INTERNATIONAL SEVEN JOURNAL
OF MULTIDISCIPLINARY
ISSN: 2764-9547

Conflict between the United States and China over semiconductors

Conflito entre Estados Unidos e China na relação dos semicondutores

10.56238/isevmjv3n1-010
Receipt of originals: 01/02/2024
Publication Acceptance: 02/19/2024

Giulia Bessa de Oliveira[1], Islania Manuela da Silva Anjos[2], João Almeida Santos[3].

ABSTRACT

The world has gone through several transformations throughout its existence, revolutions were turning points and changed history, one of the great revolutions in the world was the so-called Industrial Revolution, which brought to the world the creation of a new technology that changed the way society lives, acts and thinks. Even today, in the 21st century, we live with the effects of this revolution, because it has never stopped evolving and changing. According to some scholars, we are currently living in the so-called Industrial Revolution 4.0, with extensive studies of artificial intelligence and robotics, the use of these items has become increasingly indispensable for human beings, but many of them make use of another technology: a small "chip" called a semiconductor. The semiconductor is a material used in electrical circuits and components that partially conduct electricity, it is usually composed of silicon or germanium, it is present in computers, smartphones, appliances and other technological equipment such as microwaves. Due to its great importance in the world of technology, the semiconductor has become the target of dispute by the two great world powers, the United States and China, which seek to maintain a monopoly in the research and manufacture of these chips. This article seeks to discuss the use of semiconductors in society and their relationship in the geopolitical conflict between the United States and China. For elaboration and development, the qualitative and descriptive research method was applied, where through literature on the subject several political, economic and social aspects were analyzed.

Keywords: Semiconductors, United States, China, Technology.

INTRODUCTION

Discoveries in various fields have transformed the life of human beings and the world in general. Discoveries in the field of technology and information change the way society thinks and acts. The Industrial Revolution started in 1790 is considered one of the key moments of humanity, the human being began to have contact with steam engines, putting aside agriculture and starting the industrial age. At the beginning of the seventeenth and nineteenth centuries

[1] FATEC East Zone
Email: giulia.oliveira2@fatec.sp.gov.br
[2] FATEC East Zone
Email: islania.anjos@fatec.sp.gov.br
[3] FATEC East Zone
Email: joao.santos256@fatec.sp.gov.br

machines worked with the help of human beings and were not completely autonomous, however they produced on a large scale and as society expanded and evolved, consumerism also increased, making industries look for new ways to produce on a larger scale and faster. Cheap and practical. This situation led to the improvement of machines through the use of technology (HOBSBAWM, 1962)

In order to have an understanding of what technology is and how it relates to society Veraszton, Silva, Miranda and Simon (2009) define that "[...] Technology encompasses an organized and systematized set of different scientific, empirical, and intuitive knowledge. Thus, it enables the constant reconstruction of the space of human relationships."

Thus, technology contributes to the relationship between the human being and the environment in which he lives, in such a way that, in possession of knowledge and technological discoveries, man is able to modify the environment in which he lives.

It is this knowledge and changes that have transformed humanity over the centuries. Passing through electronic media such as computers and cell phones, digital media with the World Wide Web and up to the present moment in the 21st century with the advancement of Artificial Intelligence.

Society is currently experiencing what is called Industry 4.0, processes that have a technology aimed at the highest automation and a high level of intelligence in machines, the contact of human beings with technology has never been as close as it is now. According to Pereira and Simonetto (2018, p.8), Industry 4.0:

> It is a revolution in manufacturing processes, based, among other technologies, on Cyber-Physical Systems and the Internet of Things. CPS are equipment with the ability to integrate your physical body into the virtual world, with the ability to represent your state from the collection of information in real time, and make autonomous decisions. (PEREIRA; SIMONETTO, 2018, p.8)

In order for Industry 4.0 to take place, increasingly complex and indispensable instruments have been created in the manufacture of electronic products, such as semiconductors, which have as raw material the chemical elements Silicon (S) and Germanium (Ge). Semiconductors are fundamental parts in the manufacturing process of computers, cell phones, cars, refrigerators, robots, airplanes and several other items that surround our daily lives.

That said, the article will try to analyze the trade conflict between the United States and China, which intensifies due to semiconductors, we will discuss how this imminent "Conflict between the United States and China in relation to Semiconductors" will reflect on the world

and on Brazil.

