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August 23, 2023

Nasdaq

Semiconductors: From Integrated Circuits to Artificial Intelligence

Kevin Davitt

Head of Index Options

Content

Nasdaq

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Semiconductors: From Integrated Circuits to Artificial Intelligence (AI)

Interactive Brokers Webinar
August 23, 2023

Kevin Davitt

*Nasdaq – Head of Index Options
Content*

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Index

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Nasdaq-100® Volatility Index

The Nasdaq-100® Volatility Index (Ticker Symbol: VOLQ) is calculated and administered by The Nasdaq Stock Market LLC. The Nasdaq-100 Volatility Index is a financial benchmark designed to measure changes in 30-day implied volatility of the Nasdaq-100 Index as further described in the methodology, rules and other information. VOLQ options, which are traded on Nasdaq Phlx LLC, are complicated financial products only suitable for sophisticated market participants. Market participants should put at risk only funds that they can afford to lose without affecting their lifestyles. Transacting in VOLQ options involves the risk of loss, which can be substantial and can exceed the amount of money deposited for a Nasdaq-100 Volatility Index position (except when buying options on VOLQ, in which case the potential loss is limited to the purchase price of the options).

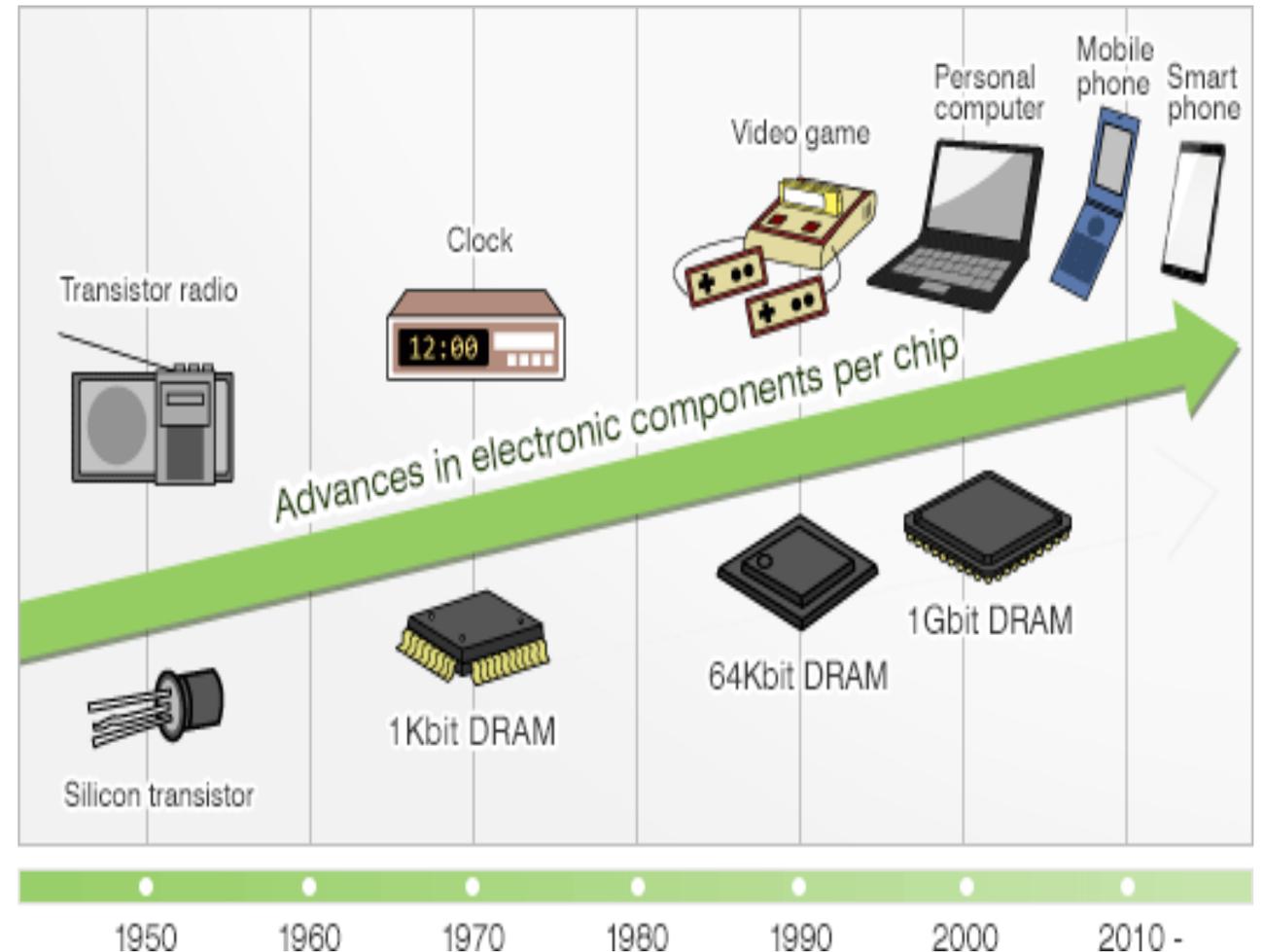
Before transacting in VOLQ options, market participants should fully inform themselves about the Nasdaq-100 Volatility Index and the characteristics and risks of VOLQ Options. Market participants also should make sure they understand the product specifications for VOLQ Options and the methodologies for calculating and settling the Nasdaq-100 Volatility Index.



Semiconductors (Semis)

Well, How Did We Get Here?

- Way Back When:
 - AC-DC converter (1874)
- 20th Century:
 - UPenn: Computer w/vacuum tubes (1946)
 - Bell Labs: Point-Contact transistor (1947)
 - Junction transistor (1948)
 - Nobel Prize: 1956^
 - Texas Instruments/Fairchild Semi: Integrated Circuit (ICs) (1959)
 - Calculators!



Source: Hitachi



Semiconductors (Semis)

Who Are the Players?

- Highest Revenue:
 - Taiwan Semi (TSM) - \$71.7B
 - **Intel Corp (INTC)* - \$69.54B**
 - **Qualcomm (QCOM)***
 - **Broadcom (AVGO)***
 - Micron Tech (MU)
 - **NVIDIA Corp (NVDA)***
 - **Applied Materials (AMAT)***
 - ASE Tech (ASX)
 - Advanced Micro Devices (AMD) - \$22.9B
 - **ASML Holding (ASML)* - \$21.3B**

*Nasdaq Listed

Source: Investopedia



- Highest Market Cap:
 - **NVIDIA Corp (NVDA)* - \$1.1T**
 - TSMC (TSM) - \$481B
 - **Broadcom (AVGO)***
 - Samsung
 - ASML Holding (ASML)*
 - Advanced Micro Devices (AMD)
 - Texas Instruments (TXN)
 - **Intel Corp (INTC)***
 - **Qualcomm (QCOM)* - \$127B**
 - **Applied Materials (AMAT)* - \$118B**

