

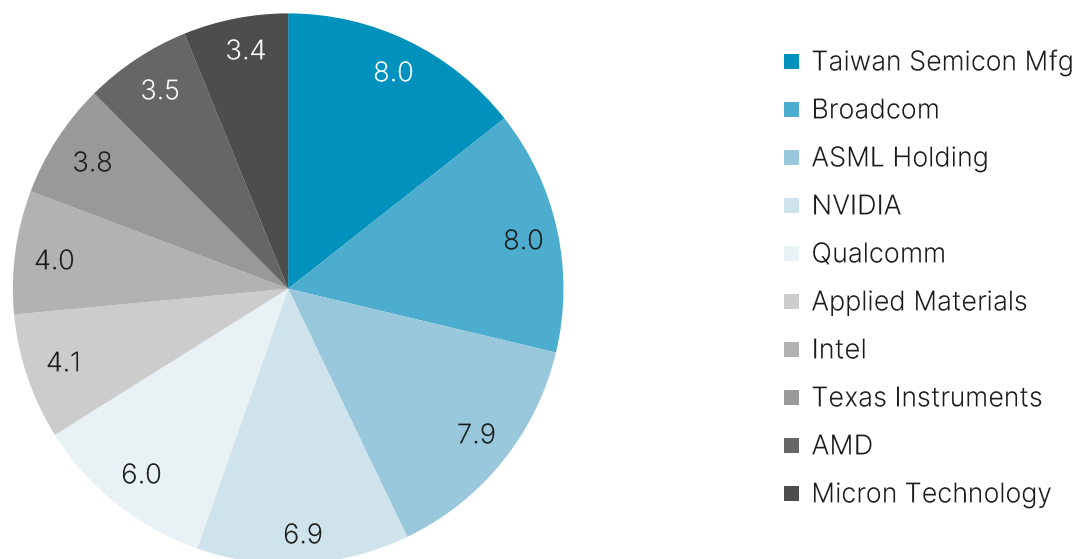
Powering Tomorrow's Thematic Technologies: Semiconductors Enter a New Era

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The Nasdaq Global Semiconductor Index™ (GSOX™) was launched on September 21, 2021. Its constituent basket consists of the top 80 securities by market capitalization in the semiconductor industry, as defined by ICB's subsector classification (inclusive of both Semiconductors and the Production Technology Equipment subsectors). Its relatively straightforward methodology employs modified market cap-weighting (8% capping for the top 5 constituents, with the rest capped at 4%) on a quarterly rebalancing schedule, with semiannual reconstitutions. Constituents must be assigned within the Nasdaq Global Index Family to the United States or to a country in Europe or Asia Pacific, and are required to meet minimum thresholds for market cap (\$150M) and liquidity (\$1M average daily trading volume over the last 3 months). ESG screening criteria – as determined by Sustainalytics – are also applied to ensure companies with certain controversial business activities are excluded. Let's review how GSOX has performed in the recent past and what its components look like today, before analyzing its importance to the broader universe of thematic technology and the overall investment case.

Current Composition

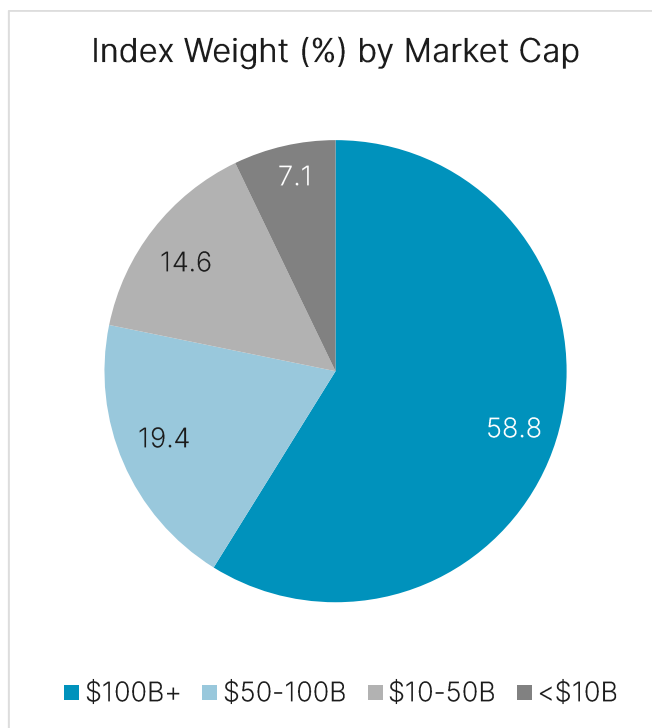
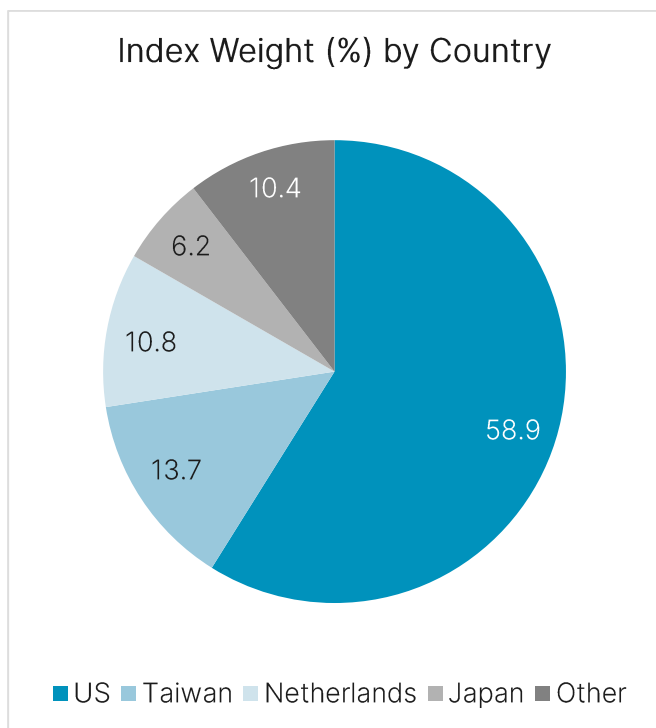
Top 10 Index Weights (%) as of December 31, 2021



