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Value Chain Analysis in the Semiconductor Industry

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List of Abbreviations

CAS	Czech Academy of Sciences
CNSC	Czech National Semiconductor Cluster
CSC	Czech Semiconductor Centre
CSO	Czech Statistical Office
CTU	Czech Technical University in Prague
EU	European Union
EUR	Euro
FDI	Foreign direct investment
FEKT VUT	Faculty of Electrical Engineering and Communication, Brno University of Technology
GPN	Global Production Networks
GVC	Global Value Chains
HW	Hardware
IoT	Internet of Things
NCCU	National Chengchi University
NRIS3	National Research and Innovation Strategy
RIS3	Research and Innovation Strategy for Smart Specialisation
SCRC	Supply Chain Resilience Center
SW	Software
UHK	University of Hradec Kralove
UK	Charles University
UPOL	Palacký University Olomouc
USA	United States of America
USD	US Dollar
R&D	Research and Development
VŠ	Higher Education Institutions
VŠB	VSB — Technical University of Ostrava
VŠCHT	University of Chemical Technology in Prague
BUT	Brno University of Technology
ZČU	University of West Bohemia in Plzeň

Introduction

Semiconductors are a key technology of the 21st century, forming the basis of modern digital devices and information technologies. Without semiconductors, it would not be possible to manufacture mobile phones, computers, cars with electronic systems or complex industrial machinery. Their importance extends far beyond electronics and includes areas such as healthcare, energy, transport and defence. As a result, semiconductors are considered a strategic resource, the availability and control of which can fundamentally affect the economic and national security of individual states.

Czechia has a long history of semiconductor manufacturing and research, dating back to the socialist era, when the first electronic components were produced in domestic enterprises. Its industrial tradition, technical education and relatively low costs saw Czechoslovakia, and later Czechia, become an important centre for semiconductor manufacturing and development in Central and Eastern Europe. Companies such as Tesla, formerly state-owned enterprises, played a major role in this field and laid the foundations for the current development of the sector.

After the change in the political regime in 1989 and the subsequent transformation of the economy, the semiconductor industry in Czechia underwent major restructuring. A number of traditional companies disappeared or were privatised, but at the same time foreign investors entered the market and new, dynamic companies emerged to join global value chains. Czechia thus became an attractive location not only for manufacturing, but also for semiconductor development and innovation.

In the current global context, semiconductor manufacturing is concentrated in several regions, with the US, China, South Korea, Japan and Taiwan being the most prominent players. Europe, and in particular the European Union, is aware of its dependence on semiconductor imports from Asia and the US, which has prompted efforts to boost domestic production and research in this strategic field. In recent years, the European Union has adopted several initiatives aimed at boosting the competitiveness of the European semiconductor industry and reducing dependence on external suppliers.

In this context, Czechia is seen as an important player that can contribute to European efforts to strengthen the semiconductor industry. Thanks to their flexibility, innovation and long tradition in this sector, Czech semiconductor companies have the potential to play a key role in the development of the European semiconductor ecosystem. An analysis of the value chain of semiconductor companies in Czechia will therefore not only reveal the internal dynamics of this sector, but also provide valuable insights into its potential and opportunities for future development at both the national and European level.

Mapping the value chain of the semiconductor industry in Czechia is key to understanding how this strategic sector operates and what its main strengths and weaknesses are. Knowing the individual stages of the value chain — from raw materials and semiconductor chip manufacturing through assembly and testing to final distribution and innovation — makes it possible to better identify key players, sources of technological expertise, points of added value and critical points that can affect the entire system. This gives companies, government and investors a better understanding of where the biggest growth opportunities lie, where capacity needs to be strengthened and what areas require greater investment or support to increase competitiveness.

In addition, value-chain mapping provides valuable information for policyvmaking at both the national and European level. The Czech semiconductor industry is part of a broader global and European ecosystem in which dependence on external supply chains is very high. Identifying critical dependencies and risks associated with geopolitical influences or supply disruptions is essential for strategic planning and ensuring resilience. At the same time, mapping enables public investment in research and development to be targeted more effectively, supports innovation and increases technological self-sufficiency, which are all crucial for maintaining and strengthening Czechia's position in this highly competitive sector.

The importance of the semiconductor industry for Czechia is also underlined by the fact that it has been identified by the Czech government as one of the so-called strategic industries. The selection of these strategic industries was based on an assessment of economic opportunities and threats, taking into account the importance of each sector for Czechia. The decisive evaluation criterion was the sector's current significance in the economy and its multiplier effects on other sectors. Czechia has defined how it would like to make use of the potential of this sector in the National Semiconductor Strategy, approved in 2024.

