



## Research Paper

# The Outlook of the Automobile and Semiconductor Industry

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### Abstract:

Within all industries, the two that are undergoing the most radical and revolutionary transformation are the automobile and semiconductors. Propelled by the advent of electric vehicles (EV) and powerful artificial intelligence(AI) machines like ChatGPT, these two economically sensitive industries are plastering the news headlines as they write an additional chapter of technological innovation after the one in the early 2000s. As EVs and semiconductors are infiltrating society at levels once inconceivable, the automobile and semiconductor sectors are and will continue to lie at the forefront of technological advancements.

This paper outlines the outlook of the automobile and semiconductor sectors through evaluations of the Fed and the two sectors' macroeconomic conditions, technological innovations, and performance in the stock market.



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### Introduction:

Carrying the torch of innovation iPhones of Apple Inc. and the internet brought in the 2000s, EVs have introduced zero-carbon-emission driving, autonomous driving, and semiconductors have made generative AI machines accessible. More than anything, EVs and semiconductors will orchestrate the lifestyle of human civilization. These scintillating changes compelled me to examine the business structure, influential macroeconomic variables, and technological advancements in the automobile and semiconductor sectors.

The automobile industry shifted its focus from oil-fueled vehicles to electric ones equipped with elementary-leveled autonomous driving features in the last 20 years. Though most automakers heavily depend on internal combustion engine (ICE) vehicles, they anchored their vision and future business plans to EVs. Tesla. Inc. and BYD Auto Co., Ltd., as the two leading players in the automobile industry, have been fiercely competitive to dominate the EV market. Along with the transformatively changing automobile sector is the semiconductor industry with a global race toward more intricate manufacturing processes and chips that offer faster computation. The most glaring rivalry has formed between Samsung Electronics Co., Ltd., Taiwan Semiconductor Manufacturing Company Limited(TSMC), and Intel Corporation as they desperately attempt to secure their market share with their advanced products.

While observations of the macroeconomic environment and technical developments specific to the automobile and semiconductors are vital, we cannot synthesize the most accurate outlook of automobile and semiconductor sectors without analyses of the Federal Reserve System(Fed), the central bank of the United States, since the Fed dictates the flow of capital throughout the world. Thus, the paper opens with thorough examinations of the Fed's history, characteristics, and recent monetary policies. Carrying on with analyses of the Fed, the paper discusses the automobile and semiconductor sectors' macroeconomic variables,



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technological improvements, and trends in the stock market. Then, the paper evaluates the competitiveness of the two leading players in the automobile sector and of the three key companies in the semiconductor industry. By analyzing the Fed's monetary policies, macroeconomic variables, and technological advancements, this paper examines why the two sectors will grow at the most rapid pace for the next decade and identifies optimal investment opportunities within them. I hope readers will be able to acquire insights into the sources of the explosive growth of the automobile and semiconductor industries and discover companies that will represent these two most promising sectors the world has to offer.

## **Methods:**

### **The Fed:**

Covid-19 foretold no signal for its unexpected appearance and is continuing to linger on our planet, taking the lives of thousands. Along with all the tragedies the virus brought, lockdowns were detrimental enough to confiscate hundreds of billion dollars worth of revenue from the semiconductor and automobile industries. The ungraspable spread of the virus forced Southeast Asian countries, like Malaysia and Singapore, to enforce lockdowns. Shutdowns in factories in Southeast Asian countries are deathly because they are major suppliers of semiconductors. Take STMicroelectronics, a French-Italian semiconductor producer, for example. Technology reporters for Bloomberg L.P. Yoolim Lee and Yantoultra Ngui publicized that the semiconductor company was not able to supply chips to world-leading customers of semiconductors such as Apple and Tesla. Cars are big consumers of semiconductors – each car can require up to 3,000 chips (Lee & Ngui).

