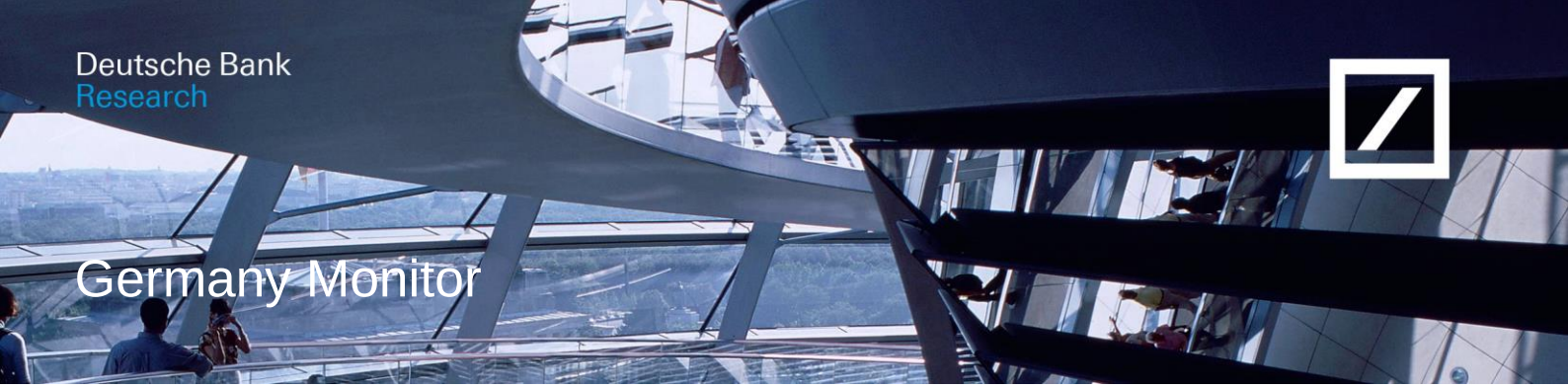

Semiconductors or petroleum – which is traded most?

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Authors
Hermann-P. Rapp
+49 69 910-43893
hermann-paul.rapp@db.com

Jochen Möbert
+49 69 910-31727
jochen.moebert@db.com

Editor
Stefan Schneider

Deutsche Bank AG
Deutsche Bank Research
Frankfurt am Main
Germany
E-mail: marketing.dbr@db.com
Fax: +49 69 910-31877

www.dbresearch.com

DB Research Management
Stefan Schneider

In our research note on global trade in semiconductors and trade chain complexity we report three important findings:

Our new Trade Chain Complexity Index (TCC Index) allows for a comparison of the ratio of global trade with sales of various goods. For semiconductors, the TCC Index shows a peak of 7.2 for 2008. Since then, the complexity value has steadily decreased with a value of 5.9 for 2020. This trend might be the first sign of more cautious supply chain strategies in a challenging macro environment – and a downward trend for semiconductor globalization in a new era of digital sovereignty.

Semiconductors rank first as the most traded goods in global trade statistics in 2020, representing 15% of total global trade in goods. Before 2015, they were surpassed by computers and crude oil, based on the HS4 categorization by the World Customs Organization (WCO).

Prices for semiconductors have fallen dramatically and steadily since 1995, both in real and nominal terms.

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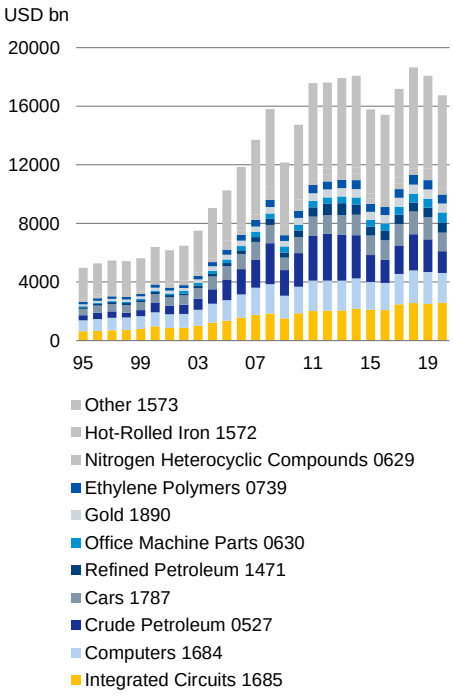
Semiconductors are essential for digital

Today, living a digital lifestyle means that we are surrounded by electronic devices. Semiconductors – as the miniaturized brains of digitalization – are hidden in most products and are key components of digital infrastructures. Rising geopolitical frictions mean that the utmost strategic importance of integrated circuit (IC) chips is emphasized by governments around the world. Digital sovereignty has become a political imperative and increasing the resilience of supply chains is now also a priority at the company level.