For these reasons, it was decided that the value chain of semiconductor companies in Czechia should be mapped. The aim of this is to determine which manufacturing segments of the value chain are represented by companies in Czechia, how these companies are distributed across these segments, and where they concentrated. The basic output of the mapping is a database of semiconductor companies. The process also aims to analyse the strengths and weaknesses of the value chain in the semiconductor industry and to formulate recommendations for targeting support in this sector. Other entities were also involved in the mapping process and will benefit from the outcomes: The Supply Chain Resilience Center (SCRC), a collaboration between Charles University and National Chengchi University (NCCU) in Taiwan, which aims to research the resilience of semiconductor supply chains, and the Czech Semiconductor Centre (CSC), a national semiconductor competence centre. Last but not least, the outcomes will also be useful at the national RIS3 level (for the update of the NRIS3 Annex and for regional innovation centres that have included the semiconductor industry among the priority specialisation domains within the RIS3 Strategy).

Methodology

1. Introduction — the Nature of Production under the Conditions of Advanced Globalisation

Since the 1960s and 1970s, the organisation of production has undergone a profound transformation — the so-called vertical disintegration of production. This new production paradigm captures the trend whereby even large companies no longer manufacture an entire product on their own, but instead focus on their core activities, while the production of downstream systems and components is entrusted to suppliers of various types and tiers. In some cases, leading companies do not own any production capacity, as they only carry out research, development and branding, while the entire manufacturing process is provided by suppliers. This production model emerged simultaneously in several places (first documented in Japan and in the USA, Thoburn, Takashima, 1992) and quickly spread across economic sectors, as it made it possible to radically reduce production costs and thus, on the one hand, increase company profits (particularly those of leading companies at the top of the production chain), and, on the other, reduce prices for customers. This new production model, following the paradigm of the vertical disintegration of production, was first reflected by the theory of global commodity chains (GCC) from the 1990s onwards. This theory primarily examines the changing structure of foreign trade and the ways in which these chains are managed, initially distinguishing between producer-driven chains (typical of manufacturing industries such as automotive, aerospace and electrical engineering) and buyer-driven chains (for example final distributors with extensive retail or wholesale networks, such as Ahold, Tesco and Walmart). A more recent theory is that of global value chains (GVCs), which primarily explains the links between the nature of relationships between companies and their economic performance and competitiveness within these global metastructures. Building on the above is the theory of global production networks (GPNs), which provides a broader perspective including, among other things, analysis of and the role played by the institutional framework at the regional, national and international level, and identifies different modes of strategic coupling, i.e. the different ways in which companies from different regions are involved in the global division of labour (organic, functional and structural modes; Coe, 2021). This theory also explains the role of the main factors shaping the dynamics of global production networks and highlights the interconnection of the macro, meso and micro levels in a globalised world. These theories offer numerous practical implications for the design of support policies at the national and regional level (see, for example, Blažek and Steen, 2022).

Value chain analysis is fundamental to the design of any support policy, as it provides a detailed insight into the structure and functioning of an entire sector, making it possible to identify the key factors affecting competitiveness, opportunities and risks in a given sector. Production chain analysis helps reveal where and how value is added, which activities are most important for success, and where bottlenecks or potential risks are located. This analysis can improve coordination between the different links in the chain, from suppliers to final manufacturers. In addition, it provides companies, governments and investors with a picture of opportunities for innovation and development, which is essential for effective strategic decision-making and investment in the future. At the same time, it makes it possible to identify weak points or dependencies that can threaten the stability of the entire chain, which is particularly important in critical sectors such as the semiconductor industry.

Within global value chains (GVCs) and global production networks (GPNs), upgrading is a key imperative for the success of both companies and regions. Gereffi (2005) explains upgrading as a shift towards higher value-added activities in production, towards improved knowledge and skills, technologies and increased profits from participation in GPNs. Upgrading is essential not only to enable companies to improve their position and expand, but is also a prerequisite for their continued presence within these global structures. The most elaborated form is economic upgrading, i.e. changes leading to higher productivity and production efficiency. Economic upgrading should then — depending, among other things, on the quality of the institutional framework — also have a positive impact on the region and society as a whole through a higher share of retained value, which should enable further development not only of human resources but also, for example, infrastructure.

There are four main types of economic upgrading: product, process, functional and inter-sectoral (Humphrey & Schmitz, 2002).

Each type of upgrading has its specific benefits, but also its pitfalls. The most ambitious is functional upgrading, in which the supplier firm acquires a new function in the chain by expanding its business activities to include higher value-added activities such as research and development, design or marketing (Humphrey & Schmitz, 2002). In connection with the need to respond to major societal challenges such as climate change, circularity and geopolitical instability, inter-sectoral upgrading is also gaining importance, as these challenges are forcing companies and entire countries to reconsider which part of production needs to be secured in-house and which products or components can be imported, from where, with what risks and at what cost. There are two basic types of inter-sectoral upgrading. The first involves companies entering other production networks in order to diversify customers and, in many cases, production. The second type of cross-sectoral upgrading involves using know-how acquired through production and supply to global production networks to manufacture one's own product for the final market, where higher margins can be achieved than within the supply chain.

Existing research (Tokatli, 2013; Pavlínek & Ženka, 2011; Fijarek & Veloso, 2010) clearly shows that upgrading is a common process across industries and that the question is therefore not whether it is possible, but which type is appropriate for a given location, industry and specific company.