The rivalry between the United States and China has been well known for many years. Its moments of tension precede the nineteenth century, however it is in the twentieth century that the tension between the countries begins to take shape. After World War II, in 1949 Mao Zedong came to power, a communist leader supported by the former Soviet Union, in the same period the United States at the head of capitalism, declared support for the Chinese nationalists who had lost the war against the Chinese Communist Party, placing them on opposite sides in the political-economic sphere. Over the years, the Cold War between the Soviet Union, present-day Russia, and the United States intensified. In 1960, China broke off relations with the USSR, an attitude that brought the United States and China closer together. U.S. President Richard Nixon paid a visit to the Asian country in 1972, and one of the agendas at the time was the Taipei Agreement, an agreement made between Taiwan and the U.S. country in 1954, which sought to ensure the territorial security of the Asian island (DEPARTMENT OF STATE PUBLICATION 6446, 2008).

The dispute over Taiwan's sovereignty is what generates the impasse between the countries, while China considers the small island as part of its territory. With the end of the Cold War in 1991, the United States consolidated itself as the hegemonic country in the political, military and economic spheres. At the same time, the countries of East and Southeast Asia were developing and achieving economic growth. (VIEIRA, 2013)

THEORETICAL BACKGROUND

Based on current technology and the relationship it has in geopolitical conflicts, the article presented aims to explain and analyze the use of semiconductors in the manufacture of new technologies, and expose the conflict between the United States and China in search of maintaining a monopoly in the manufacture of these "chips". The focus is on the world's largest semiconductor manufacturer: Taiwan, a country that has been the subject of dispute between these nations for many decades. Therefore, a study was carried out using books, articles and academic theses focused on research in areas such as Technology, History, Geopolitics and International Relations.

The study of the historical relations between the United States and China is important for us to understand the source of this dispute that initially dates back to the twentieth century and extends throughout the current twenty-first century, where these two great nations have consolidated themselves as sovereigns in both the political and economic scenarios. The theme

regarding this conflicting relationship has been worked by several authors from different areas of knowledge and it is based on these studies that this work will be based to argue the issues addressed here.

SEMICONDUCTORS

A semiconductor is a material used in electrical circuits and components that partially conduct electricity, usually composed of silicon, which conducts more electricity than an insulator, such as glass, but less than a pure conductor, such as copper or aluminum. Its conductivity and other properties can be altered by introducing impurities, called doping, to meet the specific needs of the electronic component in which it resides. Semiconductor devices can exhibit a variety of useful properties, such as showing variable resistance, passing current more easily in one direction than the other, and reacting to light and heat. Actual functionality includes signal amplification, switching, and power conversion (AWATI, 2022).

Also known as chips, semiconductors can be found in thousands of products, such as computers, smartphones, gadgets, gaming hardware, and medical equipment. The semiconductor industry revolves for one reason, and that is to make it smaller, faster, and cheaper. The benefit of being tiny is because of the amount of "power" that can be put into the chip.

The more transistors on a chip, the faster it can do its job. Transistors are three-terminal electronic devices that can act as a switch or an amplifier, their behavior can be controlled by the voltage applied to their terminals. A transistor works by controlling the flow of electrons through a semiconductor material such as silicon and carbon molecules. According to Gordon Moore (1998), the number of transistors and resistors on a chip doubles every 24 months and the number of transistors on an integrated circuit doubles in about 18 months. Moore's law causes a wide competition in the industry and with that new technologies will reduce the cost of production per chip.

Semiconductors come in two main types based on the elements that are included alongside the silicon, a process known as doping. "Impurities" are introduced into crystalline silicon to alter the properties of the finished semiconductor:

- Type N contains one or more impurities based on pentavalent atoms such as phosphorus, arsenic, antimony, and bismuth.
- P-type has dopants with five electrons in their valence shell. Phosphorus is commonly used for this purpose, as well as arsenic or antimony.

USE IN INDUSTRY

The semiconductor industry is an extremely important sector for the United States, China and the world's economies, with semiconductor components found in a vast array of consumer and trade products. Therefore, they find widespread use in almost all industries and the companies that manufacture and test them, for this reason they are considered excellent indicators of the health of the overall economy (SEGAL, 2023).

The extensive use of semiconductors in a wide range of end-use applications, such as electronics, industrial equipment, automotive, networking and communications, and data processing, is the major factor driving the growth of the global semiconductor market.