Of the 80 constituents in GSOX, the top 10 represented 56% of the index weight as of December 31, 2021. The top 5 names represented approximately 37%, while the top 20 represented 80%. The largest was Taiwan Semiconductor Manufacturing (US: TSM) at 8.0%, while the largest by pure market capitalization was NVIDIA (NVDA). The average full-year 2021 return for the top 20 was 44.5%.

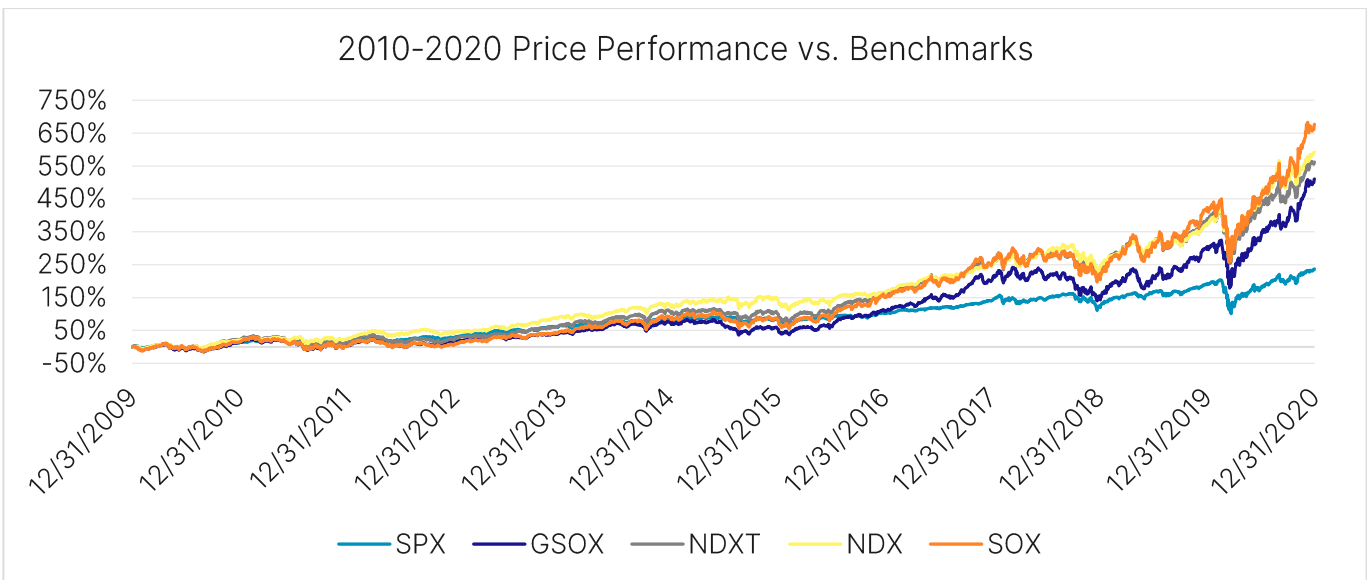
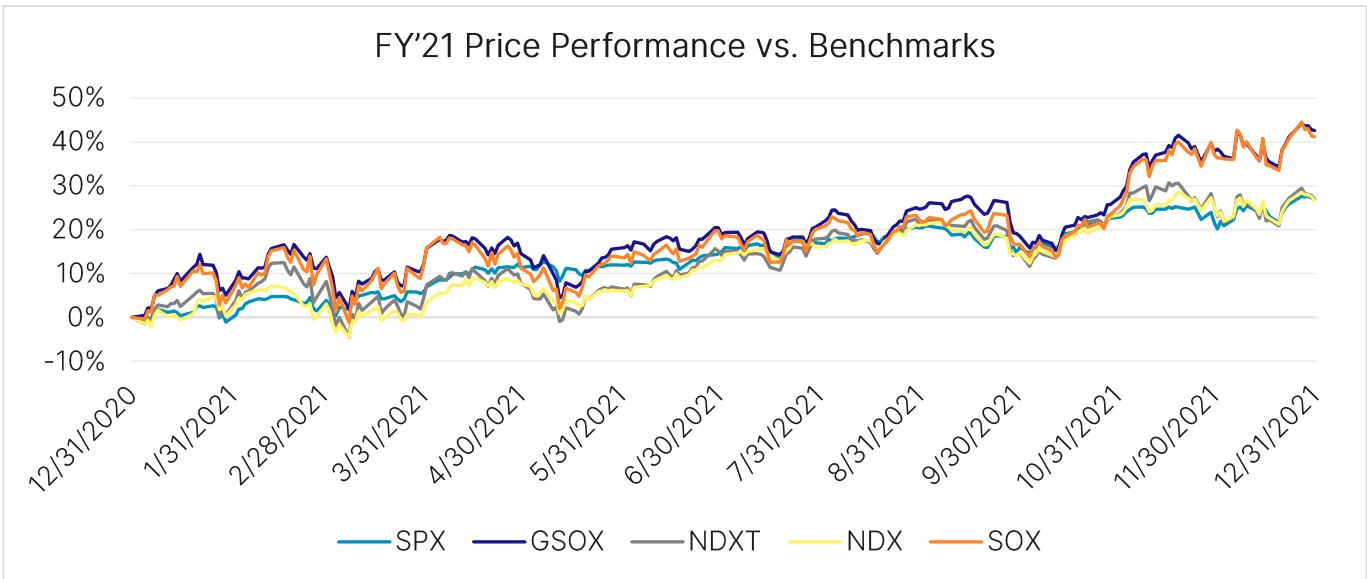