2. Methodological Procedure for the Survey of the Semiconductor Industry in Czechia

With an awareness of the nature of manufacturing as described above, which in the semiconductor industry is also among the most globalised of all sectors (Yeung, 2022), a methodological approach was applied that combines complementary quantitative and qualitative methods. Members of the Supply Chain Resilience Center at Charles University played a significant part in both parts of the analysis.

In the first step, a set of approximately 120 companies involved in the semiconductor industry in Czechia was compiled. Companies were selected for this set using a combination of several methods. First, they were selected on the basis of their knowledge of the industry and the market within CzechInvest; these were then supplemented by companies that are members of the Czech National Semiconductor Cluster (CNSC). Other companies were also added by regional innovation centres, which have more detailed mapping of companies in their respective regions. Last but not least, the mapping of the semiconductor industry also included companies identified in articles devoted to the semiconductor industry, as well as companies identified as suppliers or customers during interviews. Thus, in this case, the snowball method was used, a common method in qualitative research.

This was followed by semi-structured in-depth interviews, which became a crucial source of information on the opportunities, needs and risks faced by companies. The in-depth interviews were conducted in all regions between September 2024 and March 2025. The priority of all the interviewers involved was to visit key companies for which the semiconductor industry is either a dominant customer or supplier. By contrast, most companies in the sample are only partially engaged in activities that fall within the semiconductor industry. The interviews were conducted directly at the companies, most often with their top management (managing director, director, director of research and development).

The questionnaire (see Annex 1), which served as a basis for the interview questions, was developed in cooperation with CzechInvest, regional innovation centres, the Supply Chain Resilience Center (SCRC) at Charles University, the CNSC and FEKT BUT. Of the total set, forty-two companies were contacted. A total of 33 semi-structured interviews were conducted, all in person. The mapping involved around 10 people, mainly from CzechInvest and regional innovation centres. Two interviewers were present at some interviews, and in exceptional cases even more. During the interviews, two companies were found to be outside the semiconductor value chain and were therefore excluded from the dataset.

For each company, we also identified basic characteristics from open sources and databases, such as ownership, location, size, whether it carries out research and development, its specific product portfolio, and the sectors its products target, including specific customers. This step required, among other things, a detailed analysis of the websites of all 120 or so companies. The economic indicators for the individual companies were obtained in cooperation with SCRC from the Dun & Bradstreet database. Due to possible fluctuations in economic results associated, for example, with the Covid pandemic or the war in Ukraine, data were analysed over a six-year period (2018 to 2023), making it possible to monitor economic trends for different categories of companies. However, we consider the values for the last two years of the period under review, i.e. 2022 and 2023, to be the most important, mainly due to the waning of the Covid-19 pandemic and the rapid changes in the semiconductor industry.

In addition to basic indicators such as turnover and profitability, the calculation and subsequent interpretation of economic indicators also focused on retained value indicators, i.e. the level of staffing costs, depreciation and taxes paid. Retained value is considered more significant than created value in terms of impacts on the territory in question (Coe, 2021).

The financial health of companies was monitored using two commonly used indicators. The first is the *Cash to Debt Ratio*, which shows the extent to which a company is able to cover its debt using cash resources. The second indicator is the *Depreciation to Revenue Ratio*, which reflects how much of a company's revenue is spent on the renewal of fixed assets.

For the purpose of mapping the semiconductor manufacturing supply chain in Czechia, the value chain was divided into several manufacturing segments. Analysis of information from company websites was again used to classify the companies, and in the case of those that were visited, this was supplemented by information obtained during the interviews. The companies were first divided into two basic categories:

a) companies involved in the semiconductor value chain

b) users of the outputs from this chain

Subsequently, in collaboration with the CNSC and in line with the National Semiconductor Strategy, companies directly involved in the production chain were further divided into the following manufacturing segments:

- facilities (microelectronics production plants and buildings, including media distribution, waste and chemical management, cleanroom production, air conditioning, etc.),
- equipment (machines),
- advanced process control,
- chemicals and raw materials,
- parts and components,
- design (of chips),
- inspection and metrology,
- semiconductor wafer production,
- mask production,
- frontend manufacturing (production of microchips, circuits and transistors on semiconductor wafers),
- backend manufacturing (separation of semiconductor wafers into individual chips, packaging, integration into systems).

It should be emphasised that the number of companies in each category varies considerably and, in some categories, comprises only individual cases. The economic analysis was therefore carried out only for those categories in which more than individual companies operate.

Analytical Part

The segmentation of semiconductor categories includes integrated circuits and discrete semiconductors. Integrated circuits are the largest segment in the global semiconductor market, accounting for 82.4% of the total market value in 2023. This segment includes analogue, micro, logic and memory circuits. Integrated circuits are preferred over discrete semiconductors due to their compactness, low cost, speed and efficiency. In 2023, the integrated circuits segment was valued at USD 418.0 billion. In contrast, discrete semiconductors account for 17.6% of the total market value. This segment includes components such as transistors, diodes and others used for specific tasks. The discrete semiconductor segment was valued at USD 89.4 billion in 2023 (MarketLine, 2024).