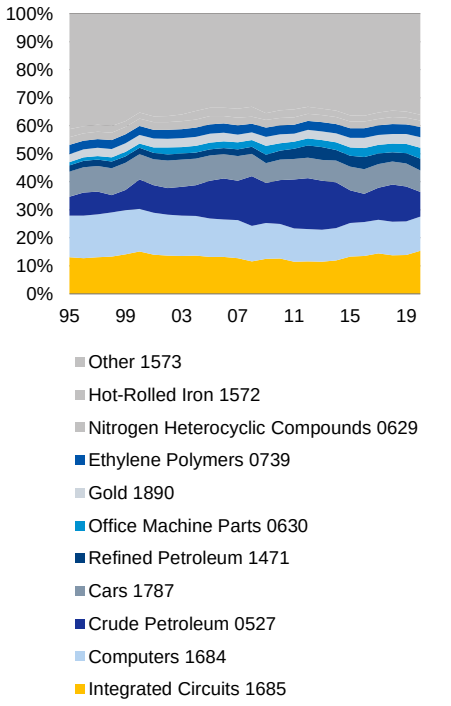
In this article – based on data from OEC – we focus on global trade. It is not widely known that semiconductors are among the most traded goods in world trade. Before 2015, they were surpassed only by computers and crude oil. Based on the latest available statistics, semiconductors held the top rank among the most traded goods from 2015 to 2020; their share in global goods trade rose from 13% to 15%. Computers followed in second place with 12% and crude petroleum third with 9%. In 2020, the absolute global values were almost USD 2.6 tr for traded semiconductors and USD 17.4 tr for goods trade in total.

Global trade by goods 1



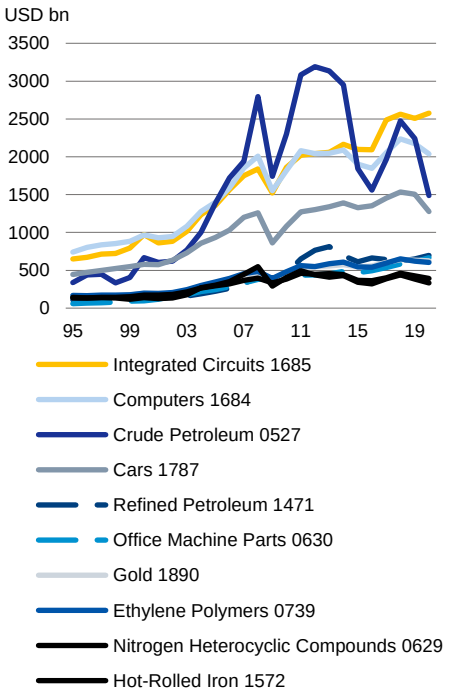
Sources: OEC, Deutsche Bank Research

Global trade by goods 2



Sources: OEC, Deutsche Bank Research

Top 10 of the most traded goods 3



No. of goods category is HS4-Code
Sources: OEC. Deutsche Bank Research

Semiconductor prices have fallen dramatically – both in nominal and real terms

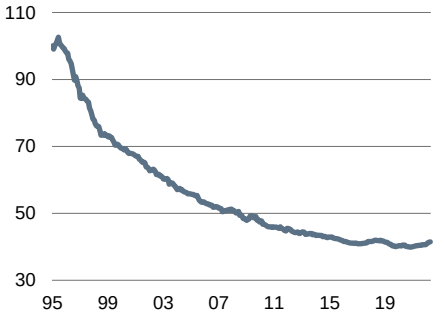
A characteristic that underpins the role of semiconductors for global trade is that their price has dramatically fallen over the last decades. US import and export prices in the sector, which we use as a very good proxy for global trade prices for semiconductors, have shrunk almost steadily since January 1995 and are now around 60% below their level at that time. If quality improvements are taken into account, the price drop is certainly even higher. Most other goods have likely become significantly more expensive over the same period. For example,

today, crude oil prices are roughly six times higher than in 1995. Hence, adjusted for inflation, the rise of semiconductors is even more significant than in nominal terms.