*Nasdaq Listed

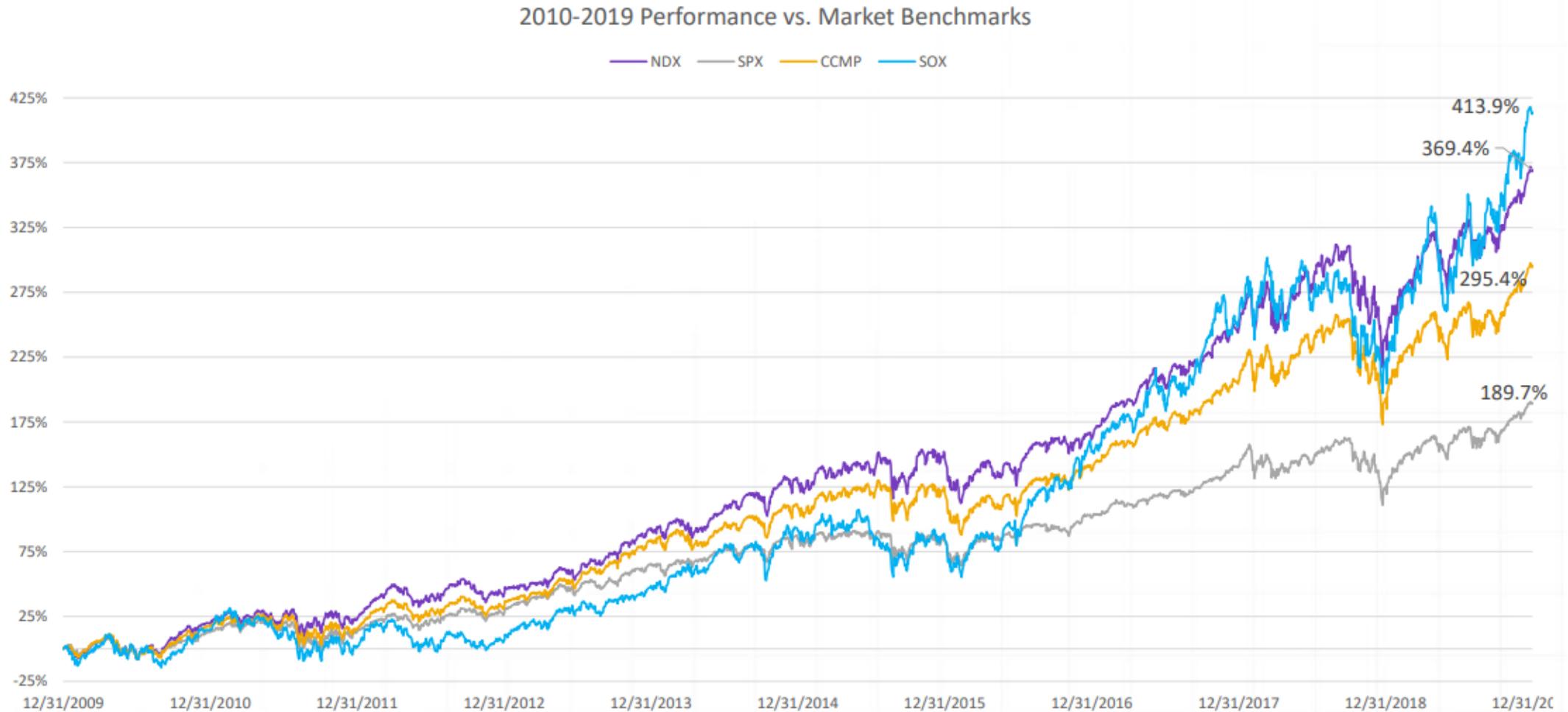
Source: CompaniesMarketCap.com

Component Type & Growth Areas

- Components:
 - Memory (largest share) ~25%
 - Cloud computing + VR/AR
 - Microcomponent
 - Electronic devices
 - Logic
 - ASIC & ASSP
 - Analog
 - Power grid + Signal conversion + Automotive
 - Optoelectronic
 - IoT + Image recognition
 - Sensor & Discrete
 - Controls + IoT applications
- Growth Markets:
 - **Artificial Intelligence & Machine Learning**
 - Automotive
 - Autonomous/EV cars
 - Industrial
 - Security + Healthcare
 - Communication
 - Smartphone + 5G
 - Electronics
 - TV/Gaming/Handhelds
 - Data Processing
 - Servers
 - IoT & LEDs

Semiconductors (Semis)

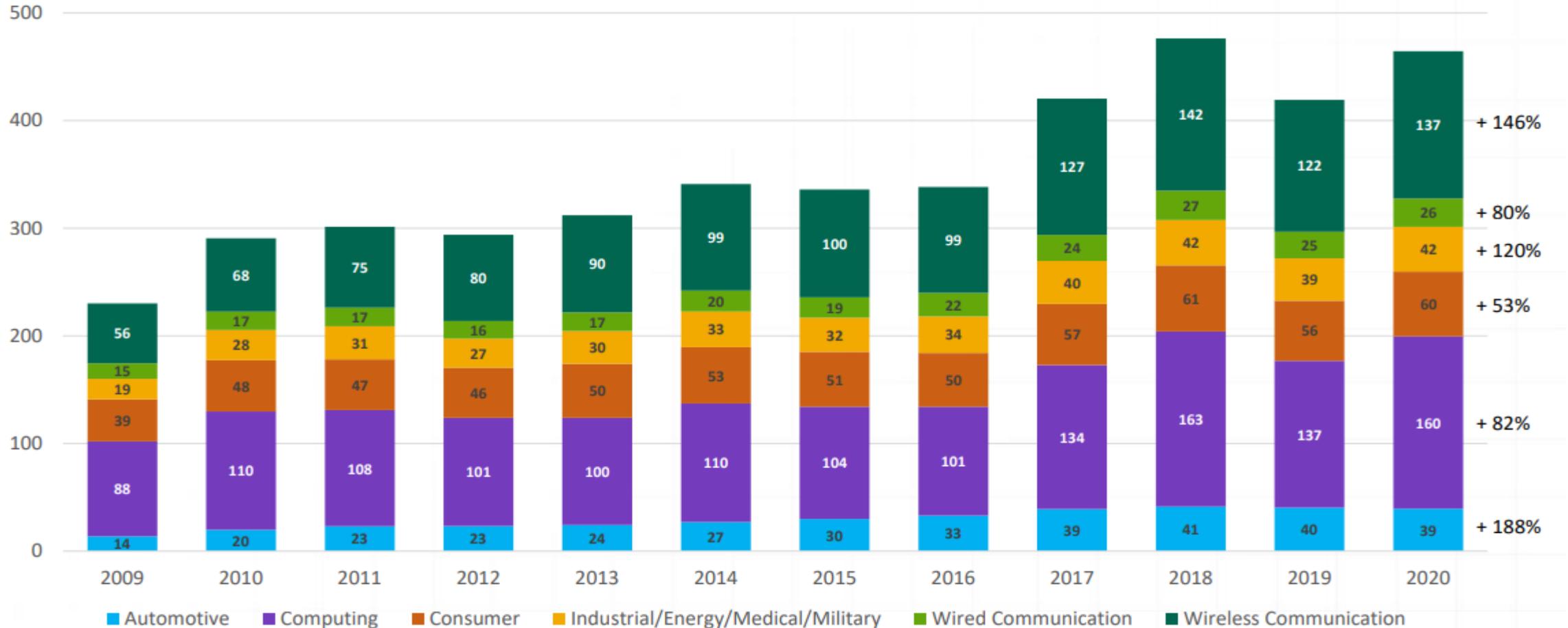
The Previous Decade (SOX, NDX, COMP, SPX)