Global context

The global semiconductor industry is characterised by a high degree of specialisation and the wide geographic distribution of the various stages of production. This fragmentation, while increasing efficiency, exposes the entire system to a number of risks. The current situation is characterised by several key aspects. Geopolitical tensions are proving to be a significant destabilising factor. Trade disputes and export restrictions between major powers, particularly the US and China, are disrupting the smooth flow of raw materials and components. This uncertainty increases costs and lengthens delivery times, which has a negative impact on the entire value chain. The concentration of production in only a few countries, particularly in Asia, creates further vulnerability. Dependence on these regions increases the risks associated with natural disasters, pandemics or geopolitical conflicts. Any disruption of production in these key areas can have a domino effect and cause a global chip shortage (Kleinhans & Baisakova, 2020).

Technological innovation is the driving force behind this industry. According to a study by Arthur D. Little (2024), the continuous development of new processors and memory chips requires considerable investment in research and development. However, it also increases the complexity of production and shortens product life cycles. Governments' response to the growing importance of semiconductors is manifested in the form of economic measures. Programmes such as the American Chips Act, the European Chips Act, and the recently approved National Semiconductor Strategy in Czechia aim to strengthen domestic production and reduce dependence on foreign suppliers. However, this effort to achieve greater self-sufficiency may lead to market fragmentation and higher costs.

The risks and challenges facing the semiconductor industry go beyond geopolitics and economics. Cyberattacks pose a serious threat to data security and operational efficiency. Climate change and water shortages can threaten production, which is highly demanding in terms of energy and water.

The geographical segmentation of the semiconductor industry shows that the Asia-Pacific region accounts for 70.1% of the value of the global semiconductor market, totalling USD 355.4 billion in 2023. This region is dominant due to the high concentration of semiconductor manufacturers and strong demand for electronic devices. The United States accounts for 18.2% of the global market, and in 2023 the value of the US market reached USD 92.3 billion. Europe accounts for 7.1% of the value of the global market, and in 2023 the value of the European market reached USD 35.9 billion. The Middle East accounts for 2.1% of the global market. The rest of the world accounts for 2.6% of the value of the global market in 2023 (MarketLine, 2024).

Foreign Investment

The table shows foreign direct investment by all companies investing in the semiconductor industry between January 2003 and June 2024.

Figure 1: Foreign Direct Investment in the Semiconductor Industry

Indicator	Value
Number of foreign investments	2,666
Jobs created	701,297
Average investment size (number of jobs)	263
Total investment costs	USD 694 046.74 million
Average investment size	USD 260.30 million

Source: fDiMarkets 2024

The table below provides an overview of projects, capital expenditure (Capex), average capital expenditure per project, jobs created, average jobs per project and number of companies for the period 2003 to 2023.

In 2023, 144 projects were carried out with total capital expenditure of USD 47,846.6 million and average capital expenditure per project of USD 332.3 million. A total of 50,900 jobs were created, representing an average of 353 jobs per project, and 102 companies were involved.

The year 2021 saw the highest capital expenditure, amounting to USD 125,160.8 million, a significant jump compared with previous years. Average expenditure per project amounted to USD 1,097.9 million, the highest figure in the entire period under review.

Conversely, the year with the lowest expenditure was 2016. In that year, capital expenditure was only USD 5,260.3 million. Average expenditure per project was USD 74.1 million. During that year, 71 projects were implemented and 13,239 jobs were created.

A comparison of the two years shows that capital expenditure in 2021 was more than 23 times higher than in 2016. Average expenditure per project in 2021 was almost 15 times higher than in 2016. However, it is interesting that the number of new jobs created in 2021 was only four times higher than in 2016.

In 2020, the number of projects dropped significantly to 56, the lowest figure since 2003. This decline may be the result of global restrictions on foreign investment due to the COVID-19 pandemic.

Figure 2: Data for Companies Investing in the Semiconductor Industry (2003—2023)

Year	Number of projects	Capital expenditure	Average capital expenditure	Jobs created	Average number of jobs created	Number of companies
2023	144	47,846.6	332.3	50,900	353	102
2022	141	89,977.6	638.1	44,699	317	97
2021	114	125,160.8	1097.9	47,551	417	73
2020	56	16,735.4	298.8	10,382	185	48
2019	72	18,085.4	251.2	18,493	256	56
2018	105	29,911.2	284.9	27,860	265	79
2017	96	27,065.9	281.9	23,430	244	66
2016	71	5,260.3	74.1	13,239	186	60
2015	92	15,084.1	164.0	22,321	242	72
2014	72	8,497.8	118.0	16,570	230	56
2013	97	8,057.9	83.1	15,707	161	61
2012	74	9,163.5	123.8	11,858	160	63
2011	110	18,303.2	166.4	25,355	230	81
2010	119	18,920.0	159.0	26,319	221	85
2009	92	14,838.7	161.3	20,789	225	71
2008	140	14,112.9	100.8	28,463	203	106
2007	169	17,804.8	105.4	39,744	235	118
2006	217	33,480.9	154.3	62,823	289	147
2005	181	18,603.8	102.8	37,710	208	130
2004	229	29,718.7	129.8	52,080	227	144
2003	207	24,613.8	118.9	59,281	286	129
Total	**2,598**	**591,243.1**	**227.6**	**655,574**	**252**	**989**

Source: © fDi Markets, from the Financial Times Ltd 2024. Data subject to terms and conditions of use

Notes:
All Capital investment (capex) figures shown in the table are in United States Dollar millions
Capex data includes estimated values Financial Times Ltd takes no responsibility for the accuracy or otherwise of this data.
Jobs data includes estimated values Financial Times Ltd takes no responsibility for the accuracy or otherwise of this data.

