10 largest corridors for EMS payment flows for 2021 and 2023. In each corridor below, the EMS firm may be located in the remitter (left side), receiver (right side) or both.

Figure 6. 2021 Country to Country Payment Flow for EMS, \$USD

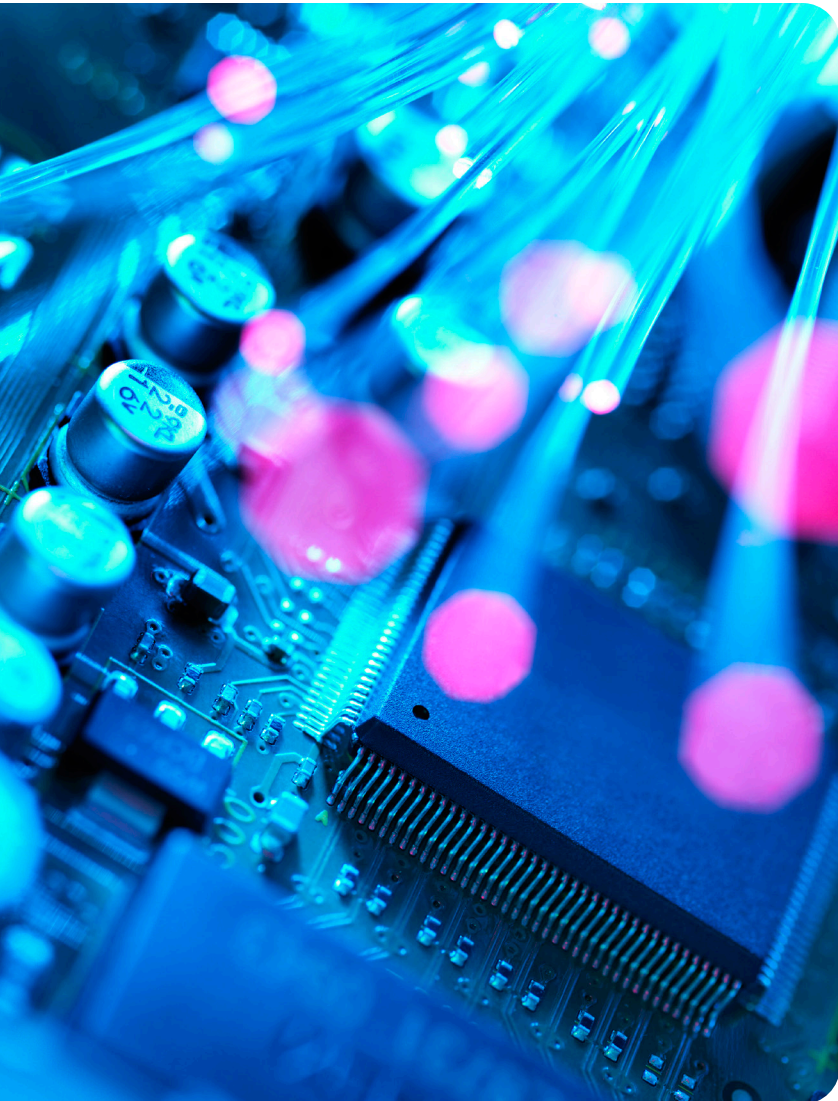


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Figure 7. 2023 Country to Country Payment Flow for EMS, \$USD



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Overall, the top payment flow clusters correspond with the countries known to have semiconductor fabrications.

From 2021 to 2023, flows from Taiwan (TW) into Singapore (SG) increased substantially, as the city-state continues to attract foreign direct investment (FDI) from corporates in the semiconductor space looking to develop additional capacity while expanding their geographical footprint.⁷ Additionally, Singapore is commonly used as a regional treasury center by global corporates.

For one of the world's largest electronic manufacturing services (EMS) providers, their role sitting between buyers and suppliers of semiconductors, required them to be highly attentive to their own working capital needs, especially given the intensive nature of their industry's working capital needs.