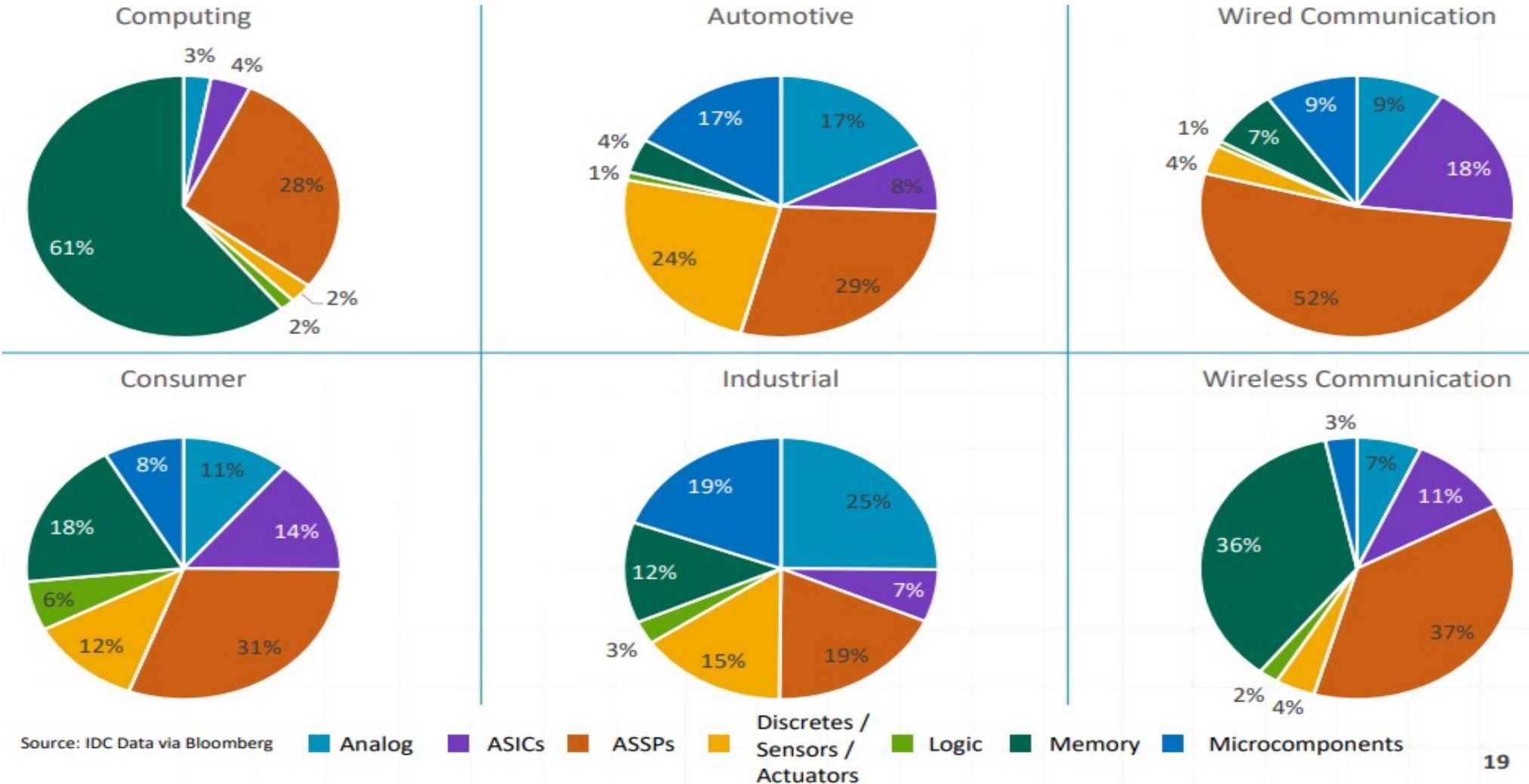
Semiconductors (Semis)

Revenues Double in a Decade!

Growth in Semiconductor Revenue by Industry of Usage, \$Bn



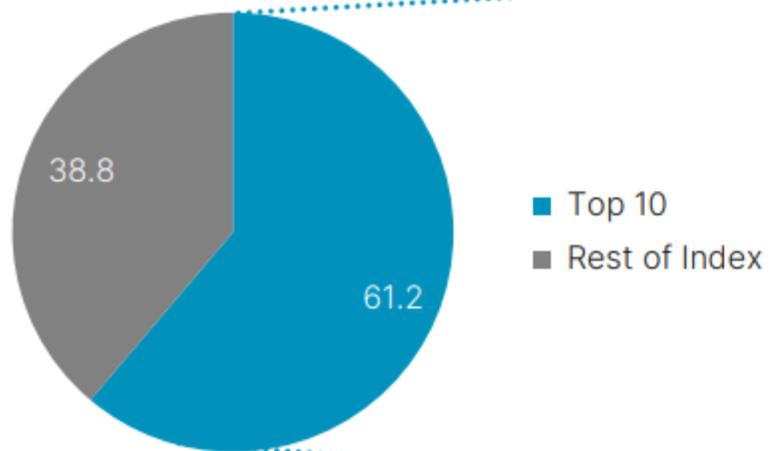
Money in Every Corner of the Economy



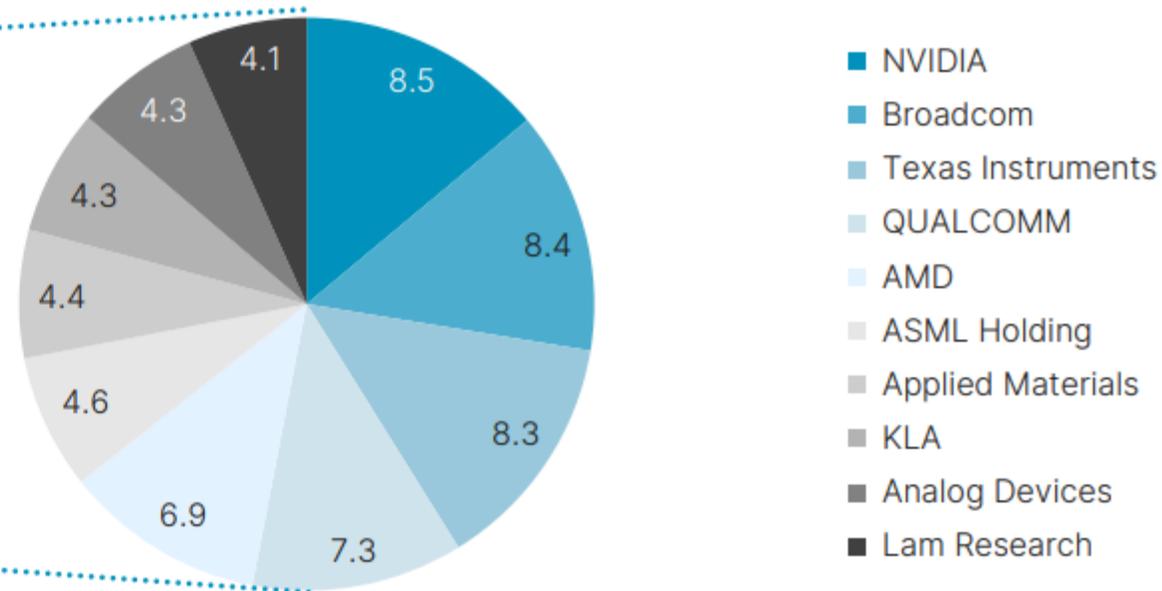
PHLX Semiconductor Index (SOX)

The PHLX Semiconductor Sector Index™ is designed to track the performance of the 30 largest US-listed semiconductor companies. In order to qualify for inclusion, companies must be classified under the Semiconductors Subsector or Production Technology Equipment Subsector according to the Industry Classification Benchmark (ICB). Each constituent must have a market capitalization of at least \$100 million and a six-month average daily traded volume of at least 1.5 million shares. The index is modified market capitalization-weighted, and was launched on December 1, 1993.