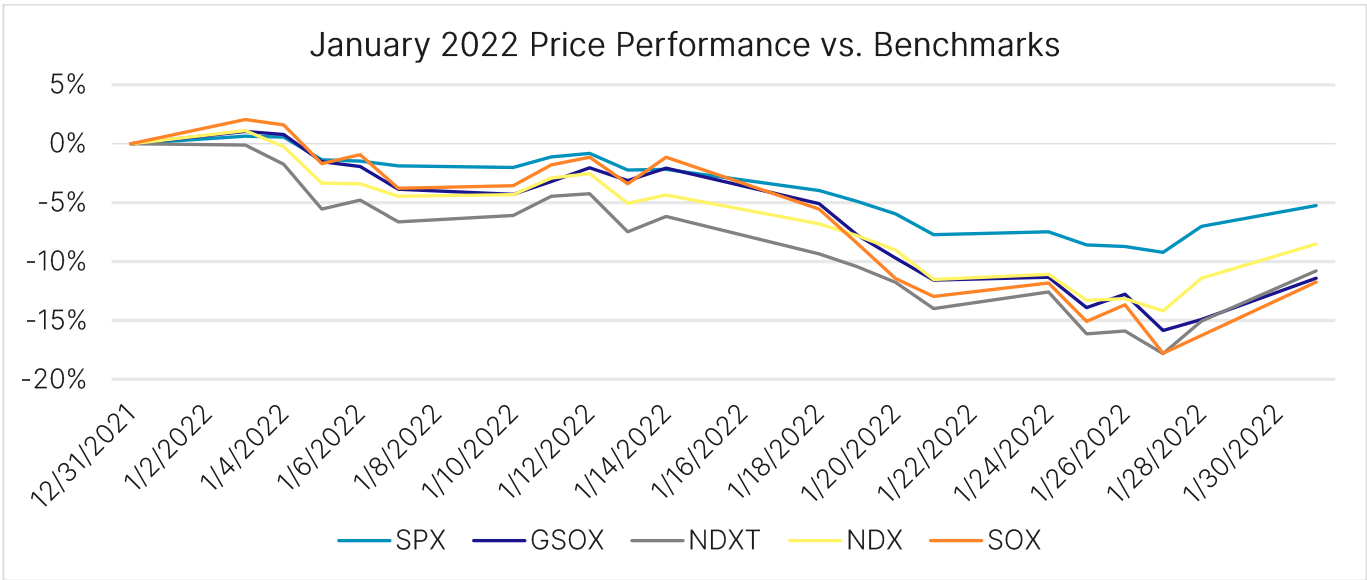
In terms of market capitalization for the overall group, the average was \$54.2B, while the weighted average was \$209.6B. The median was \$9.4B, and the range from largest to smallest was \$733.0B.

In terms of geographical and size diversity, GSOX’s constituents are rather concentrated in the US and within the mega cap segment (>\$100B market cap) at 59% each, but better diversified than other US-only semiconductor indexes.