Average inflation targeting was an unprecedented path the Fed took to explicitly demonstrate its supportive stance on the stock market in 2020. But, prior to touching upon the original policy, a



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supplementary recap of the history of how the Fed transformed from an inflation fighter to a deflation fighter is critical. As President Richard Nixon terminated the gold standard in 1971, a policy in which an ounce of gold was fixed to a price of 35 dollars, the United States began to print dollars as much as it desired. Naturally, inflation soared because of the abrupt injection of cash into the economy. The fearful inflation was aggravated as the Organization of the Petroleum Exporting Countries drastically tightened oil production. Oil prices skyrocketed and fueled dreary inflation. From that point on, the Fed had solidified its identity as a world-leading inflation fighter. The formulation of the new identity was characterized by former Fed Chairman Paul Volcker's aggressive rate hikes. Bolker countered the ever-growing inflation by raising the federal fund rate to 20% in 1981. But, according to Kun Young Oh, the Deputy General Manager of Shinhan Bank Co., Ltd., deflation and its subsequent consequences transformed the Fed to progressively transition away from inflation and switch its main opponent to deflation (Oh 261). The Japanese real estate bubble, a traumatizing and indelible event that created devastating stagflation, and the global financial crisis of 2008 led the Fed to prioritize combating inflation with a novel tool: QE.

On top of an incomprehensible-sized QE, the Fed adopted a policy named "average inflation targeting" in 2020. Average inflation targeting signifies that the Fed does not retrieve liquidity until the average inflation rates of the recent four years meet the eye line of the Fed's standard 2% inflation rate. Throughout the past few years, specifically from 2017 through 2019, inflation rates of the United States came short of the standard 2% rate by 0.5%. These numbers have successfully convinced the stock market that the Fed will always stay on the right side and support it with liquidity. The stock market experienced a minor correction intermittently, which ranged from a 3 to 5% drop since March 2020, but it did not encounter a major one until November 2021.

However, since March 2022, the Fed has again turned into an avid inflation fighter. Stretching from its quantitative tightening(QT) after the 7.6 trillion dollars quantitative easing, which had taken place over



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the course of the past two years since the outbreak of the coronavirus pandemic, the Fed has rapidly raised the federal funds rate from 0% to 0.25% range to the current 5% to 5.25% in range in a mere year, one of the briskest paces in history.

As demonstrated by Jeanna Smialek, an economy reporter for the American daily newspaper New York Times, Jerome Powell, the head of the Fed, did not directly hint at implementing its tightening measures as he stressed the importance of the Fed in remaining “humble and nimble” (Smialek). Many different interpretations have been proposed, but one can approach Powell’s comments by focusing on the Fed’s capricious comments on rate hikes. The underpinning intention behind the Fed’s inconsistency lies in the Fed’s effort to alert people with precedence and observe the market’s reaction before determining the number of rate hikes. As the stark taper tantrum in 2014 reprimanded the Fed, the Fed’s “goal is never to surprise people,” remarked Claudia Sahm, the director of macroeconomic research for the Jain Family Institute and a former Fed economist (Sahm).

The current inflation will remain durable until factories resume their operation and the global supply chain shortage gets mitigated or tackled. The Fed will also continue to implement liquidity-tightening policies as long as the economic conditions are healthy and inflation readings such as Consumer Price Index(CPI) and Personal Consumption Expenditures Price Index(PCE) remain high. Since January 2022, the United States unemployment rate never climbed above the 4.0% mark, a symbolic number that signifies the employment market is as healthy as it used to be prior to the outbreak of coronavirus. Economy reporters for the Bloomberg L.P Olivia Rockeman and Read Pickert inform that Powell trusts the current employment rate is robust enough for the economy to accommodate QT or other forms of policies that retrieve liquidity, “Most FOMC participants agree that labor market conditions are consistent with maximum employment in the sense of the highest level of employment that is consistent with price stability” (Rockeman and Pickert).



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Consistently sliding from their 6% peak, both the CPI and PCE have cooled to the 4% range.

According to Investing.com, one of the three most-used financial platforms in the world, the core CPI and core PCE, which excludes fluctuations in the volatile food and energy sectors, have also declined from their respective 6.6% peak in October 2022 and 5.4% peak in March 2022. But they still remain distant from the Fed's 2% inflation targeting as their latest readings measured 5.3% in June 2023 and 4.7% in May 2023 because the sharp retreat in the global oil price led to the decline of CPI and PCE (Investing.com). In other words, prices of nearly all other economic variables that measure inflation are steadfastly high. While the Fed signaled additional two increases in the federal funds rate within 2023 in their latest June 2023 FOMC meeting, core CPI and core PCE hold the baton for the pace of future Fed rate hikes. Until these two inflation metrics hold on, the Fed will maintain its hawkish stance and continue raising interest rates in 2024.