Top 10 vs. Rest of Index



Top 10 Index Weights (%) as of November 30, 2022

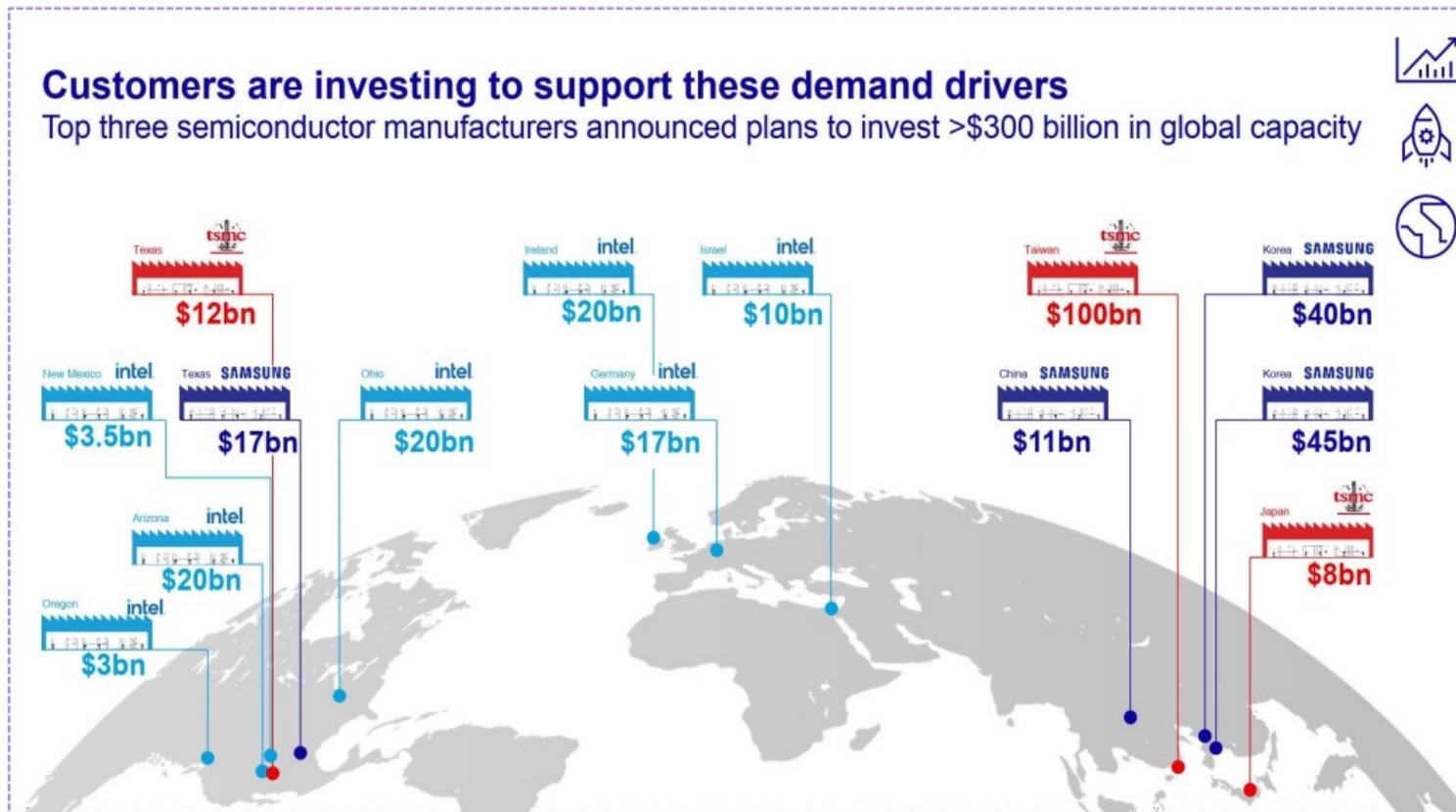


Semiconductors (Semis)

Demand/Growth Continues

The **WORLD** needs semiconductors – not a niche market!

Capital expenditures fuel future growth?



Thesis:

Want long exposure to Semi sector via long options.

Alternative: Long Index proxy (via ETF).

Why 2016?

Mega Trend: GPU arguably became more important than CPU.

Resources:

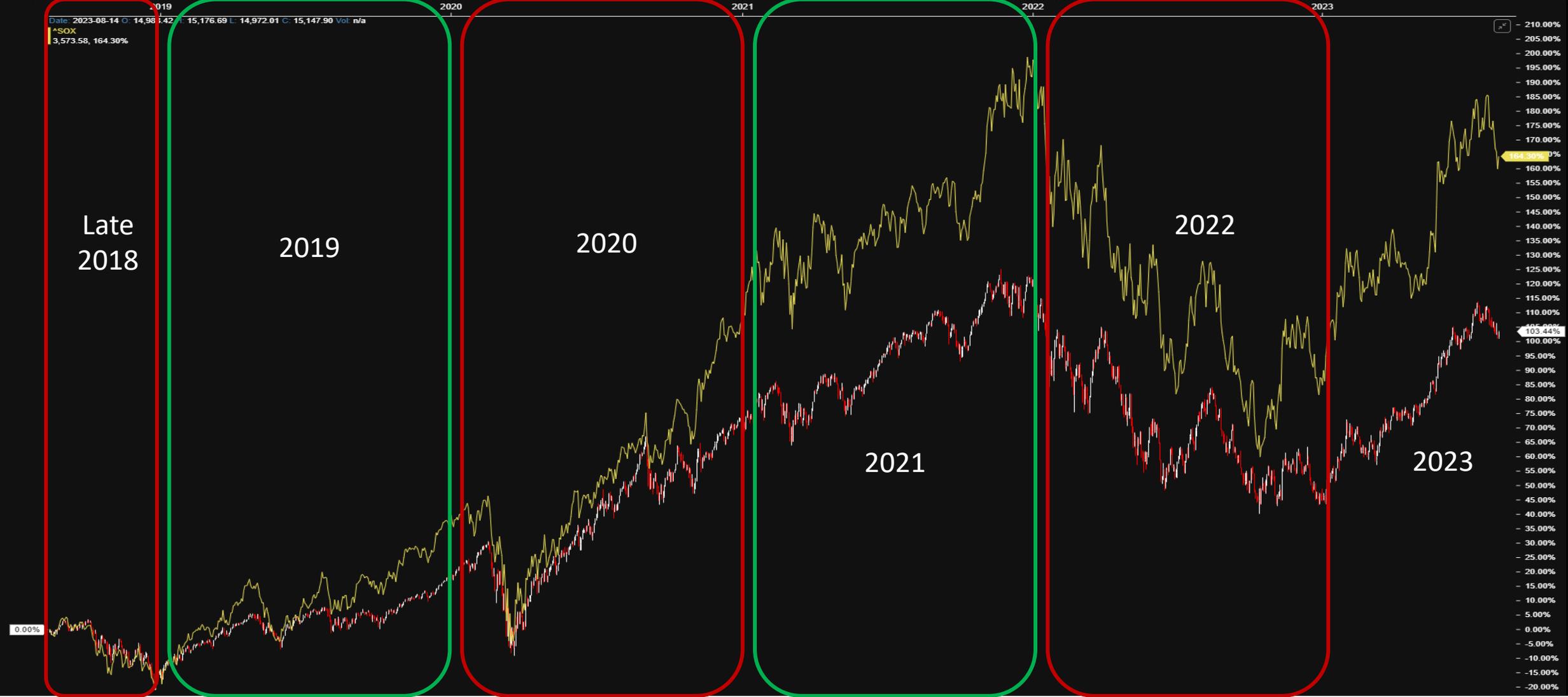
[PHLX SOX Overview](#)