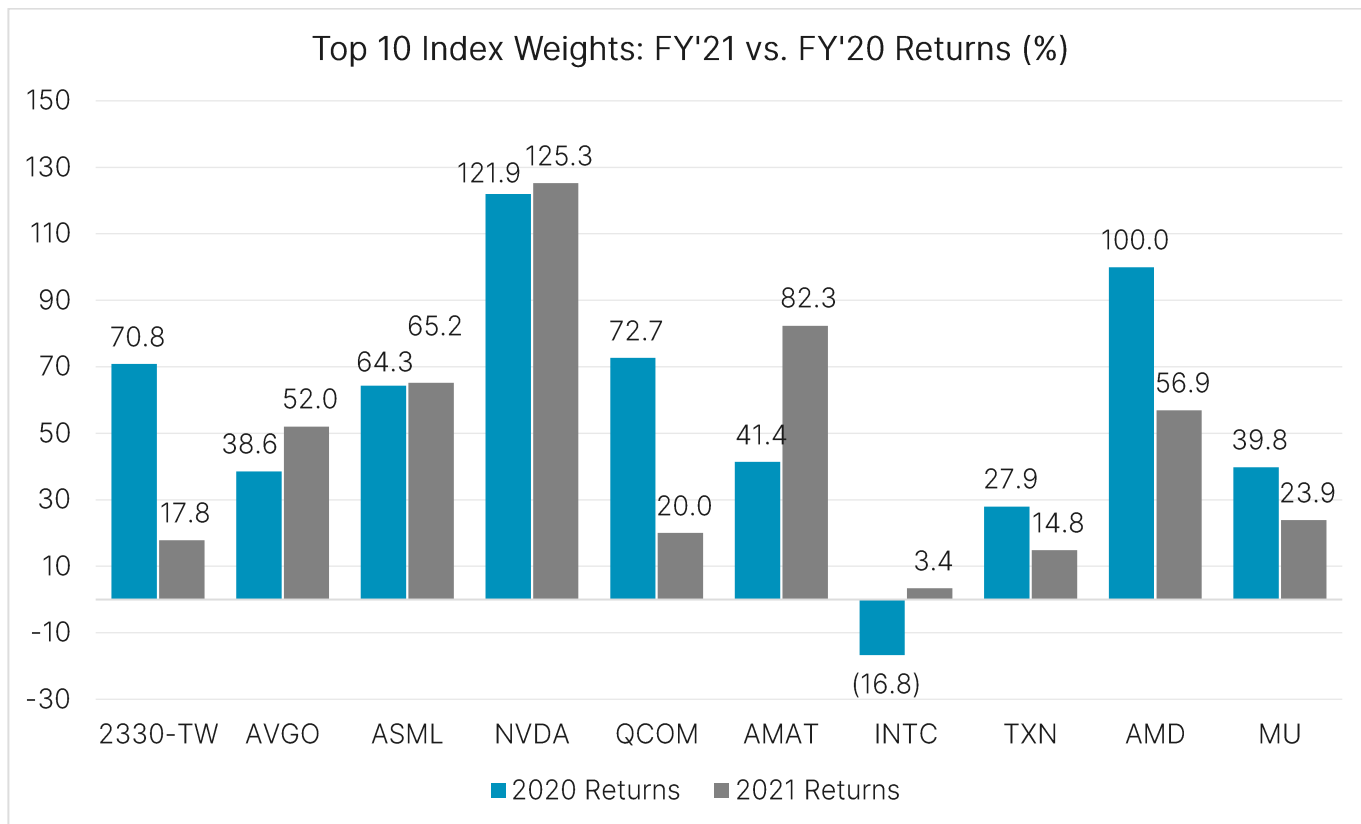
Recent Performance

GSOX outperformed both the Nasdaq-100® (NDX®) and the S&P 500 (SPX) over the course of 2021, with a gain of 42.6% vs. 26.6% and 26.9%, respectively (price-return basis). Even the Nasdaq-100 Technology Sector Index™ (NDXT™) could not keep pace with GSOX, which is still in the midst of the longest-running and sharpest streak of outperformance in its history. In the first month of 2022, GSOX entered a technical correction along with much of the broader Technology sector, pacing the declines in NDXT. Over a longer time horizon, however, GSOX is still outperforming the S&P 500 by more than two times, nearly matching the outperformance of the Nasdaq-100 since year-end 2009. It remains to be seen whether this most recent correction is a blip on the way to new highs for the index, or the beginning of a longer downturn. Industry fundamentals remain strongly supportive, in contrast to other areas of Tech.



Individual and Industry Drivers of Performance

Among the top 10 largest constituents of GSOX, 2021 saw generally lower, but still strongly positive returns – up 46.2% on average vs. 56.1% for the same group in 2020. Applied Materials (AMAT) and Intel (INTC) saw the biggest YoY improvements in performance, while Taiwan Semiconductor Manufacturing (2330-TW), Qualcomm (QCOM), and Advanced Micro Devices (AMD) saw the largest YoY decelerations.