## Automobile:

The automobile industry is a cyclical business, meaning that its sales heavily fluctuate according to economic conditions. People decide to purchase automobiles when their financial status is adequate enough to provide confidence or room to reach out for consumer discretionary products. Consumer discretionaries pertains to peripheral products people seek to buy when they possess sustainable income. The value of the vast majority of consumer discretionaries sways according to variations of consumer preferences and qualities of products. Since income status determines the level of demand for automobiles, employment and interest rate changes are critical to automotive players. Specifically, low-interest rates and high employment rates stimulate spending whereas high-interest rates and poor employment cut it.

Automakers of a couple of years ago were manufacturing companies. They believed that the more cars produced, the more profit they gained—mass manufacturing was the overarching theme of the automobile producers. But, the conventional business structure centered on mass manufacturing of gasoline and diesel



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cars has two limitations for survival: the rapid alternation in customer trends and global advancement to cope with climate change.

Moving away from ordinary cars that require a driver and are not communicable with other vehicles, consumers now demand cars with autonomous driving and 5G technology. The integration of the two features into the automobile sector creates synergies beyond efficiency. One key benefit is the unity of devices. Cars these days are not capable of exchanging signals or codes—each device is on its own. However, interconnected devices and the formation of a communication web open space for autonomous driving and 5G technologies to shine. Advanced driver-assistance systems(ADAS) are one of many autonomous driving technologies that follow the development of communicative cars. Autonomous driving technology is divided into six stages of completion, and ADAS belongs to the second level. Vipin Kukkala, a Ph.D. student in the Electrical and Computer Engineering Department at Colorado State University, and others reveal that ADAS technology enhances drivers' safety by alerting surrounding objects to the driver and maintaining a safe distance and speed of the car (Vipin et al.). Taking a step further, the harmony between Vehicle to Everything(V2X) technology and ADAS advances drivers' safety and efficiency by another level. V2X technology communicates with vehicles, and infrastructure, like bridges, roads, and pedestrians at 5G speeds. This method of communication is similar to how people communicate through phones and tablets.

The global movement to generalize green-field vehicles in response to daily aggravating climate change is another impediment to traditional Original Equipment Manufacturers (OEM). OEMs that possess their own electric vehicle(EV) platform and actively create joint ventures with other companies will thrive, but those that do not take a flexible approach to the fast-changing industry will not. As Ankit Jain, a former Director of Engineering at Google LLC and the founder and Chief Executive Officer of Infinitus Systems, Inc., unveils, governments across the planet are placing regulations and making fearless investments to minimize carbon emissions from automobiles (Jain). A bold example comes from the McKinsey Company



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which informs that the Italian government has played a crucial figure in leading bike shops to run out of stock by providing subsidies/bonuses worth 500 euros. In addition, the Massachusetts Institute of Technology demonstrates that China has required Chinese automakers to raise the percentage of EVs in proportion to their total production to 40% by 2030. Since regulations to make OEMs transition to EVs have been and will stay omnipresent, OEMs will make daring investments to expand production for green energy vehicles.

ICE vehicles no longer sit on the throne of the automobile industry: EVs do. Automobiles powered by self-driving technology and green energy will drive the automobile industry's uncontested growth rate by replacing outdated ICE cars.

The causes of the elongated correction in the automobile sector had been inflation and semiconductor supply chain disruptions. The recent tumble of the equities of Tesla, Inc. corroborated the devastating impact of the broken semiconductor supply chain on the automobile sector. Throughout November and December 2021, the world-dominating electric automobile producer again boasted its fast-growing production rate and cheered the investors by hinting to them at two million vehicle sales for 2022. According to Yahoo! Finance, a financial news and data provider, Tesla's stock soared up to the 52-week-high of 414.497 dollars for a share in October 2021, and joined the one trillion dollar market capitalization alongside Apple Inc., Amazon.com, Inc., Microsoft Corporation, and Alphabet Inc. But, as concerns for the decline in car sales led by forecasts of persisting semiconductor shortages marred the bright outlook of Tesla, the company's publicized shares steadily dropped to 101.81 dollars per share in January 2023 (Yahoo! Finance).