[PHLX SOX Research 2022](#)

[PHLX SOX Research 2021](#)



SOX vs. NDX (5 Years)



Source: Live Vol Pro



SOX vs. NDX Takeaways

- Leading Indicator?
 - Leader during 2019 advance
 - SOX +64.5% v. NDX +41.2% (2019)
 - Led both ways in 2020
 - SOX (31%) NDX (19.8%) - March
 - SOX +51.2% v. NDX +48% Year End
 - SOX led throughout 2021 +44.4% v. NDX +28% for full year
 - SOX slightly outpaced NDX on downside in 2022; declining by 36% v. NDX down 34%
- Semis & the Broader Economy:
 - Most modern-day tech requires semiconductors
 - Demand serves as bellwether for potential growth
 - Manufacturing and IP continues to be a sticking point
 - ~5Y to create semi fabrication plant
 - CHIPS Act: Into law August 2022
 - \$280B in funding for DOMESTIC research and manufacturing
 - Tax incentives aimed at onshoring Chinese operations



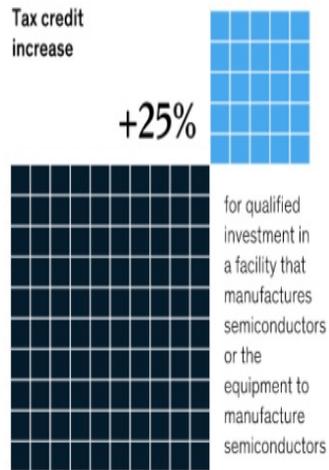
Semiconductors (Semis)

Government Support Doesn't Hurt!

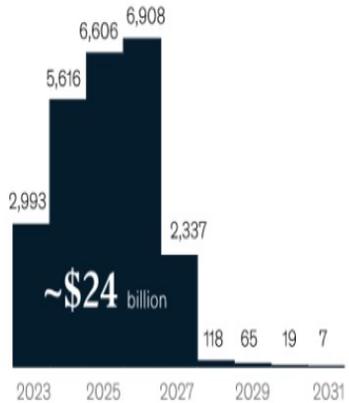
- CHIPS & other legislation is incentivizing onshore semiconductor production. The indirect investment is BIG!

The CHIPS and Science Act establishes a semiconductor investment tax credit of approximately \$24 billion to spur private investment until January 1, 2027.

Advanced manufacturing investment tax credit

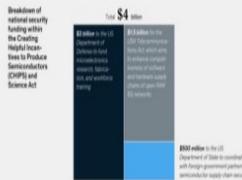


Estimated outlays of advanced manufacturing investment tax credits by US Treasury, \$ million



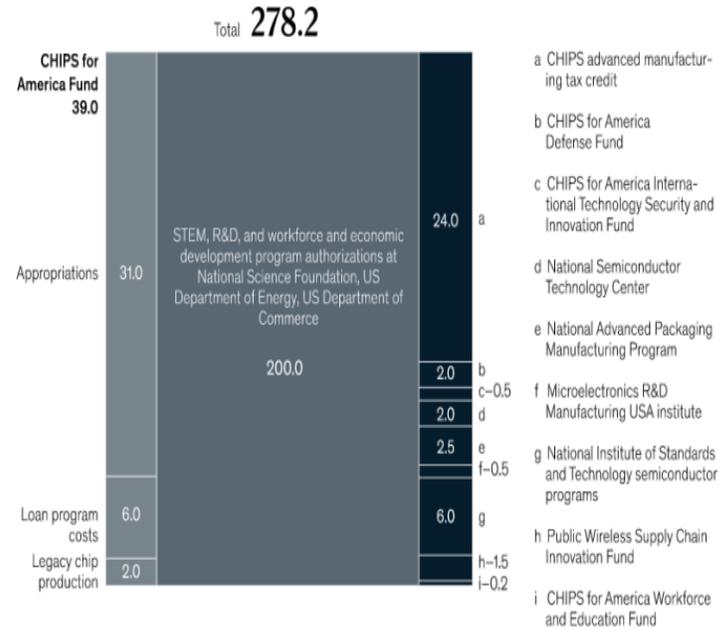
Boosting national security and 5G supply chains: The CHIPS Act allocates \$2 billion to the US Department of Defense to fund microelectronics research, fabrication, and workforce training. An additional \$500 million goes to the US Department of State¹¹ to coordinate with foreign-government partners on semiconductor supply chain security. And \$1.5 billion funds the USA Telecommunications Act of 2020, which aims to enhance competitiveness of software and hardware supply chains of open RAN (radio access network) 5G networks.

The CHIPS and Science Act will fund a national network of semiconductor technologies for the defense industrial base and investments in supply chain resilience.



The CHIPS and Science Act of 2022 directs \$280 billion in spending over the next ten years, with the bulk for scientific R&D.

CHIPS and Science Act funding for 2022–26, \$ billion

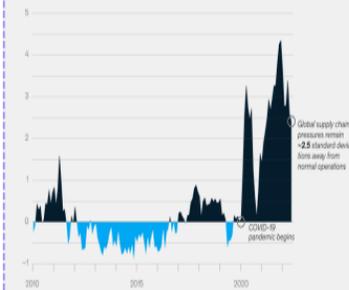


Source: Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022, H.R. 4346, 117th Cong. (2022)

The chips are down: The United States makes 12 percent of the world's semiconductors, compared with 37 percent in the 1990s, according to US government statistics.¹¹ Many US firms are dependent on chips made abroad, and the fragility of those supply chains has been laid bare over the past 18 months. Moreover, McKinsey research estimates that worldwide demand will keep growing, with semiconductors poised to become a \$1 trillion industry by the end of the decade.

Semiconductor shortages have been a key aspect of global supply chain pressures over the past 18 months.