A global supply chain finance program was the right solution to help this EMS provider improve their working capital. And given this structure involved a leading global EMS provider, it was especially important that the program be able to support both its multiple buying entities as well as their multicurrency needs. Citi was able to help the EMS corporate establish a Citi Supplier Finance program that was both highly scalable and tailored to meet the corporate's specific needs.

⁷The Straits Times, Singapore will stay a vibrant, competitive semiconductor hub despite challenges: DPM Wong, 2023

Working Capital for *Semiconductor Manufacturers*



Semiconductor manufacturers Cash Conversion Cycle

Compared to other companies, semiconductor manufacturers cash conversion cycles (CCC), or the measure of time it takes a company to convert goods and services back into cash, is measurably longer than in other industries. In Q4 2023, the semiconductor median CCC was 156 days, 87 days longer than the global median of 69 days (Figure 8). The chief driver for the elongated cash conversion cycle stems from the upward pressure caused by the industry's outsized measures in DIO and the trend showed limited signs of reversing through the end of 2023.



Semiconductor manufacturers Days Inventory Outstanding

Managing inventory for semiconductor manufacturers is challenging on two fronts. First, the industry tends to hold more “buffer stock” compared to other industries. Second, the relative concentration of the industry's supply chain coupled with the number of end users reliant on semiconductors makes it susceptible to disruption.⁸ From Q4 2022 to Q4 2023 median semiconductor manufacturer DIO climbed by 95 days (Figure 10).



Semiconductor manufacturers Days Sales Outstanding

Days Sales Outstanding for semiconductor manufacturers median has been relatively unchanged between 40–50 days during the period 2021–2023 (Figure 9). The relative health of corporate end-users across the PC makers, smartphone and auto manufacturers likely contributed to the narrow band of variation between the median and top quartile manufacturers. The concentration of a few leading manufacturers may explain the industry's ability to demand shorter payment terms. As chip sales are expected to grow 17% in 2024,⁹ companies that can optimize DSO will see improved return on assets vs. industry peers.



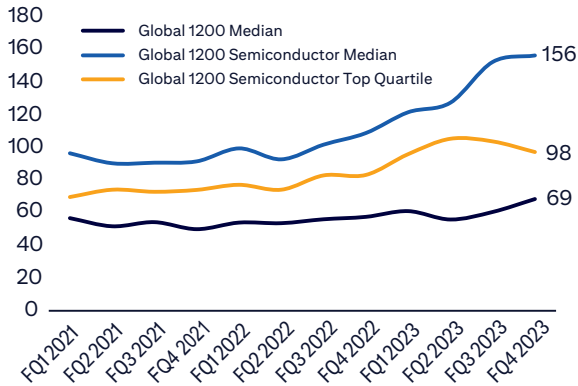
Semiconductor manufacturers Days Payable Outstanding

Conversely, median DPO for semiconductor manufacturers trailed the global median by 18 days, which could be emblematic of suppliers looking for shorter payment terms.

⁸ OECD, Vulnerabilities in the semiconductor supply chain, 2023

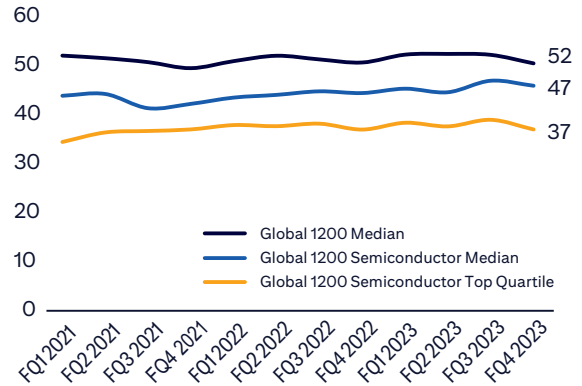
⁹ Gartner, Gartner Forecasts Worldwide Semiconductor Revenue to Grow 17% in 2024, 2023