However, the opening gate for success in the automobile industry is no longer the recovery of the on-time semiconductor supply and demand cycle but individual fundamentals. Rebounding more than 60% from its 52-week low, Tesla's strong fundamentals and its supercharger partnership with General Motors(GM) and





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Ford Motor Company, assured its investors that it is capable of establishing Tesla's charger ecosystem as the standard of the current sporadically-located, expensive, and slow EV charging systems. Tesla's deal with these two competitors in the EV market holds promising implications. Michael Wayland, a reporter for CNBC, illustrates that, in supplying 12,000 Tesla superchargers to GM and Ford users, Tesla will fascinate GM and Ford consumers with its fastest charging devices that fuel cars 200 miles in 15 minutes, an incomparably higher efficiency compared to 41 miles charging in 10 minutes with DC fast charger and 100 miles charging in 12 minutes with the identical charger (Wayland). Enticed by the top efficiency of Tesla chargers, the GM and Ford users will actively transform into Tesla buyers, and such a trend will occur for other EV makers as Tesla boasts its superior technology in EVs and its correlated services.

Even though the automobile industry contains significant growth potential, investors need to take prudent considerations prior to opening investment positions in the sector. When an industry enters into a new stage of development that overturns the old structure, new players also step into the game field and pursue a shared goal to acquire market share in heated competition. Unfortunately, the competitive nature dampens investor sentiment because the ambition to achieve an identical object inevitably lowers the chance for all companies to take a solid share of the industry. In a transition to a new industrial phase, companies that possess superexcellence – technologies that grant a limited number of companies ascendancy from the new-born, emerging players—become the leaders and occupy a solid share of the industry's market.



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### **Semiconductors:**

Throughout history, the semiconductor sector has experienced a series of upswings and downswings within intervals of two years or shorter—it is also cyclical like the automobile industry. A customary cycle of the price of semiconductors commences as demand for semiconductor chips strengthens. The popularity of the chips hands the chip producers a higher level of profit, which is reflected by the robust return of their publicized stock shares. Then, the surging popularity of chips draws the chip producers to expand their production line to accommodate the demand. The trigger for the solid upbound for chip usage is the emergence of innovative services that ask for greater quantities and more compact chips. However, as nothing can last perpetually, the extension of production lines condones the supply to override the demand. Semiconductor consumers, in this case referring to companies with their products or services powered by semiconductors, do not feel the necessity in sweeping the chips in urgency – consumers form a consensus to gather semiconductors with all their will when they believe the competition to possess the chips becomes evident. Their interest in stockpiling the chips from the producers revives when the quantity of the chips in the inventory shrinks and acknowledges the urge in purchasing the chips before other competing companies take possession of them. Such a phenomenon is provisional and a distinct characteristic of cyclical industries. But, while macroeconomic factors are still influential, as the following examination will confirm, cutting-edge technology is the genuine game-changer for the semiconductor industry.

Since Intel released its central processing unit(CPU) manufactured in the 14-nanometer manufacturing process with its fin field-effect transistor(FinFET) in 2012, the company has not shown a system semiconductor that requires a more advanced dynamic random-access memory(DRAM) to go along, which has laid a huge obstacle in improvements of speed in DRAM. But, how does Intel's stationary stance towards the development of their CPUs or systems semiconductors connect to a long delay of upgrades in the speed of DRAM? Intel is undeniably the largest and most influential supplier of system semiconductors,



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especially CPUs of personal computers and corporate servers. Intel's processors have permeated deep enough that people likely use them almost daily; they are omnipresent. Intel's customers include Microsoft Corporation; Amazon.com, Inc.; and Dell. However, nearly a decade of time has passed since Intel launched its CPU processed under a 14-nanometer manufacturing technology. 10 years was sufficient time to nullify Moore's law, which states the number of transistors in integrated circuits doubles every two years. Engineers and researchers appraise Intel's new project "Sapphire Rapids" to mark the end of the dark tunnel. Sapphire Rapids represents Intel's new processor manufactured in a 10-nanometer SuperFin process based on the Embedded Multi-Die Interconnect Bridge technique. The processor integrates four silicon chips that embrace internal circuits and form a shape of a monolithic chip. Companies have loved monolithic design in the past because of its simplicity and fast data transmission speed, but as demands for small-sized chips with smaller nodes override the past trend, the production yield of monolithic design chips has decreased simultaneously. The alternative to the monolithic structure is the microservice design, which separates dies into independent units. However, as demonstrated by Dr. Ian Cutress, the Senior Writer for Anandtech.com, the structure of Sapphire Rapids proved that Intel did not follow the long-held preference (Cutress). Through Sapphire Rapids, Intel took advantage of both the strengths of the monolithic and microservice applications. An assembly of dies on an interposer opened more space to spread information and reduce the chances of latency caused by leakage current. The memorable advancement in the structure of Intel's processors will stimulate the current DRAMs to step up and become equipped with faster data transportation speed, opening a new stage for DDR5s. A DDR5 ram will deliver data with a maximum speed of 7.2 billion bits per second (Gbps), a number nearly as two times that of a DDR4 with a maximum rate of 3.2 billion bits per second. Prospects of DDR5 ram are bright as experts expect supercomputers, enterprise servers, and data centers to act as pioneers for drawing demand for the cutting-edge rams.