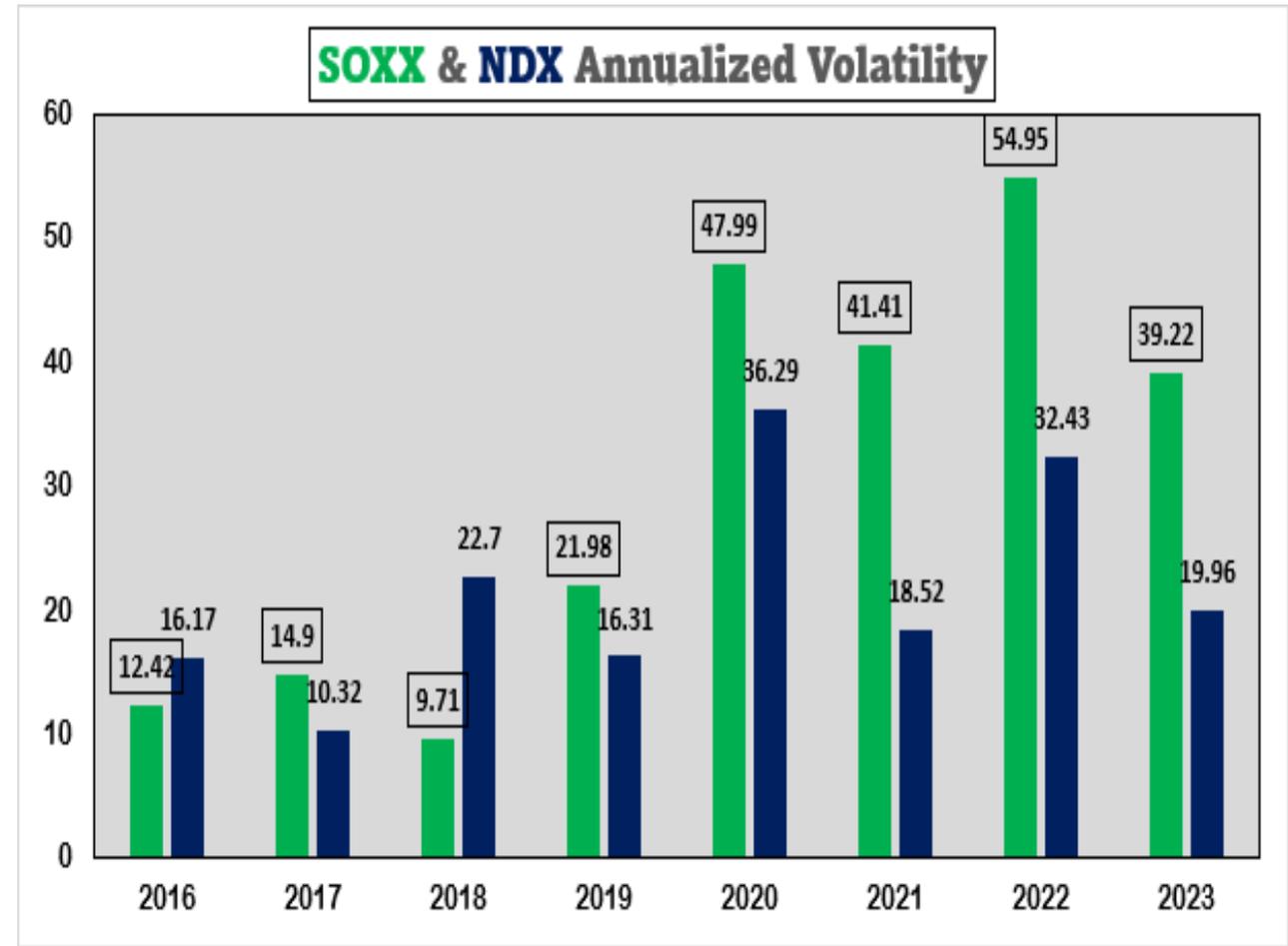
Global Supply Chain Pressure Index, standard deviations from average value



Source: Federal Reserve Bank of New York, S&P Global PMI Commodity Price and Supply Indicators

Higher Volatility

- “Volatility Just Is:”
 - Volatility is a way to measure risk, but it does not imply direction
 - The risk/reward relationship is unique across sectors
 - SOX realized volatility > NDX vol most of the time
- Tech DRIVES the Economy:
 - Every facet of the global economy is tethered to tech in some way
 - Energy analogy – it’s a matter of what TYPE
 - Options can help mitigate specific volatility exposure



Source: Bloomberg & Nasdaq



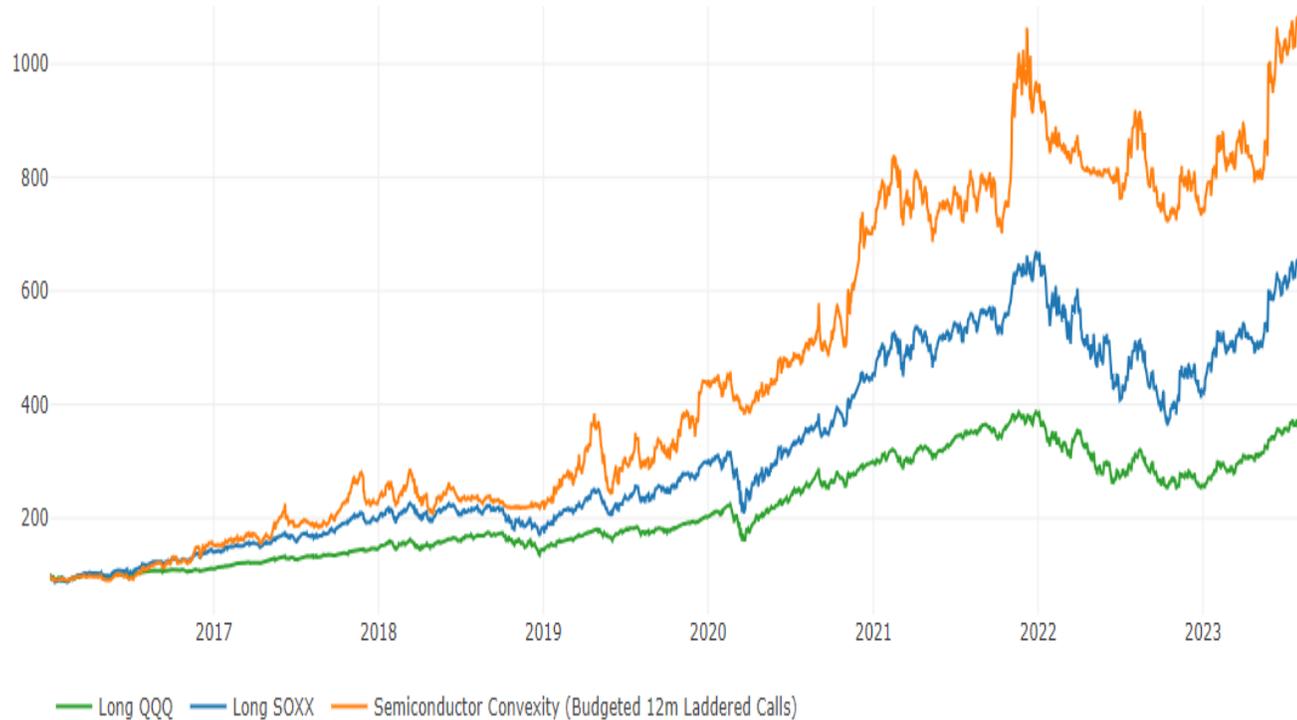
Semiconductors (Semis)

Structured Options Exposure

Options Based Exposure – Semi Convexity Structure

Long SOXX Index (proxy)

Long NDX Index (proxy)



Thesis:

Want long exposure to Semi sector via long options.

Alternative: Long Index proxy (via ETF).

Why 2016?

Mega Trend: GPU arguably became more important than CPU.

Issues:

Risk full value of option premium.

- Rolls every 6 months to preserve budget.