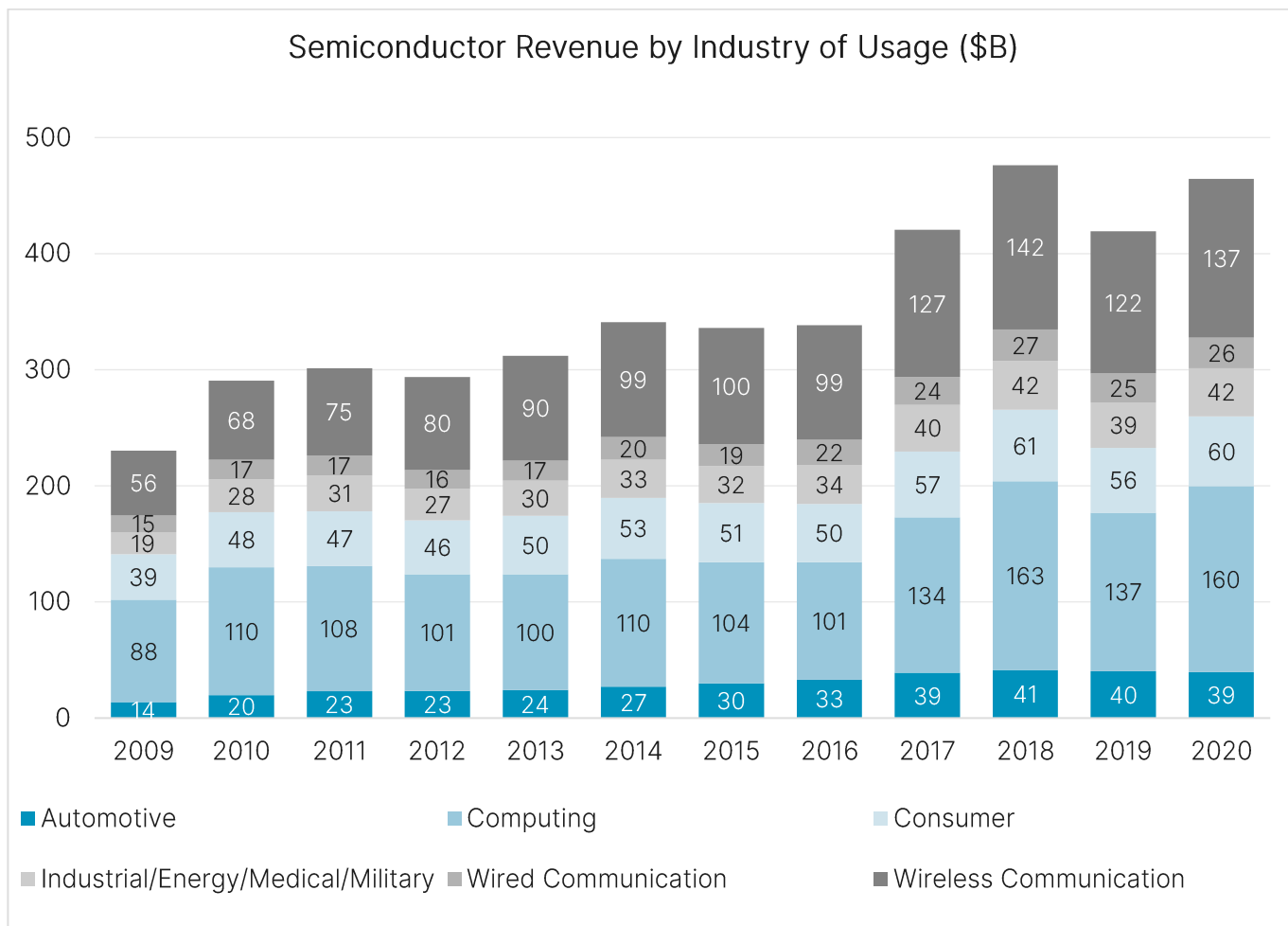


What drove GSOX's stellar performance in 2021, 2020, and in years prior? Semiconductor firms have been riding a wave of increasing demand for their products, which power an ever wider array of devices thanks to the rise of Artificial Intelligence, Cloud Computing, and the Internet of Things (IoT). As more devices become "smart" and connect to the cloud, there will continue to be a need for ever smaller and more powerful computer chips and processors. Continuous advances in mobile phones, gaming and media entertainment, blockchain/cryptocurrency, and new machinery such as drones, robots, and autonomous vehicles will drive further innovation in this competitive field. With that comes growing sales, but also the necessity of ongoing investment in raw manufacturing capacity as well as research and development.