The increasing penetration of digital technologies and the increasing adoption of various consumer electronics across the globe promote the growth of the semiconductor market. In addition, the rise in popularity of the latest technologies, such as artificial intelligence, which allow memory chips to process a huge volume of data in less time, are stimulating the demand for semiconductors. (SPRINGS; NOWAK, 2021)

The evolution of the Internet of Things (IoT) is observed to bring technological advancement in the global semiconductor market. The increasing demand for connected devices and smart appliances drives the need for semiconductor solutions (EVANS, 2011). Additionally, artificial intelligence and machine learning applications require more powerful processors and specialized chips, leading to opportunities for semiconductor companies worldwide. Another impacted sector is healthcare, which can be seen as its reliance on advanced technologies for medical imaging, monitoring, and diagnostics increases. (NIKHAL, 2023). All of these elements open up a set of opportunities for the semiconductor market to grow.

The semiconductor industry relies heavily on a global supply chain, with components and raw materials often sourced from different countries such as the Netherlands, Japan, and Brazil. Any disruptions in transportation, logistics, and production in one region can cause delays and shortages, affecting the entire market. Semiconductor manufacturing requires several essential components, such as rare metals and advanced materials. If the supply of these components is disrupted, it can lead to production delays and higher costs.

The recent COVID-19 pandemic, which has shown how vulnerable the semiconductor industry is, has resulted in supply chain disruptions such as factory closures, labor shortages, and supply chain restrictions have impacted creating a disruption not only in the semiconductor industry but in all industrial sectors. However, this shortage will be filled due to increasing

investments by market players such as the United States and China to expand production facilities, and to reduce the gap between the demand and the supply of semiconductors. In addition, due to the pandemic, there has been a rapid growth in the work-from-home trend worldwide, significantly promoting the demand for laptops, personal computers, and smartphones, which has resulted in the need for a significant amount of semiconductors worldwide (OCHONOGOR; OSHO; ANOKA; OJUMU, 2023).

Another factor is the growth in demand for semiconductors in the industrial equipment sector that have contributed significantly to the increase in semiconductor consumption. Another sector that has been driving this increase is the automobile industry, with the popularity of electric vehicles and their gradual adoption among consumers is fueling the global semiconductor market. And the demand for integrated circuits in developing countries will further drive the semiconductor market (JIRAVACHARA; SANGMANACHAROEN, 2022)

Substantial support from governments in the semiconductor market can positively influence the market by improving the ecosystem, promoting technological advancements, and ensuring a more robust and sustainable industry. This support can perform several functions such as the Canadian Government, which in March 2023 announced $36 million in investments for the Ottawa-based Ranovus Inc industry.

Canadian Minister of Innovation, Science and Industry François-Philippe Champagne in a press release in March 2023 stated that semiconductors are part of everyday life. They're in cell phones, cars, and gadgets. He claimed that through this investment, he is supporting innovative Canadians, helping to create good jobs, intellectual properties and developing the semiconductor industry in Canada and thereby building a more resilient economy. It stated that Canada will continue to play a leading role in the rapidly growing semiconductor industry, helping to strengthen and protect the North American supply chain

The development of smaller, cheaper, faster, and more powerful chip designs requires companies competing in the production of these chips to invest substantially in research and development to achieve cutting-edge technology and efficient results.

Semiconductors can be divided into four categories, namely, microprocessors, wafer or as also known slice, integrated circuits and system-on-a-chip. The main player in semiconductor manufacturing is the company TSMC - Taiwan Semiconductor Manufacturing Co. Ltd., founded by Morris Chang almost forty years ago (1987) is one of the largest companies established in Tawian, specializing in the category of integrated circuits and wafer.

TSMC's chips are used in personal computers and peripheral products, information

applications, wired and wireless communications system products, automotive and industrial equipment, including consumer electronics such as digital video compact disc reader, digital television, game consoles, and digital cameras. TSMC is the main supplier to US tech giants such as Apple Inc., Intel Corporation, Qualcomm Inc, as well as Chinese companies such as Huawei Technologies.

The Asia-Pacific region dominated the global semiconductor market in 2022, in terms of revenue. And this happened on account of TSMC which alone obtained 2,263,891,292 net revenue. The company has supplied its products to 532 customers, implemented 288 distinct process technologies, and produced 12,698 each for a different application (TSMC ANNUAL REPORT, 2022).