Risk entire exposure to Index proxy.

- Capitulate in 2018/2020 or 2022?

Risk not capitalizing on long-term trend.



Semiconductors (Semis)

Structured Options Exposure

Structure Breakdown (based on overall portfolio value):

12% allocated to 1Y 50 delta calls

2.5% allocated to 1Y 25 delta calls

0.5% allocated to 1Y 10 delta calls

Semiconductor Convexity (Budgeted 12m Laddered Calls)

Start Date: 2011-01-03 Initial Value: 100 Framework: Volos Strategy Engine

Created by: demo@volossoftware.com Created on: 2023-08-15 12:08:29 PM

Group A, Leg 1: SOXX Long Call. 0.5 Delta. 12 month Target Expiration. Roll every 6 months. Jun Series. 12% Budget per Roll.

Group A, Leg 2: SOXX Long Call. 0.25 Delta. 12 month Target Expiration. Roll every 6 months. Jun Series. 2.5% Budget per Roll.

Group A, Leg 3: SOXX Long Call. 0.1 Delta. 12 month Target Expiration. Roll every 6 months. Jun Series. 0.5% Budget per Roll.

 Edit Strategy

Thesis:

Long options exhibit convexity, particularly OTM options. Potential way to capture more upside on dollar-for-dollar basis.

Options don't move 1:1

Long options also have long gamma which acts as potential performance accelerant.

Issues:

Consistent grind lower.

Long convexity comes at a cost – decay.

- Theoretically/practically far less decay in longer dated exposure.

Vega component.



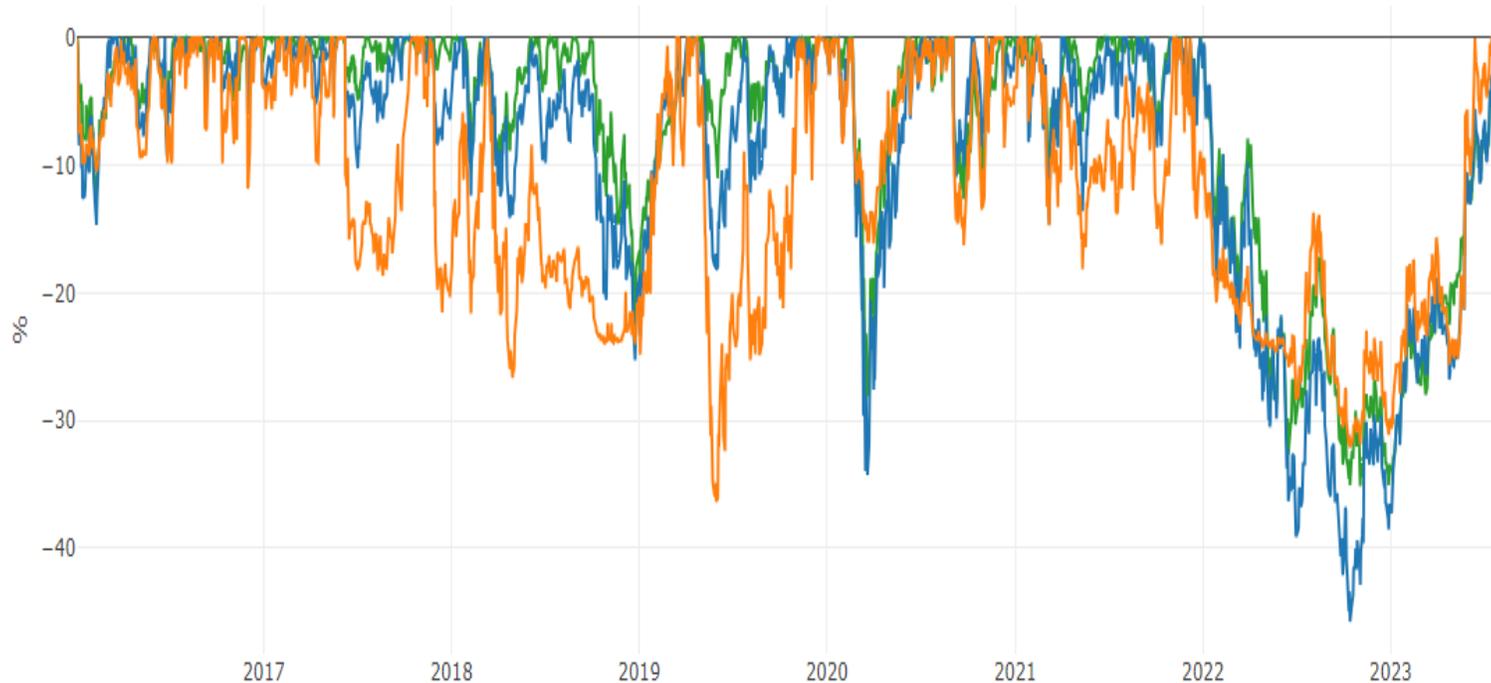
Semiconductors (Semis)

Structured Options Exposure

Semi Convexity Structure drawdown

Long SOXX Index (proxy) drawdown

Long NDX Index (proxy) drawdown



— Long QQQ — Long SOXX — Semiconductor Convexity (Budgeted 12m Laddered Calls)

Source: Volos Software

Overall:

Option-based exposure experienced > drawdowns for most of 2016 – 2021.

The Convexity exposure outperformed during 2022 bear market. (Vol up).

Convex v. Linear:

The structure has an inherent upside bias and can benefit from higher vol (2022)/upside skew.

Issues:

Underlying lower and vol lower = ☹️

Interesting dynamic during 2022 bear market & recovery into 2023.

- Unusual skew behavior.