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The current burden for the semiconductor sector in the stock market is the disruption in the supply chain as a product of shutdowns in factories of semiconductor producers across the world. The White House pinpoints the unanticipated eruption in demand for personal electronic products as the fundamental cause of the chip shortage and claims that the impact of the issue has spread to suppression of automobile sales and communication service productions (The White House).

On top of this, inflation and rate hikes have debilitated investment sentiment for the semiconductor sector as the stock market categorizes it into a tech industry. Sectors with technological development as their main profit source are vulnerable and do not make desired returns during inflation because the rising bond rates can damage their profitability. However, even cautious perspectives toward the semiconductor sector during inflation and rising interest rates cannot penetrate into the fundamentals of the industry and efface its shining title: the frontline industry of the Fourth industrial revolution. Economic circumstances and monetary policies do not stop companies from expanding production lines. The essence of the minuscule chips smaller than human blood cells has been spotlighted more brightly than ever as the demands for AI machines and green energy automobiles have surged. The global world is seeking semiconductors with its neck out.

Drawing a parallel to the automobile industry, the state of investor sentiment for the semiconductor sector was primarily linked to the supply chain repairment and movements of the long-term bond yields—short-term bonds are bonds that expire in less than three years. Enter the emergence of ChatGPT. Rendering the macroeconomic variables negligible, the introduction of ChatGPT shed light on the overlooked potential of semiconductors. ChatGPT not only enlightened people that AI was an indispensable tool for humans but also prompted the production of advanced chips to accommodate the development of AI machines.

Notably, hardware chips, like GPU, have received the most spotlight from this shocking event. As AI systems require tremendously faster computation and data transmission for their servers, hardware chips must undergo radical development to support the servers. The global attention on AI systems and GPU



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advancements has excited Nvidia Corporation and Advanced Micro Devices, Inc(AMD). Nvidia has developed the A-100 general purpose graphics processing unit(GPGPU) and AMD launched MI300X GPGPU in their heated competition to become the leading chip maker for AI generators. The two players' investment in AI chip development sequentially has tightened the global chip manufacturers such as Samsung and TSMC more than ever. Data from Yahoo! Finance shows that, with the backdrop of skyrocketing demand for AI chip production and more sophisticated manufacturing process skill, Nvidia has shot up to 422.09 dollars per share from its 52-week low of 108.13, AMD to 110.01 dollars a share from its 52-week low of 54.57 dollars, Samsung to 72,400 Korean Won from its 52-week low of 51,800 won, and TSMC to 101.91 dollars a share from its 52-week low of 59.43 dollars as of June 26, 2023 (Yahoo! Finance). Amid the new stage of semiconductor advancement, the players with chips that are capable of supporting AI machines and will propel further AI development will dominate the semiconductor.



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### Conclusion:

The Fed has shifted numerous times in the past from a deflation fighter to an inflation fighter. However, since the onset of the 2008 Financial Crisis, the Fed has responded to economic turmoils with QE. As the Fed repeatedly treasures the powerful monetary policy as the quickest and most surefire catalyst for an economic rebound, the Fed will continue to inject newly-created liquidity into the economy in future economic crises. Even if the Fed were to retrieve the money it printed, the automobile and semiconductor industries will have sufficiently absorbed the supplied liquidity to not only produce more sales but respond efficiently to the Fed's tightening measures, just like they are now. Ultimately, the Fed will act as a tailwind for the two industries' growth.

The cyclical nature of the automobile and semiconductor sectors will cause several fluctuations every year. Still, it will be negligible in tainting the long-term growth of the two sectors since technological improvements will be the deciding variable in the outlook of the automobile and semiconductor players, not the macroeconomic environment.