Global supply chains: The TCC Index as a new complexity metric

Price index for semiconductors 4

January 1, 1995 = 100



Based on average of US export und import prices

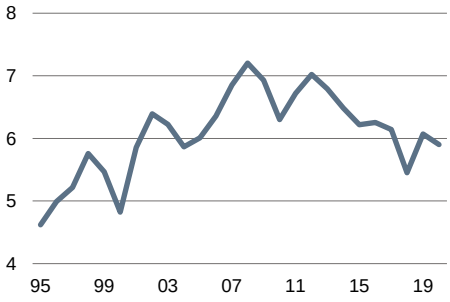
Sources: Deutsche Bank Research, Haver Analytics Inc.

Our focus on world trade can contribute a high-level view putting figures for trade and sales in relation – and computing a straightforward Trade Chain Complexity Index (TCC) for semiconductors.

Our findings show that for 2020, the number of semiconductors traded was almost six times higher than sales[1]. For 2020, OEC data for trade in semiconductors amounted to USD 2.6 tr while sales reached USD 437 bn. This means that semiconductors are imported and exported several times before they are integrated into finished products. An exemplary trade chain for customized semiconductor logistics for the automobile industry could involve a production country such as Taiwan, two Asian countries where semiconductors are assembled, tested and packaged, and then shipped via a European airport to an automotive supplier in Central Europe, until they are finally integrated into a car as the final product. The trade chains of most other goods are less complex. In comparison, for crude petroleum the ratio is only about 1.2, and roughly 0.7 in the automobile sector. The high TCC value for semiconductors is facilitated by the low transportation cost of semiconductors, especially compared to many commodities and manufactured products that are bigger in size and weight. The high TCC ratio in the chip industry is also a result of supply chains trimmed for efficiency and companies located at the most efficient sites. In the semiconductor industry, these are typically locations where various suppliers and fabs are clustered, sometimes even in the same industrial park. This effect can also be observed in the assembling, packaging, and testing stage.

TCC Index: Trade-to-Sales 5

dimensionless



Sources: OEC, Deutsche Bank Research, WSTS

High efficiency and cost effectiveness are features of all chip types (logic, analog, memory, optoelectronics, discrete semiconductors, optoelectronics and sensors). Due to the complexity of the production process, any changes or reorganizations are costly and complex. So, any plans of reshoring or nearshoring might be much more challenging in practice.

When looking at the time period of 1995 to 2020, two phases regarding the complexity of semiconductor supply chains can be distinguished. First, during the years until the financial crisis 2007/08 trade in semiconductors increased up to a peak of 7.2 times of sales. Since the second peak with seven times higher trade than sales in 2012, the TCC Index is steadily decreasing with a value of 5.9 for 2020. We assume that this downward trend reflects the increasing concentration in the semiconductor industry.

Outlook: Many headwinds – but also important tailwinds

The semiconductor industry faces a barrage of challenges which will have an impact on global trade. First, the tech trade war threatens to separate the global semiconductor markets into US- and Chinese-dominated spheres. In October 2022, the announcement of US export controls for semiconductors once again signaled that geopolitical tensions will remain high for the foreseeable future.

Secondly, the pandemic caused supply shortages – which brought to light the vulnerabilities of existing supply chains – that are still ongoing. Increasing the resilience of supply chains by aligning regional production and consumption is high on the agenda of many business leaders and politically incentivized. We

[1] For 2020, OEC data for trade in semiconductor amounted to USD 2.6 tr while sales reached USD 437 bn.

think the headwinds for global trade will mainly unfold in the medium- to long-run as more defensive strategies with a high priority of supply chain resilience are to be implemented.

Thirdly, government initiatives emphasizing digital sovereignty and incentives for reshoring or nearshoring point in the same direction. These developments will potentially impact negatively on global trade in semiconductors and lead to trade diversion or even partial deglobalization where semiconductors would be produced increasingly only for domestic products and infrastructures.