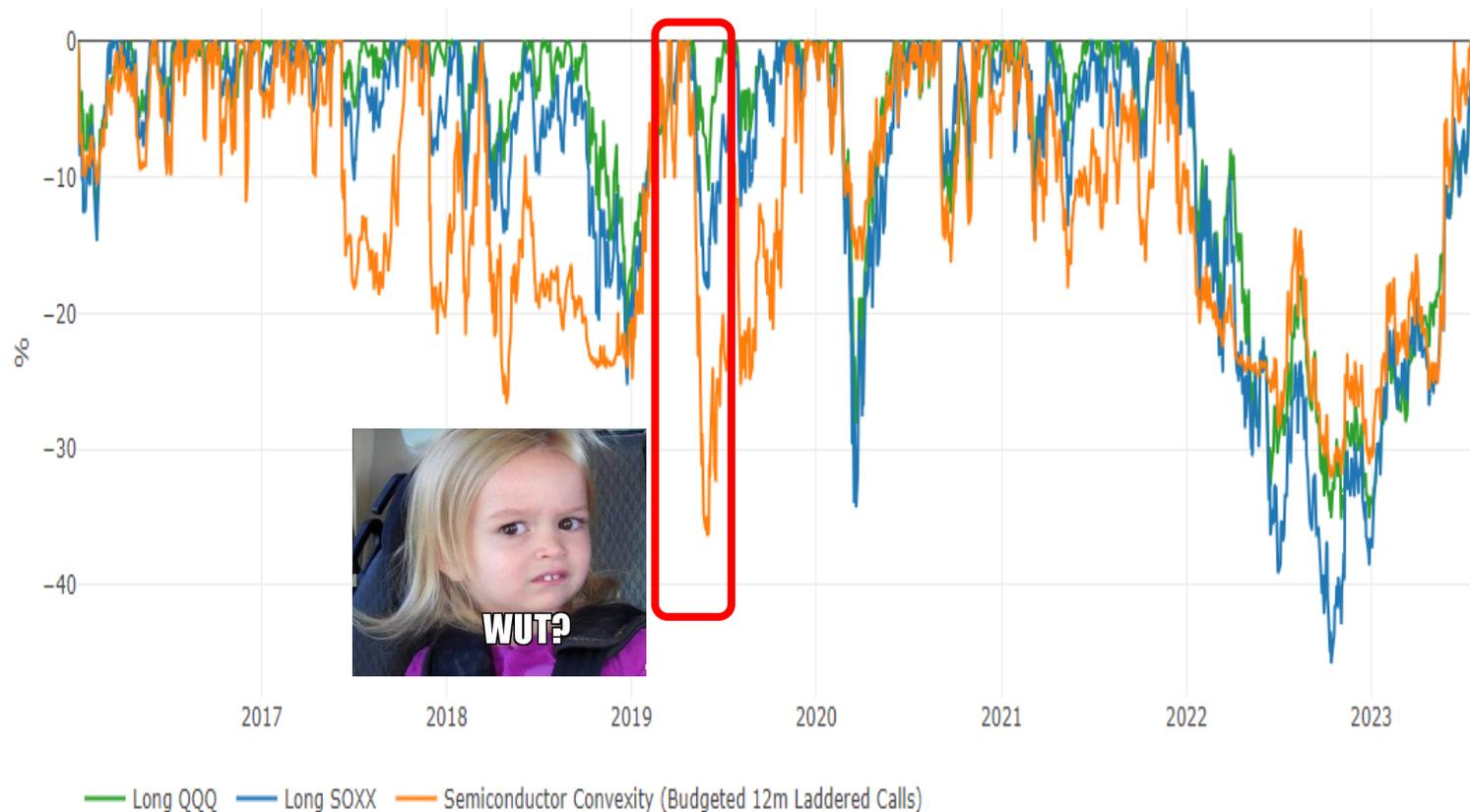


Semiconductors (Semis)

Structured Options Exposure

Late 2018 – Early 2019: Semi Index rallies 50% (April 2019)

May-June 2019 – Semi Index falls 20% quickly



Thesis:

Want long exposure to Semi sector via long options.

Alternative: Long Index proxy (via ETF = linear).

Why 2019?

Mega trend 2.0 (late 2019) best exemplified by NVDA.

Issues:

Index (& components) lower with volatility compression.

- Double whammy for upside convexity structure.



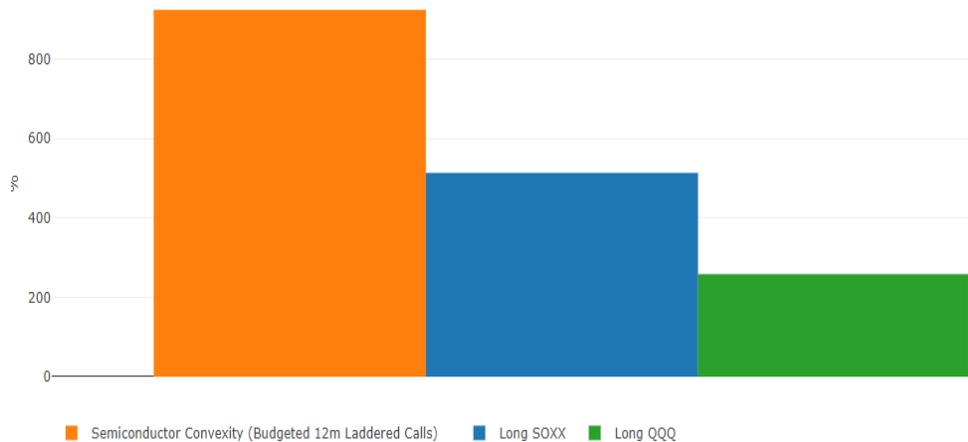
Source: Volos Software

Semiconductors (Semis)

More Risk Metrics

- Understanding the WHY!
 - Convexity strategy exhibits both higher & lower 30D vol depending on direction/macros.
 - Informed construction of option-based strategies may help avoid emotional exits

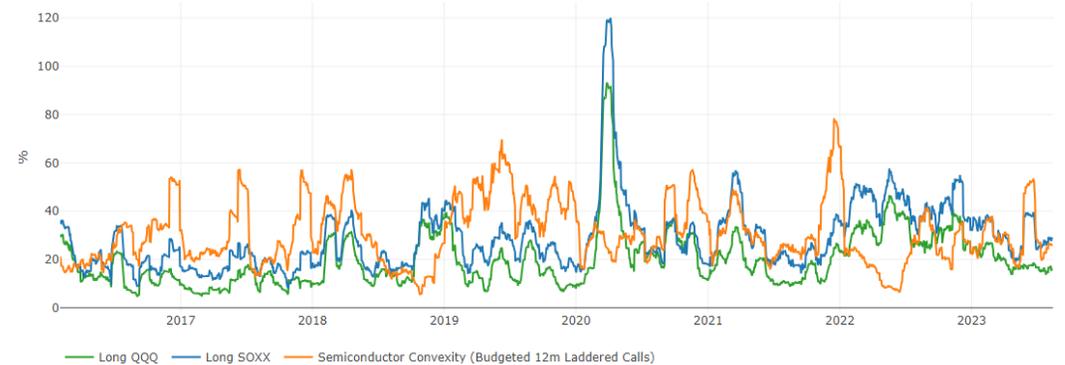
Cumulative Returns



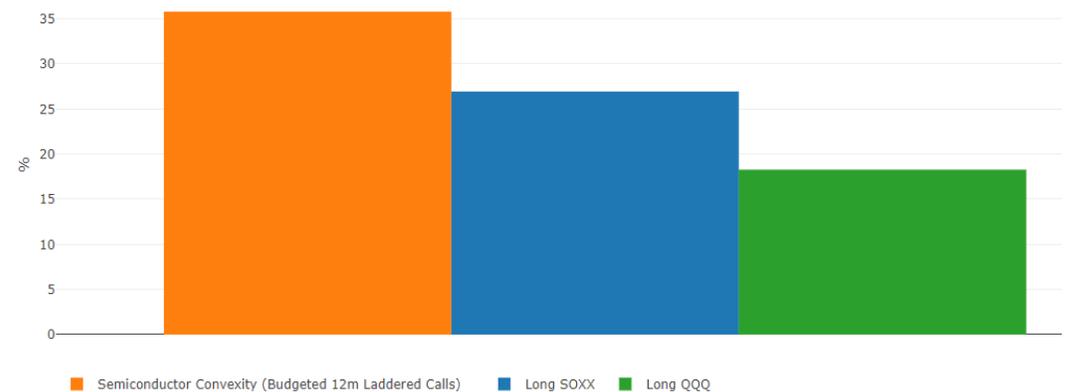
Correlation



30 Day Volatility



Annual Returns



Risk Management – Have a PLAN!

- Semis: From niche to necessary
 - Semis are engrained in nearly every corner of the global economy
 - PHLX SOX Index tracks semi designer/distribution + manufacturing/sale
- Plan Carefully
 - Options provide flexibility whereas long outright exposure is more rigid
 - Options have unique risks which need to be understood