Capital Expenditure

In 2003, average expenditure per project was USD 118.9 million. This trend changed in the following years, with average expenditure reaching USD 154.3 million in 2006. In 2008, it fell to USD 100.8 million.

In 2011, average expenditure was USD 166.4 million, representing a significant increase compared with previous years. This trend continued until 2013, when average expenditure fell to USD 83.1 million. In 2016, it reached a low of USD 74.1 million.

From 2017 onwards, average expenditure began to rise again, peaking at USD 1,097.9 million in 2021, the highest value over the entire period. In 2022, average expenditure declined to USD 638.1 million, and reached USD 332.3 million in 2023.

Jobs

In 2003, 59,281 jobs were created. This figure changed over the following years, peaking at 62,823 jobs in 2006. In 2007, the figure fell to 39,744 jobs. From 2017 onwards, the number of jobs created began to rise again, reaching 50,900 in 2023. The total number of jobs created shows an upward trend.

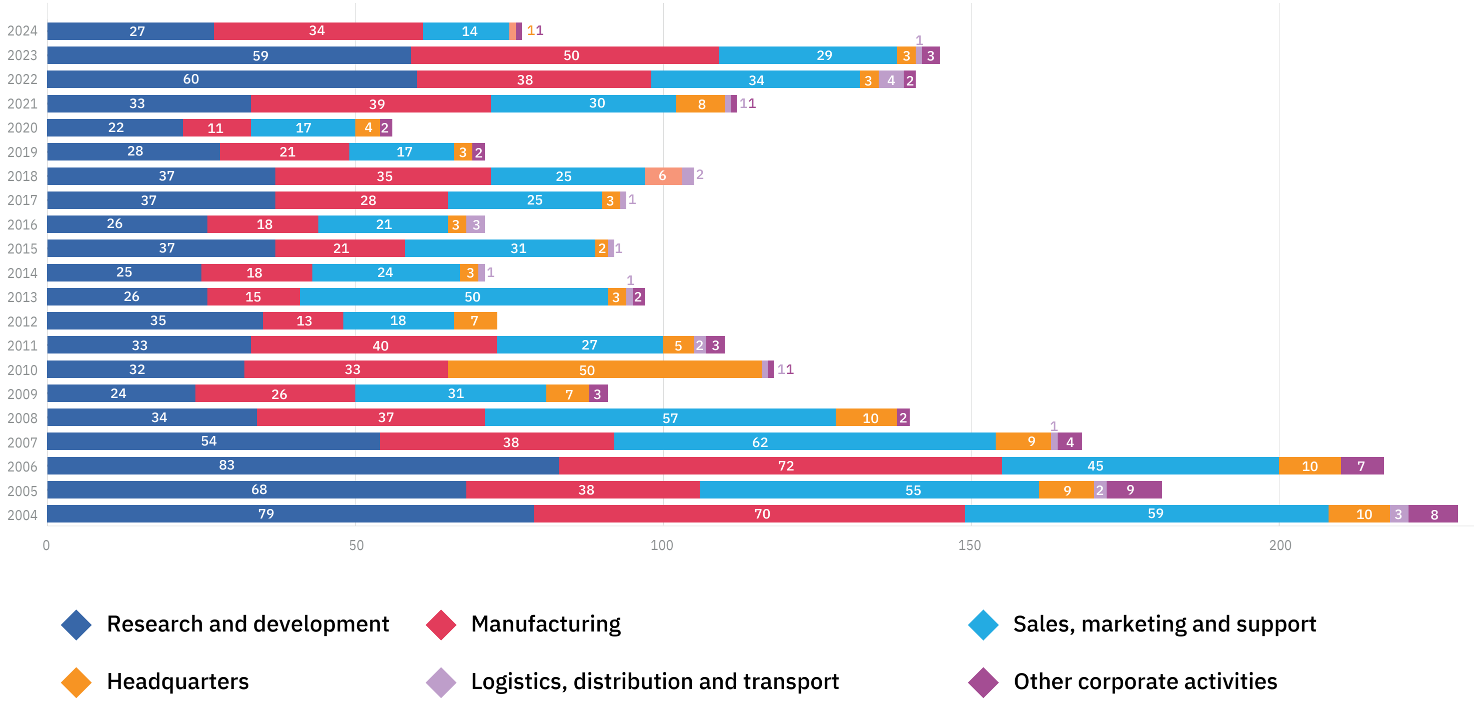
These data show significant fluctuations in capital expenditure and the number of created jobs from year to year, which may be due to various economic and market conditions. However, the overall trend indicates a rise in the number of projects and companies involved.