Reuters reported in May 2023 that TSMC is building two factories in Arizona, USA, the first is planned to start its wafer production in 2024, which is the first step towards building semiconductors. And the second for 2026, the impact generated with these two factories in the United States will be on who will buy their products, TSMC customer companies such as Intel Corporation and Qualcomm are located in the state and other consumers are located in neighboring states (NELLIS; SHEPARDSON, 2020). According to Arizona Governor Doug Ducey, the company chose the state because of its "unbeatable business climate, already thriving technology sector, and ready access to an international supply chain."

UNITED STATES AND CHINA

To understand the dispute between the United States and China for the semiconductor monopoly, it is important to understand why these two countries seek this raw material. As seen earlier, semiconductors are essential artifacts for the manufacture of technologies such as cell phones, cars, computers and even weapons, of such an important character these items become essential for industrialized countries, among the prominent countries are China and the United States that maintain a dispute for not only technological sovereignty, but also economic and political. According to Jackson and Sorensen (2013), the concept of sovereignty is linked to the independence of a country, but not in terms of isolation, but rather the freedom it has in relation to the external environment, since it unites nations is important for the country's insertion in the international market. It is from this sovereignty that the United States and China seek, internal independence and control of the international market.

However, this dispute comes from a historical past of these countries that throughout their development entered opposite sides in terms of political management, but reached an

economic and geopolitical level that equalized them and started several confrontations.

Before being called the center of industrial production in the world and categorized as the second richest country in the world, China experienced several changes from its Antiquity until the so-called Chinese Revolution in 1949, led by the political revolutionary Mao Tse-Tung, from that moment on the country became what we know today as the People's Republic of China, a communist country (ANDRADE, 2017).

While China was experiencing its own internal political conflicts, on the other side of the Pacific Ocean the United States was experiencing the effects of the post-World War II period, as a way to circumvent an economic depression and avoid a communist expansion, the United States began the Marshall Plan where there was funding for the reconstruction of Western Europe and Japan. thus creating an export market that moved its economy internally and placed the country in a leading position externally (WERNER; COMBAT, 2023).

In addition to the internal and external impacts for the post-World War II countries, it also culminated in the emergence of the Cold War that began in 1947, where the world was divided into two distinct regimes, capitalism on the "Western" side with the United States as the main representative and communism on the "Eastern" side with the Union of Soviet Socialist Republics as leader. The "Iron Curtain", a term used to define the division between capitalist and communist countries, was one of the points of high tension during the war, because each country sought to defend its interests and avoid loss of territory (HOBSBAWM, 1994).

Within this scenario, China was seen as a country of complex positioning, both by the Americans and by the then Soviets, because, despite having a communist regime and having the Soviet Union as an ally, the relationship between these two countries was shaken over the years, ideological differences, rivalry for leadership and dispute for territory, These were some of the aspects that influenced the rupture between these two countries. (GOULART; SILVA, 2018).

On the other hand, the United States already has a conflicting history with China, because during the Chinese Revolution the opponent of Mao Tse-Tung and opponent of communism, the leader Chiang Kai-Shek, received support from the Americans to suppress the communist rise in China, but strikes and agitations by Chinese citizens and the interference of the People's Liberation Army caused the overthrow of Kai-Shek, who fled to the island of Taiwan with the The Chinese bourgeoisie and the support of the United States (ANDRADE, 2017), from this moment on, Taiwan emerges as a country of capitalist domination with American support, but which has Chinese roots and becomes a role of dispute between both

countries to this day. The dynamic between these three countries and China's rise on the international stage began with the end of the Cold War in the 1990s, and then created a dynamic in Southeast Asia. According to Pinto (2005):

> The end of the Cold War in the 1990s had a profound and unprecedented impact on Southeast Asia. The region then began to experience its own dynamics, with adjustments in relations between the countries of the area, as well as between them and external powers. (PINTO, 2005)

It is in this complex environment that, with internal improvement and expansion in the Asian region, China develops economically and reaches a superpower position, starting the dispute with the United States for world influence.

According to data from Tranding Economics, in September 2023, one of the sectors with the highest level of growth in China was the electrical machinery and equipment industry (11.5%) (CHINA INDUSTRIAL PRODUCTION apud NATIONAL BUREAU OF STATISTICS OF CHINA, 2023), while in the United States about 78% of production is concentrated in the manufacturing sector. Analyzing this data, it is possible to understand why the dispute between these two nations for the dominance of semiconductors, both are responsible both indirectly and directly for the manufacture of products in the world, and many of these products have semiconductors as a material (UNITED STATES INDUSTRIAL PRODUCTION, 2023)

As a way to lead this race and stay ahead in semiconductor manufacturing, then-President of the United States Joe Biden signed in August 2022 the federal CHIPS and Science Act, which proposes to fund companies in nationwide research for semiconductor manufacturing (H.R.7178 - CHIPS FOR AMERICA ACT).