Autonomous driving systems and chips to accommodate AI machines will mutually drive the growth of the automobile and semiconductor industry. The development of autonomous driving technology will empower the vehicles to communicate with the surrounding infrastructure to ensure the utmost safety of the passengers and allow the drivers to be completely hands-off from driving. Such an advancement requires enhanced semiconductors that support the integration of AI tools capable of deep learning and mass data collection of proximate infrastructure through cameras installed on vehicles. Inevitably, global chip producers have and will invest their utmost capital and time in making chips for AI tools, symbiotically securing an unmatched level of growth in the automobile and semiconductor sectors.

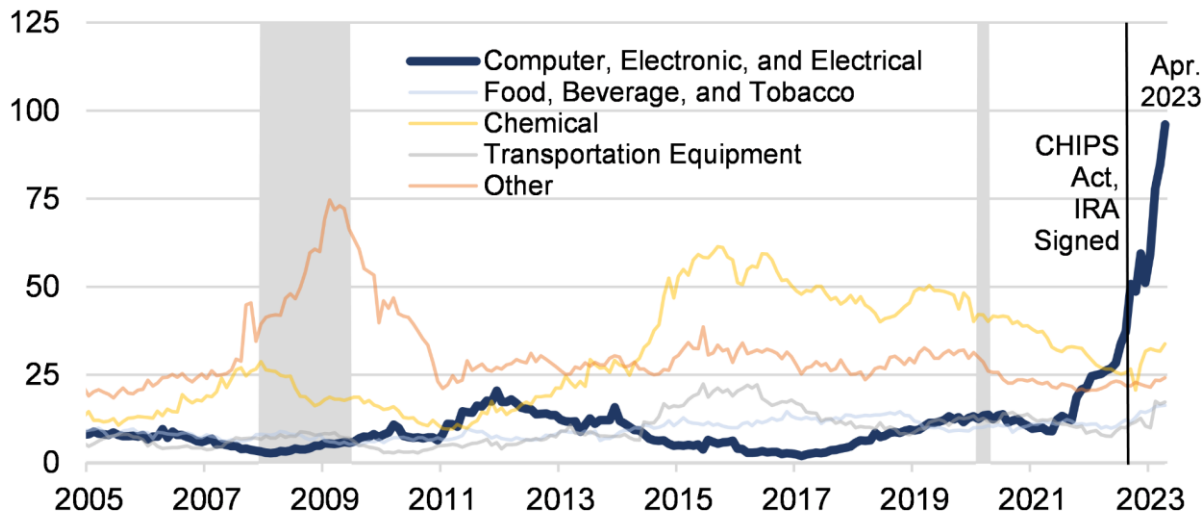


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Furthermore, the United States government has intensively focused its investment on semiconductors and EVs. The manufacturing construction spending data from the Department of the Treasury(USDT) transparently shows that Washington channeled 100 billion dollars as of 2023 into “computer, electronic, and electrical,” a number comparably bigger than that for other categories like “chemical” and “transportation equipment” (the Department of the Treasury).

### Figure 2: Real Manufacturing Construction Spending by Type

Billions of 2022 U.S. Dollars



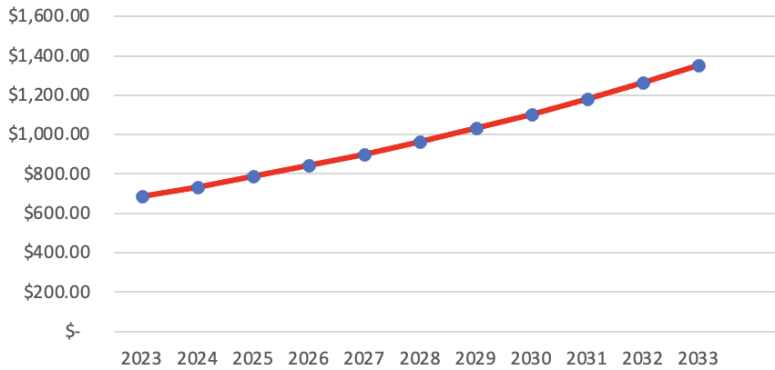
Notes: Value of Private Construction Put in Place for Manufacturing, U.S. Census Bureau, decomposed by Detailed Type. Monthly at a seasonally adjusted, annualized rate. Nominal spending deflated by the Producer Price Index for Intermediate Demand Materials and Components for Construction, Bureau of Labor Statistics.