Key Findings

Almost half of all projects are attributable to key investors. The largest 10% of investors accounted for 47% of all projects. Together, these investors created a total of 408,917 jobs. The aggregate capital investment of these companies amounted to USD 485.48 billion, equivalent to more than two-thirds of the total volume of all companies.

In other sectors, it is not common for research and development to be the main business activity. More than a third of FDI projects in the semiconductor industry consisted of research and development.

Figure 3: Number of FDI Projects by Year and Business Activity



Source: fDi Intelligence from The Financial Times Ltd 2024

Out of a total of 13 business activities, research and development projects accounted for 34.8% of projects. The volume of projects in this business activity peaked in 2006, when 83 projects were recorded. Total job creation and capital investment in this business activity amounted to 144,048 jobs and USD 40.56 billion.

The largest projects originate from Taiwan. With an average project size of USD 1.01 billion, projects originating from Taiwan are approximately four times larger than the average for all source countries. Taiwan ranked fourth in the total number of recorded projects, with a total of 172. In total, companies from this country created 89,097 jobs and capital investment amounting to USD 173.65 billion.

Of the 68 destination countries, the top five account for almost half of all projects. China is the main destination country, accounting for a fifth of the projects monitored. Total investment in China led to the creation of 206,216 jobs and capital investment of USD 117.95 billion, representing an average of 386 jobs and investment of USD 220.90 million per project. China has created the highest number of total jobs, while Malaysia has the largest average project size with 596 jobs per project. The United States has the highest total and average investment, at USD 170.43 billion overall and USD 781.80 million per project.

Figure 4: Trends in Foreign Direct Investment by Destination Country

Destination country	Number of projects	Number of companies	Number of jobs created		Capital investment	
			Total	Average	Total (USD million)	Average (USD million)
China	534	292	206,216	386	117,947.80	220.90
India	247	144	87,315	353	37,694.50	152.60
USA	218	143	43,238	198	170,433.50	781.80
Taiwan	164	139	25,010	152	8,911.40	54.30
Germany	139	101	17,814	128	66,468.70	478.20
Singapore	138	86	33,548	243	40,339.20	292.30
United Kingdom	131	104	5,252	40	2,867.90	21.90
Japan	124	97	46,189	372	66,218.60	534.00
Malaysia	96	65	57,271	596	32,358.90	337.10
France	82	55	6,234	76	6,499.90	79.30
Other destination countries	793	611	173,210	218	144,306.20	182.00
Total	**2,666**	**1,009**	**701,297**	**263**	**694,046.70**	**260.30**

Source: fDi Intelligence from The Financial Times Ltd

The largest number of investments (USD 247.90 billion) and the highest number of jobs (307,102) were created by companies from the United States. Taiwan has the largest average project size in terms of both investment and job creation.

Figure 5: Trends in Foreign Direct Investment by Country of Origin

Country of origin	Number of projects	Number of companies	Number of jobs created		Capital investment	
			Total	Average	Total (USD million)	Average (USD million)
USA	1,176	387	307,102	261	247,896.10	210.80
Japan	255	136	67,396	264	26,933.80	105.60
Germany	197	61	48,883	248	30,471.80	154.70
Taiwan	172	68	89,097	518	173,651.10	1,009.60
South Korea	114	52	56,942	499	109,671.30	962.00
United Kingdom	114	50	8,825	77	4,471.00	39.20
Switzerland	106	17	25,405	239	17,549.60	165.60
Netherlands	69	20	13,722	198	7,410.80	107.40
China	65	39	12,359	190	10,263.70	157.90
France	55	32	3,100	56	2,561.60	46.60
Other countries of origin	343	164	68,466	199	63,165.80	184.20
Total	**2,666**	**1,009**	**701,297**	**263**	**694,046.70**	**260.30**