The positive side is that various government initiatives will increase the global production capabilities of semiconductors with the construction of new semiconductor manufacturing sites. Presumably, even more important is the structural demand boost driven by the ongoing digitalization of almost all industry sectors. The chip industry with its huge creative potential is developing innovations with regard to new chip designs, smaller chip size and new architectures and materials. Over the whole history of the semiconductor industry, new products with more computing power came steadily on the market and stimulated demand. This structural trend is here to stay. In many sectors digitalization may also help to reduce the environmental and carbon footprint and may also reduce the resource consumption. So, the increasing importance of ESG is likely to increase the demand for semiconductors, too.

In sum, the positive developments should boost global trade and overcompensate the negative effects. This implies that the TCC Index is likely to remain high. We have calculated that global goods trade in semiconductors in 2021 exceeded USD 3.0 tr, which would mean a plus of roughly 15% relative to 2020. It implies that chips were again the most traded goods worldwide. In 2022, crude petroleum has likely taken first place due to the oil price shock. However, this should be only a snapshot. Over the decade, substitution effects should reduce the importance for crude petroleum for global trade and we have clearly outlined that the huge demand for digitalization, new products and higher supply capacities will stimulate trade in semiconductors. We expect that semiconductors will regain the top rank in global trade statistics in the coming years.

Hermann P. Rapp (+49 69 910-43893, hermann-paul.rapp@db.com)
Jochen Möbert (+49 69 910-31727, jochen.moebert@db.com)

Appendix 1: Classification of goods in World Trade Statistics

In this article, we have analyzed current developments in world trade. For this analysis, we used the product classification of the Harmonized System (HS) of the World Customs Union (WCO 2022), The HS plays a central role in international world trade systems to document international trade between the approximately 200 WCO member countries since its introduction in 1988.

The HS is divided by sections, which are further subdivided into chapters and subchapters. Semiconductors and integrated circuits are listed in Section XVI in Chapter 85[2]. The HS defines semiconductors or semiconductors as electronic circuits that form the core of electronic devices and digital infrastructures as a whole.

[2] Note 12 (b) (iv) to Chapter 85 (WCO, 2022)

Appendix 2: HS classification for semiconductors and integrated circuits

Trade data are coded based on the four-digit HS4 product codes that are grouped into sections and chapters.

HS classification for semiconductors and integrated circuits 6

Section XVI	Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
Chapter 85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
8541 Semiconductor devices	E.g. diodes, transistors, semiconductor-based transducers; photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules or made up into panels (excl. photovoltaic generators); light emitting diodes "LED", whether or not assembled with other light-emitting diodes "LED"; mounted piezoelectric crystals; parts thereof
8542 Integrated Circuits	Electronic integrated circuits; parts thereof

Source: WCO (2022)

Besides semiconductor devices and integrated circuits there are three other categories for consumer electronics:

HS classification for consumer electronics 7

8471 Computers	Automatic data-processing machines, and units thereof. It covers computers commonly found at home or in offices which include standard operating systems, software and storage, such as laptops, desktops and tablets. The heading also includes separately presented items such as keyboards and a mouse.
	Many products that perform a specific function other than data processing are excluded from heading 8471*. Although they have a microprocessor onboard or work in conjunction with a computer, they are labelled according to their specific function, for example:
	- Printers and copiers (heading 8443)
	- Cameras (heading 8525)
	- Monitors and projectors (heading 8528)
	- Communication apparatus (heading 8517)
	- Loudspeakers and microphones (heading 8518)
8517 Telephones	Telephone sets, including smartphones and other telephones for cellular networks or for other wireless networks; other apparatus for the transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network).
8528 Television Sets	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus; video monitors and video projectors.

* https://www.gov.uk/guidance/classifying-computers-and-software

Source: WCO (2022)

The HS classification is updated annually to reflect the state of the art and consequently new products in global trade. One example is the Internet of Things (IoT) with devices such as semiconductor-based sensors and actuators. Another example is the inclusion of multi-integrated circuits (MCOs) in Chapter 85.Note 12 (b) (iv) to Chapter 85 (WCO, 2022) MCOs are semiconductor devices that combine integrated circuits and discrete components in a single package fabricated with semiconductor technology.

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