Over the next four years alone, Taiwan Semiconductor and Intel are projected to devote upwards of \$250 billion to capex, mainly targeting the construction of new semiconductor fabrication plants in the US and globally. While the passage of the CHIPS Act in the US would steer \$50 billion of subsidies towards increasing production, Intel has already announced major new investments in Ohio, Arizona, and other locations as part of perhaps the most ambitious pivot in its business strategy ever undertaken: to launch Intel Foundry Services and finally compete with TSM in the business of manufacturing chips for other "fabless" semiconductor design firms, such as NVIDIA and AMD.¹²

¹ <https://www.reuters.com/technology/intel-plans-new-chip-manufacturing-site-ohio-report-2022-01-21/>

² <https://www.reuters.com/technology/intel-breaks-ground-20-bln-arizona-plants-us-chip-factory-race-heats-up-2021-09-24/>



Source: IDC Data via Bloomberg

Since 2009, global semiconductor revenues have grown by over 150%, reaching \$581.5 billion in 2021 after a blistering year of 25% growth.³ While we do not yet know the exact breakdown of 2021 revenue by industry of usage (per IDC), we can look at the trends through 2020 to see the biggest drivers of growth: Wireless Communication (e.g. smart phones) contributed \$81 billion of incremental semiconductor demand, while Automotive grew at the fastest rate, up 188% vs. 2009. Computing grew by \$72 billion, or 82%, while the once-small subset of Industrial/Energy/Medical/Military end-customers more than doubled, up 120% to \$42 billion.

The supportive trends in place prior to Covid-19 have only accelerated with the pandemic spurring widespread work-from-home, learn-at-home, and play-at-home. Per Gartner, worldwide PC shipments reached 340 million units in 2021, up 10% year-over-year and extending 2020’s record for the highest growth rate seen in ten years.⁴ Tablet sales grew to a new record of 169 million units in 2021, following nearly 20% year-over-year growth in 2020.⁵ Sales of gaming consoles are on track to hit fresh records in 2021 after exceeding 50 million shipments for the first time in 2020.⁶ Smartphones saw strong year-over-year growth as well, up 5.7% to 1.35 billion units.⁷

³ <https://www.gartner.com/en/newsroom/press-releases/2022-01-19-gartner-says-worldwide-semiconductor-revenue-grew-25-point-one-percent-in-2021-exceeding-500-billion-for-the-first-time>

⁴ <https://www.gartner.com/en/newsroom/press-releases/2022-01-12-gartner-says-worldwide-pc-shipments-declined-5-percent-in-fourth-quarter-of-2021-but-grew-nearly-10-percent-for-the-year>

⁵ <https://www.cnet.com/tech/computing/apple-keeps-its-grip-on-the-tablet-market-despite-shipment-slowdown/>

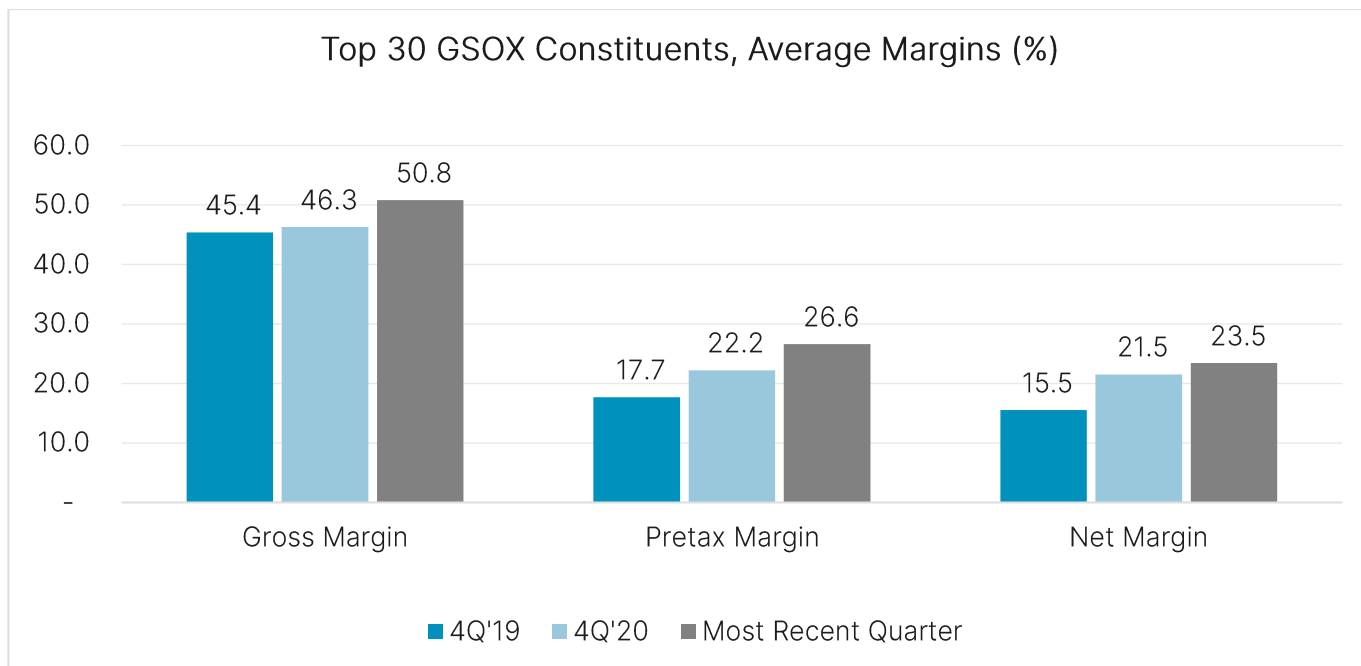
⁶ <https://www.visualcapitalist.com/multi-billion-dollar-console-gaming-market/>