The law however also puts in check the relationship of companies with China, in March 2023 the US Department of Commerce released rules that propose a "national protection and security" agreement where the same companies that were financed by the United States are prohibited for 10 years from engaging in research or expanding their production capacity to countries such as Iran, Russia, North Korea and China

The Chinese as the main competitors for the sovereignty of semiconductors saw the law as an exaggerated response of the United States for the monopoly of Chips, in response the spokesperson of the Mystery of Commerce, Shu Jueting questioned the law since it does not follow the rules imposed by the WTO - World Trade Organization and stated that China had implemented measures to safeguard its rights (MINISTRY COMMERCE OF THE PEOPLE'S REPUBLIC OF CHINA, 2022)

MATERIALS AND METHODS

For the elaboration of this article, the qualitative and descriptive research method was applied, where through literature on the subject were analyzed the various political, economic and social aspects in relation to the United States and China.

In order to gather information for the legitimacy of the article, bibliographic research was carried out in order to collect data related to semiconductor technology and what it generates around the discussion.

The purpose of this study was to analyze through authors, concepts and research what will result from this "technological race" of semiconductors between China and the United States.

OUTCOME OF THE DISCUSSION

This article sought to discuss the creation and use of semiconductors in society, an indispensable item for everyone, so that it is linked to practically all technological objects that we have in hand, therefore, it is an item disputed by the great powers while all seek to maintain their technological sovereignty, in view of this the geopolitical conflict between the two great nations today the United States and China comes into focus.

Investigating the historical relationship between the United States and China is indispensable to understanding the beginning of this dispute. This theme has been studied by several authors from different areas of knowledge and the studies carried out were used to develop and anchor this article.

In addition to the problem involving the research and trade of semiconductors, the conflict between the United States and China is even greater when it comes to the scope of Taiwan, the island located off the southwest coast of China lives and is recognized as a country by other major nations, but China considers the region as part of its territory and, as seen before, these issues refer to a historical past of the Chinese Revolution. this disagreement remains to this day without a solution but is becoming greater and greater (AMARAL, 2023).

The conflict is further aggravated as the Taiwanese nation has become a major economic hub in technology manufacturing, the largest semiconductor factory in the world, TSMC - *Taiwan Semiconductor Manufacturing Co., Ltd*. is headquartered in the country. Both countries seek not only the sovereignty of the region but also the technology it provides, and this conflict could have consequences not only for Taiwan but also for the rest of the world. In a column for USP radio, Professor Alberto do Amaral (2023) states:

> [...] the possibility of a conflict between China and the United States because of what the Chinese Government considers to be the wrong policy, that is, a policy that supports Taiwan. This is an absolutely fundamental issue, which can interfere with the destinies of Asia and the destinies of the world and can have catastrophic consequences for all of us. (AMARAL, 2023)

According to Gordon Moore (1965) the number of transistors and resistors on a chip would double every 24 months and the number of transistors on an integrated circuit would double every 18 months, it is possible to observe that Moore's law has materialized and continues to happen, but with the advancement of technology and the race for domination of this sector this period will decrease, In the future, we will see this and other technologies with a different look, since, in a way, since its discovery until the present moment, society has undergone several changes that have changed its way of thinking and acting.

CONCLUSION

Technology and the Artificial Intelligence that arises as a result of it has already come to dominate the life of society in the 21st century, there are several discussions about the limits of technology and how far it can go, however, what few know is that for all these "gears" to work it is necessary to use small chips, the semiconductors responsible for commanding all the electronic devices we know today, Seen by many as the "gold" of the 21st century, semiconductors have become the target of dispute between the two great world powers, the United States and China, which seek to maintain their sovereignty in the face of research and manufacture of this technology. It was by observing this conflict that we based our study on the relationship of semiconductors in the geopolitical conflict between the United States and China.

From the data presented we conclude that the conflict between countries will depend on the circumstances in which the world is, taking into account the large amount of changes that humanity has gone through over the last few centuries we can expect a society divided in a bipolar way with the United States and China defending their interests, conflicts such as the Ukraine War and what is happening between Israel and Hamas already demonstrate this conflict of In addition, other factors such as sanctions imposed against China and the sanctions that are also imposed against the United States could lead these countries in different directions.

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