Figure 8. Cash Conversion Cycle



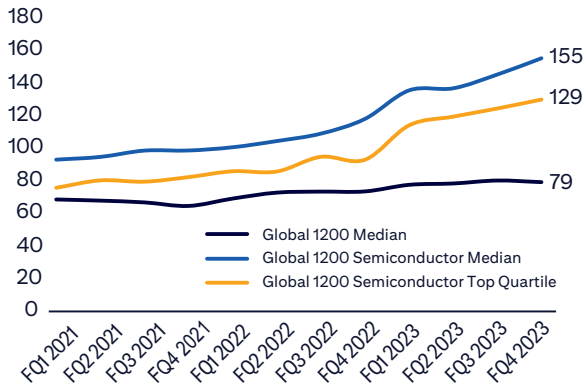
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Figure 9. Days Sales Outstanding



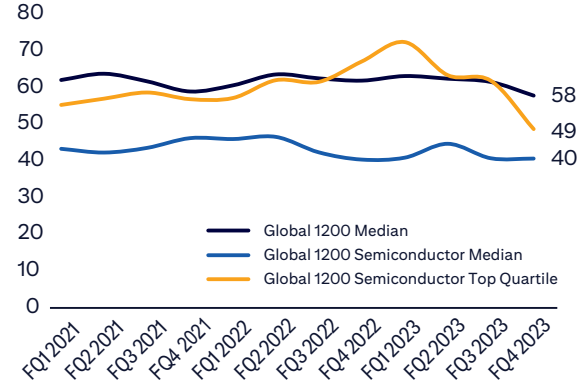
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Figure 10. Days Inventory Outstanding



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Figure 11. Days Payable Outstanding



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Top performing semiconductor manufacturers narrowly outperform the global median across all industries on DPO, but still comfortably trail the global median on DIO. As such, the data suggests semiconductor manufacturers are focused on matching payment terms to the reality of their inventory conversion cycles, underscoring the importance of providing suppliers the Supply chain financing solutions to meet their operational and liquidity needs. Additionally, the cost of capital has increased dramatically over the past two years as the Fed has hiked interest rates, and banks have reduced their loan exposures.¹⁰ Alternatively, DSO has been relatively stagnant in the industry across the last 12 quarters. Incorporating an AR financing structure into a working capital strategy is one channel semiconductor manufacturers may help manage DSO lower.

¹⁰ FRBNY, Effective Federal Funds Rates, 2024

Semiconductor manufacturers around the world are looking at ways to develop additional capacity to satisfy the surging global demand for chips throughout the world and this requires investment. With a customer base that often consists of other large, highly rated corporates, monetizing receivables can be an extremely efficient mechanism for accessing liquidity.

This was the case for one of the world's significant chip makers looking at ways to fund their capital expenditures.

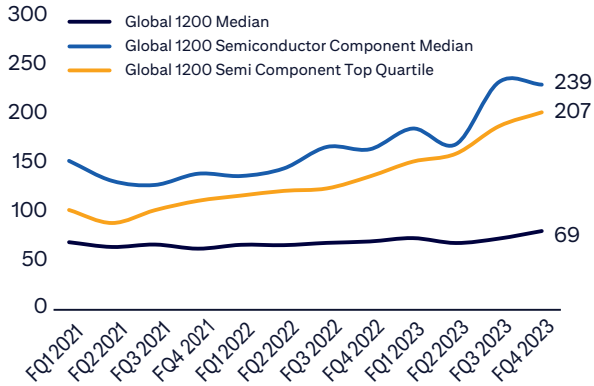
A Global Accounts Receivable Purchase program was the right solution for the corporate to unlock the most liquidity at the best price possible given the number of obligors involved and their investment grade rating.

The unlocked liquidity is helpful for the corporate, which is currently amid a global expansion.

Working Capital for *Semiconductor Materials & Equipment*

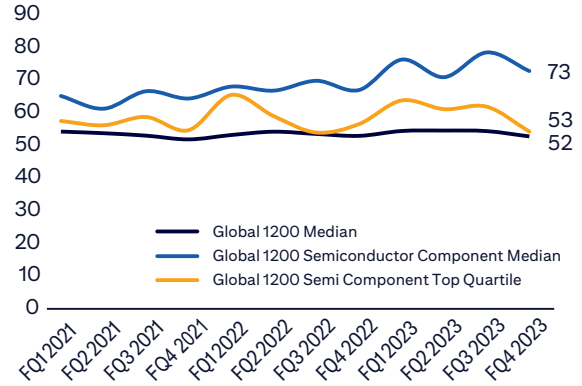
Cash conversion cycles for suppliers to semiconductor industry largely mimics those of the semiconductor manufacturers themselves in shape. Median CCC for semiconductor material and equipment firms in Q4 2023 239 is roughly 3.4x longer than that of the global median in Q4 2022 (69), primarily due to outsized measures of Days Inventory Outstanding (median of 238 days in Q4 2023) and shorter Days Payable Outstanding (38 days in Q4 2023). Since Q1 2022 DIO has increased by a staggering 122 days with limited evidence of the trend reversing course.