Source: fDi Intelligence from The Financial Times Ltd

European Context

The EU's position in the global semiconductor value chain

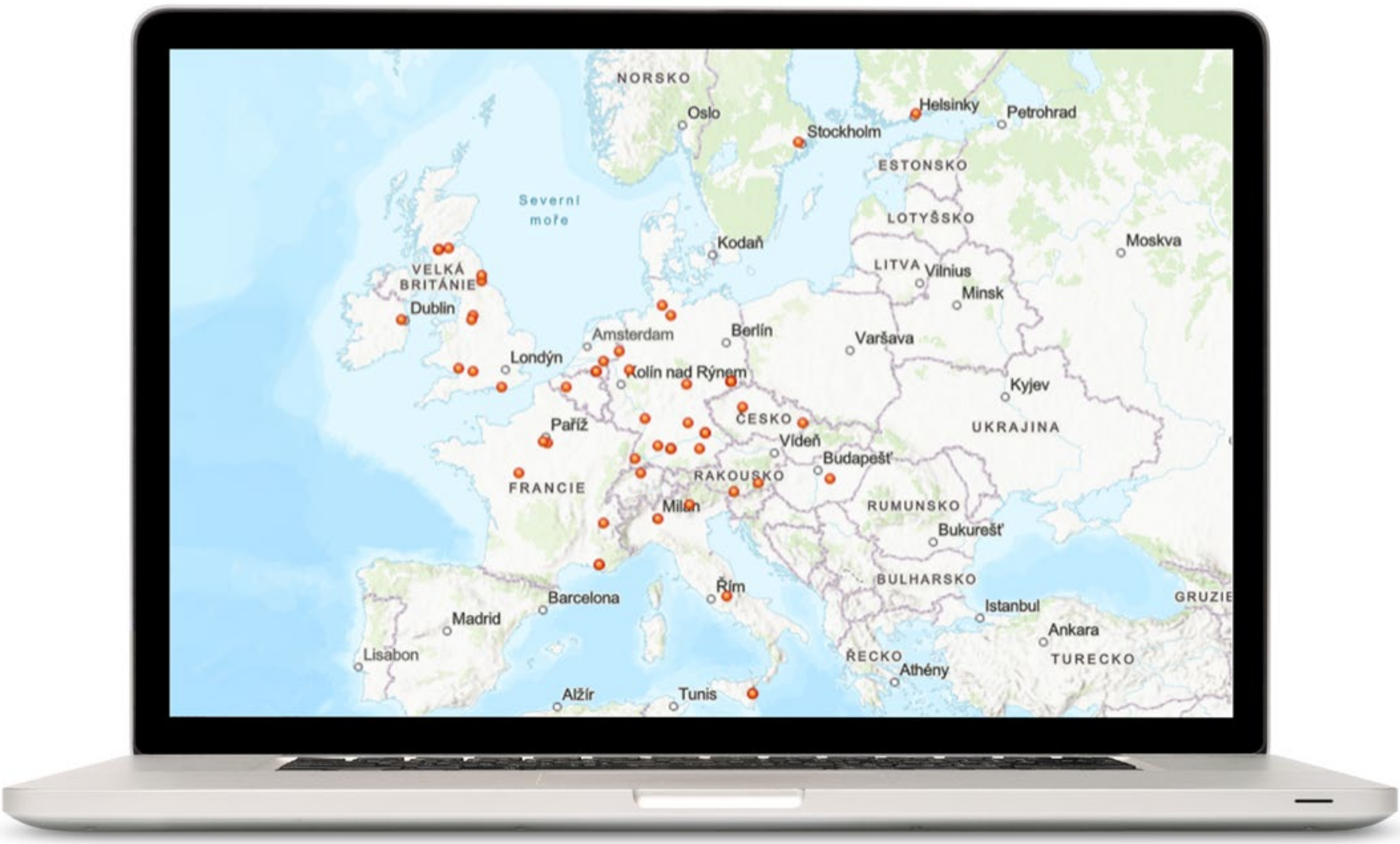
According to JRC (2022), the European Union is a net importer of transistors, diodes and integrated circuits, with most of these semiconductors originating from China and Taiwan. Taiwan is a major source of processors and other electronic circuits. On the other hand, the EU is a major exporter of semiconductor manufacturing machinery, which is exported mainly to China, Taiwan and South Korea. In terms of raw materials, the EU imports key semiconductor materials such as beryllium, chromium, germanium, vanadium and gallium, primarily from the US, Russia and China.

The JRC report (2022) indicates that European companies play a crucial role in the global semiconductor supply chain. Their dominance is particularly evident in the supply of machinery and materials necessary for chip production. With a 27% share of the global machinery market and a 33% share of the materials market, European companies represent a vital base for the entire sector. Although European companies excel in providing equipment and raw materials, their position in actual chip manufacturing and design is significantly weaker. The foundry (chip manufacturing) and fabless (chip design) segments are dominated by Taiwanese, South Korean and US companies. Europe's share in these highly innovative and capital-intensive segments is negligible. On the other hand, European companies make up a significant proportion of integrated semiconductor manufacturers (IDMs), which combine both chip design and manufacturing. With a 17% share of global IDM turnover, European companies represent an important player in the global market.

Trade balance

The European Union has a trade deficit in semiconductors, particularly with China and Taiwan, and this deficit has been widening since 2016. Between 2015 and 2021, foreign companies invested EUR 33 billion in European semiconductor companies, with the largest share of these investments coming from US companies, followed by investors from Norway, the Cayman Islands and the United Kingdom. The majority of foreign investments (91%) consist of minority stakes, with foreign investors acquiring less than 10% of the shares of target companies (JRC, 2022).

Figure 6: Map of Semiconductor Manufacturers in Europe



Source: CzechInvest, authors' own analysis 2025

Companies in the Semiconductor Industry in Czechia

History of Semiconductor Manufacturing in Czechia

Czechia has a long and rich history in semiconductor manufacturing. The roots of this industry go back to the second half of the 20th century, when the first electronic components began to be manufactured in what was then Czechoslovakia. One of the key players in this field was Tesla. Tesla's factories, particularly its plant in Rožnov pod Radhoštěm, became an important centre for the production of electronic components, including semiconductors. As early as the 1950s, the first germanium diodes and transistors were produced there, followed by silicon transistors.