This figure does transparently show that the United States acknowledges semiconductors and EVs as the two most promising investment subjects for the years to come. With exclusive support from Washington, the semiconductor and automobile industry will exhibit a compound annual growth rate(CAGR) of 9% and 15% respectively for the coming decade.

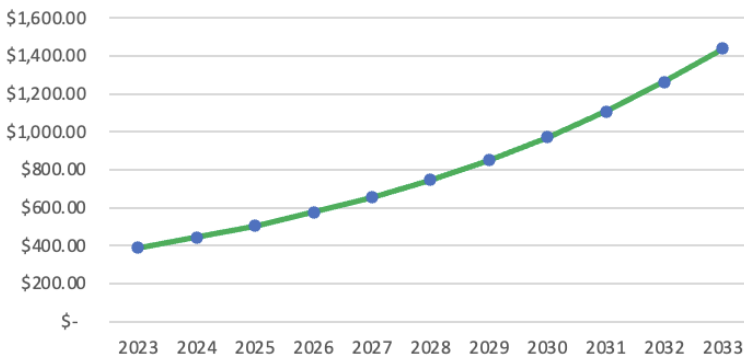


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### Semiconductor Market Capital Trend for the Next Decade - USD Billions



### EV Market Capital Trend for the Next Decade - USD Billions



The new phase of the automobile market has just commenced as the generalization of EVs armed with automated driving and cutting-edge mobile communication systems that require incorporations of advanced semiconductor chips dethrones the two hundred-year-era of ICE cars. This transformation entails the replacement of the leader in the automobile industry: the commencement of the era of Tesla Inc. Guided by Elon Musk's scintillating leadership and aspiring vision, Tesla has steadily built the foundation to develop into an invincible player in the novel automobile industry. Through persistent research and data collection, Tesla rapidly rose to and cemented its title as the *number one* in the automobile sector in the past decade. Armed with the combination of plentiful liquidity supplied to the economy by the Fed, the accelerated





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advancement of semiconductor chips for automation and ever-faster calculation speeds, and, most importantly, the mass production system that supports an annual production of millions of automobiles, which no other automaker in the industry possesses(except for BYD) Tesla stock will gain as much as the dazzling 100,000 % return Apple Inc. made from its inception date in the next three decades. In the emerging EV market, Tesla does face competition from BYD, which surpassed Tesla's annual production in 2022. However, Tesla's higher revenue, higher free cash flow, more diversified pool of investors, and unquestionably more advanced automated driving technology than those of BYD empower Tesla to garner funds from the global asset market more efficiently, reflecting Tesla stock's supreme growth potential. Surpassing BYD, whose primary investors strictly consist of Chinese institutions, Tesla will take advantage of the support from its diversified network of investors across the globe(notably the United States, the United Kingdom, and the Netherlands) to not only record the most number of EV sales but also dominate the cost-efficient and safe lithium iron phosphate batteries(LFP) market, solidifying its premier status in the EV market.

Meanwhile, Samsung and TSMC have been entangled in a searing battle to take first place in the foundry business. Intel and Samsung are integrated device manufacturers(IDM), companies that both design and manufacture semiconductors whereas TSMC is a foundry, a company that only offers manufacturing. While Intel has lost a critical amount of share in both due to its lagged advancements in the manufacturing process(Intel's most advanced manufacturing process is still 7nm), Samsung and TSMC have already acquired 4nm manufacturing process skills(TSMC even possesses 2nm technology).

In terms of foundry business, TSMC currently holds an absolute command. The runner-up Samsung is far behind in both manufacturing process technology, the number of customers, and the number of manufacturing facilities. However, that does not guarantee eternal superiority for TSMC. Not only has the geopolitical tension between mainland China and Taiwan risks TSMC's autonomy in its business, but also



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TSMC's major customers such as Nvidia, have lost their trust in TSMC because it has impartially prioritized fulfilling Apple's orders while delaying those of others. Furthermore, it is only a matter of time before Samsung's manufacturing process technology levels with that of TSMC—Samsung has begun to mass produce 3nm chips last year, under the groundbreaking Gate-All-Around(GAA) technology which boosts transistor efficiency and computation speeds by an astounding margin than those of conventional chips.

Aside from its astounding growth potential in the foundry business, Samsung solidly maintained to serve as the largest producer of DRAM and NAND flash memory. Samsung will continue to be the leading chip maker in the world by solidifying its top-tier technology in memory chip production and maturing in its foundry business, persistently challenging the longevity of TSMC's supremacy.

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