Figure 12. Cash Conversion Cycle



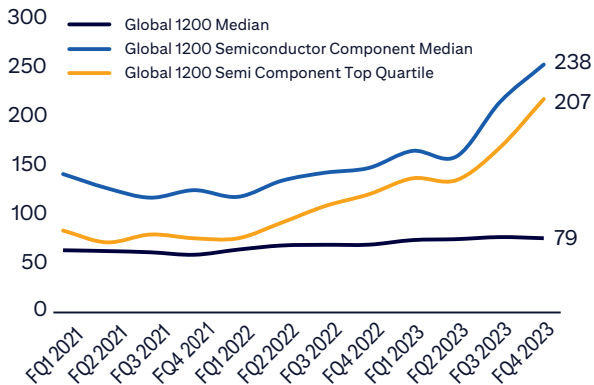
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Figure 13. Days Sales Outstanding



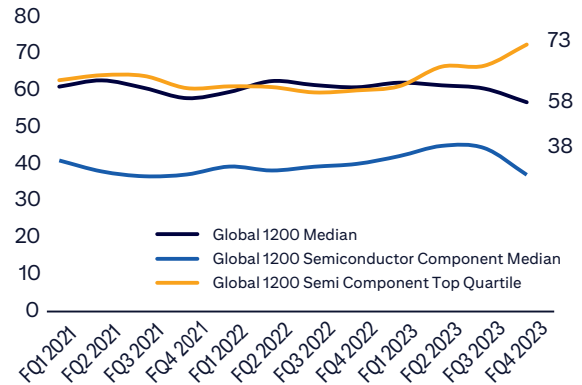
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Figure 14. Days Inventory Outstanding



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Figure 15. Days Payable Outstanding



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One potential explanation for the upwards pressure on DIO is the result of “just-in-case” inventory management practices as a way to mitigate supply chain disruptions. In addition, semiconductor manufacturers increased inventory during COVID as supply chains were overwhelmed by unexpected global demand for PC’s, laptops and work from home computer peripherals. This short-lived spike resulted in PC-related chip inventory oversupply and demand mismatch. These inventory imbalances are likely to occur again as generative AI chips may see demand volatility in 2024-2025 as consumers determine the full value of AI embedded products. Separately, suppliers may also be facing increased pressure to hold inventory on their balance sheets as customers seek ways to shift inventory off their own balance sheets. In an industry focused on developing the next generation of capabilities, sound working capital management tools designed to optimize inventory turnover and smooth inventory/demand cyclicity.

¹¹ CNBC, How the World Went from a Semiconductor Shortage to a Major Glut, 2023

Conclusion

Despite ongoing supply chain disruptions and inventory challenges, semiconductors continue to be an indispensable component for corporates in all industries. Semiconductor industry participants remained focused on limiting adverse impacts to working capital management and have a few points to consider when making decisions on their overall working capital management strategy.

- **Access to reliable financing is essential for resilient semiconductor supply chains:** By ensuring financing reaches participants throughout the entire supply chain, participants can embed resiliency while limiting impact from changes in the economic cycle.
- **Maximize liquidity to fund expansion and R&D:** Diligent working capital management may help maximize liquidity that can support the industry's rapid expansion and development of new capabilities.
- **Having the correct solutions in the right location:** Finding working capital solutions and providers in markets, including re-shoring markets, is an essential component of an overall holistic strategy.

Citi's Global Trade Working Capital Advisory team can help firms assess how to they can benefit from working capital improvements and can support clients in the implementation of comprehensive working capital management solutions.



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