⁷ <https://www.idc.com/getdoc.jsp?containerId=prUS48830822#:~:text=On%20an%20annual%20basis%2C%20the,IDC's%20Worldwide%20Mobile%20Device%20Trackers>

Finally, the global auto market is also expecting a continued rebound in 2022 after considerable disruption in 2020 and 2021, driven to a large extent by a shortage in automotive semiconductors. Some cars – especially electric-powered, but even high-end combustion engine vehicles with sophisticated media and driver assistance systems – can require thousands of semiconductors.⁸ The global market share of EVs more than doubled in 2021, contributing essentially all of the net growth in auto sales for the year. While some automakers began acknowledging fewer shortages and delays in late 2021 going into 2022, it remains to be seen just how long it will take for production to fully normalize and finally begin to meet pre-pandemic levels of demand.

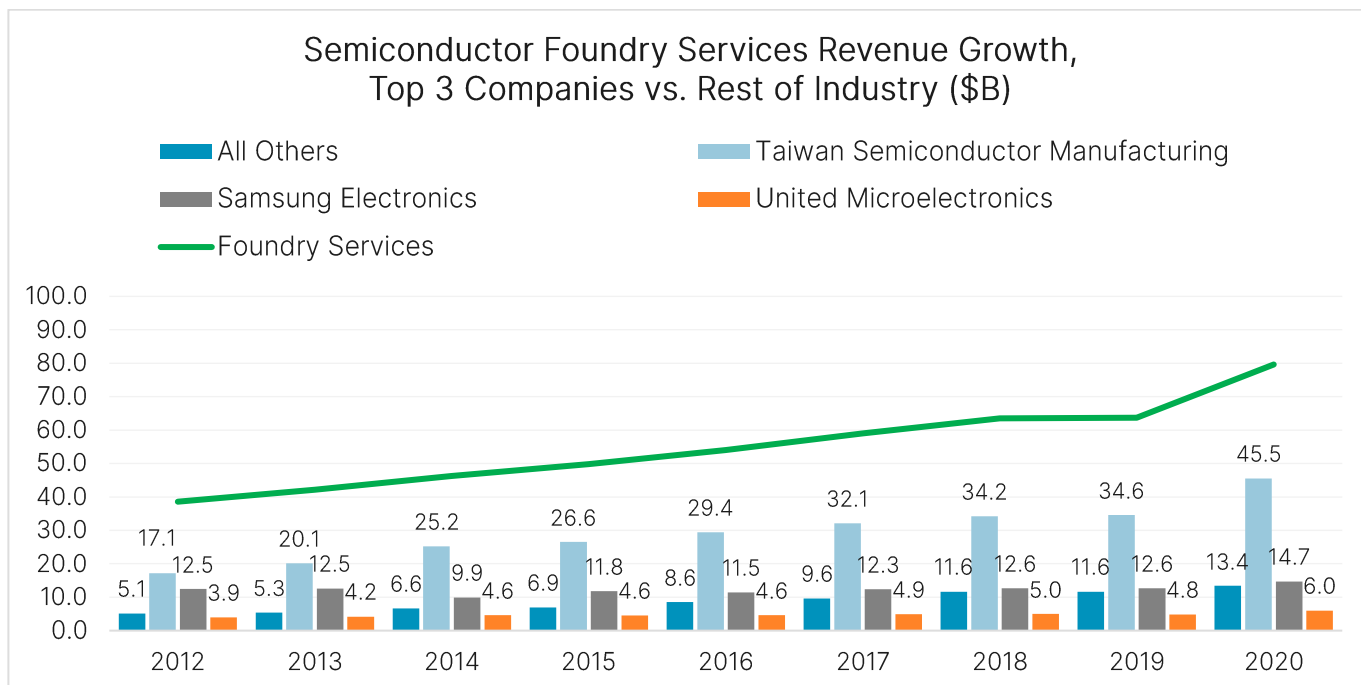
Semiconductors' Secular Uptrend Meets a Highly Consolidated Industry

The semiconductor industry has experienced tremendous consolidation during the 21st century, with the rise of several monopolistic, duopolistic, or oligopolistic segments. This unique combination of a seemingly permanent uptrend in end-user demand among multiple product types – with a highly concentrated industry, all in the backdrop of widespread, long-running shortages – suggests considerable long-term pricing power for many of the dominant players in the space. This should all be supportive of margins, even in the face of wage and commodity inflation. In fact, we have already seen substantial improvement since just before the Covid-19 pandemic hit and accelerated the supply/demand imbalances for many parts of the industry. Using company-level financial data as of February 3, 2022, the average net income margin of the top 30 GSOX constituents (representing 89% of index weight) was 23.5% in the most recent quarter, compared to only 15.5% eight quarters ago. Similar improvement is evident in both pretax and gross margins, as well.



In terms of specific areas of concentration and consolidation, look no further than Taiwan Semi, perhaps the single most important company in the industry. Its dominance in foundry services has compounded its revenue lead over Samsung, the 2nd largest player in the space, to more than three times as of full-year 2020. According to the latest estimates from Factset, TSM now accounts for 67% of foundry services revenue globally. Moreover, its continuous investments in R&D have given it a virtual monopoly in leading-edge manufacturing, currently at 5-nanometer (and soon to be 3-nanometer) thickness. In other words, for the most advanced chip designs, there is only one manufacturer at scale today, and that's Taiwan Semi.

⁸ <https://www.caranddriver.com/news/a35228204/microchip-shortage-car-production-disruption/>



Yet TSM is just one example. Intel retains its dominance in computer microprocessor (CPU) design and manufacturing, with an 83% share of global revenues in the category. Qualcomm's share in smartphones and other communication-specific semiconductors is up to 94%. ASML's share in photolithography equipment manufacturing is 71%; like TSM, it has a monopoly on the most advanced, cutting-edge Extreme Ultraviolet Lithography (EUV) machines – of which one unit requires some 4,000 different suppliers to assemble and retails for upwards of \$150 million. Lastly, while NVIDIA and AMD share similar overall swaths of the video multimedia category, the former is now the undisputed leader in designing the most advanced graphics processing units (GPUs) and “system on a chip” (SOCs) that are instrumental in the evolution of artificial intelligence. As AI becomes more and more applicable to everyday uses, the need for massive amounts of data processing and analysis will explode the demand for AI-specific chips even higher than that of traditional CPUs. The equity market has acknowledged this incredible potential by bidding up the value of NVIDIA to \$735B as of year-end 2021.

Ticker	Company Name	Factset Semiconductor Revenue Category	% of Product Category	% of Company Revenue
INTC	Intel	Microprocessor	83%	85%
TSM	Taiwan Semi	Semiconductor Foundry Services	67%	97%
QCOM	Qualcomm	Communications	94%	79%
MU	Micron Technology	Volatile Memory Semiconductors	45%	86%
AMAT	Applied Materials	Other Front End Processing Equipment	28%	92%
AVGO	Broadcom	RF/Analog/Mixed Signal	86%	74%
ASML	ASML Holding	Photolithography Equipment	71%	98%
LRCX	Lam Research	Other Front End Processing Equipment	20%	100%

TXN	Texas Instruments	General Analog/Mixed Signal	31%	75%
AMD	AMD	Video Multimedia	46%	66%
NVDA	NVIDIA	Video Multimedia	42%	59%
KLAC	KLA	Test, Measurement & Metrology Equipment	37%	84%

Source: Factset Revere as of February 3, 2022. Sorted by total company revenue, largest to smallest.

Summary

GSOX clearly demonstrates its importance as a must-follow subsector index, representing companies that facilitate and embody technological advancement. Similar to the Nasdaq-100, it has outperformed broader market benchmarks such as the S&P 500 and the Nasdaq Composite® in recent years, despite being less diversified on a sector basis. It tracks constituent firms that are both household names (e.g. Intel) as well as the lesser-known, but equally vital players in the Tech ecosystem. It is heavily tilted towards US firms, but not restricted by geography. There is ultimately very strong overlap with the Nasdaq-100; 16 of the index's 80 constituents were also in the Nasdaq-100 as of December 31, 2021, representing 63% of GSOX's index weight. Given the Nasdaq-100's global reputation for innovation-leading, high-growth companies, it should thus come as no surprise that GSOX ranks highly in performance when compared to many other leading index benchmarks.

With the rise in popularity of various thematic tech indexes and tracking funds, it is worth considering just how central semiconductors are to the many products and services that comprise the modern landscape of thematic technology and beyond. With a transparent, practical methodology and a robust, backtested index history of 20 years, the Nasdaq Global Semiconductor Sector Index (GSOX) offers investors the ability to track this compelling industry with an effective, stable, and highly accessible benchmark.

ETFs currently tracking GSOX include the HSBC Nasdaq Global Semiconductor ETF (London: HNSC).

Sources: FactSet, Bloomberg, Nasdaq Global Indexes.

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