In the 1970s and 1980s, semiconductor production in Czechoslovakia continued to develop. A wide range of bipolar technologies was mastered and simple integrated circuits were produced. Czechoslovak semiconductors were used in many domestic electronic devices, but were also exported to other countries. After the Velvet Revolution and the transition to a market economy, Czech semiconductor production underwent significant changes. Many state-owned enterprises were privatised and a new era began in which Czech companies had to cope with intense competition on the global market.

Today, Czechia is still a major player in the global semiconductor market. Companies like onsemi (formerly Tesla Rožnov) are investing billions of crowns in the development and production of new technologies, particularly in the field of silicon carbide. Czech research and development in this area is world-class and contributes to innovation in many industrial sectors.

The Semiconductor Industry in Czechia

According to the National Semiconductor Strategy, the size of the Czech semiconductor components market in 2024 is estimated at approximately EUR 1.97 billion (USD 2.13 billion and CZK 49 billion). The market in Czechia is expected to grow to approximately EUR 2.97 billion (USD 3.17 billion and CZK 75 billion) by 2029. This represents an average annual growth rate of around 8.51%. The highest revenues, EUR 830 million, are recorded for memory devices, followed by micro integrated circuits (mainly microprocessors and microcontrollers) with EUR 550 million, logic integrated circuits (EUR 188.3 million), analogue integrated circuits (EUR 163.9 million) and discrete semiconductors (EUR 124.0 million).

The Czech semiconductor industry is strong in the supply of machinery and equipment for the production of integrated circuits, particularly electron microscopes, optical components and specialised machinery. Czech companies are involved in the construction of factories, including cleanrooms and liquid and gas distribution systems, and also have export potential. The design of integrated circuits is carried out by branches of foreign companies as well as domestic companies focused on analogue and digital circuits, particularly ASIC chips. Production in Czechia includes analogue integrated circuits and discrete components, and companies operating in Czechia are also involved in their design.

Analyses of the financial statements of companies operating in the semiconductor industry showed that the integrated circuit design sector in Czechia employed approximately 1,000 people in 2021 and had a turnover of approximately CZK 1,360 million. The production of integrated circuits and discrete semiconductor components employed approximately 2,000 people and generated a turnover of approximately CZK 7.3 billion. (Data from the Czech Statistical Office put production in Czechia in 2023 at approximately CZK 7.9 billion.) Suppliers to the semiconductor industry generate approximately CZK 25 billion in revenue and employ an estimated 3,000 people. Overall, this sector employs about 6,000 people in Czechia and generates revenues of CZK 33.66 billion (National Semiconductor Strategy, 2024).

Czechia's share of the EU market is estimated at 0.7%. This is less than would correspond to the strength of the economy (the Czech economy accounts for 1.8% of the total EU economy measured on a GDP basis).

Foreign Direct Investment

The role of foreign investors in the semiconductor industry in Czechia is considerable. Figure 7 shows a summary of foreign direct investment by all companies investing in the Czech semiconductor industry from January 2003 to June 2024. Thanks to foreign direct investment, 2,652 new jobs were created in Czechia in this sector. Total capital investment amounted to USD 2,582.03 million, with an average project size of USD 198.60 million.

During this period, i.e. since 2003, 12 semiconductor-related investment projects have been implemented in Czechia (fDiMarkets, 2024). The highest investment was made by onsemi (ON Semiconductor), amounting to USD 300 million in 2021. This was an expansion in Rožnov pod Radhoštěm, through which onsemi significantly increased its production capacity for silicon carbide semiconductor wafers. The production of polished silicon carbide wafers and silicon carbide epitaxial wafers started at the existing semiconductor silicon wafer and chip manufacturing plant in Rožnov in 2019. Onsemi (headquartered in Scottsdale, Arizona, USA) is also the most frequent investor in this sector in Czechia, having carried out 5 out of the total 12 investments.

Of the total 12 investment projects, five went to Prague, five to the Zlín Region and two to the South Moravian Region. Looking at the source destinations, we find that the highest number of investments came from the United States (8), followed by two from Japan and one each from Ireland and Sweden.

Another reason for supporting the semiconductor industry, alongside its undeniable strategic importance, is the fact that it is a sector with high added value that plays a crucial role for research and development. This is also confirmed by data on foreign investment:, 42% of these investments in Czechia went to research and development, 17% to trade and marketing and 8% to education and training. All three of these activities can be classified as high value-added activities (Shin et al, 2012). In the case of semiconductors, it is indisputable that manufacturing (where 33% of foreign investment was directed) also represents a high value-added activity.

Figure 7: Foreign Direct Investment in the Semiconductor Industry (2003—2024)

Indicator	Value
Number of foreign investments	12
Jobs created	2,652
Average investment size (number of jobs)	204
Total investment costs	USD 2,388 million
Average investment size	USD 199 million

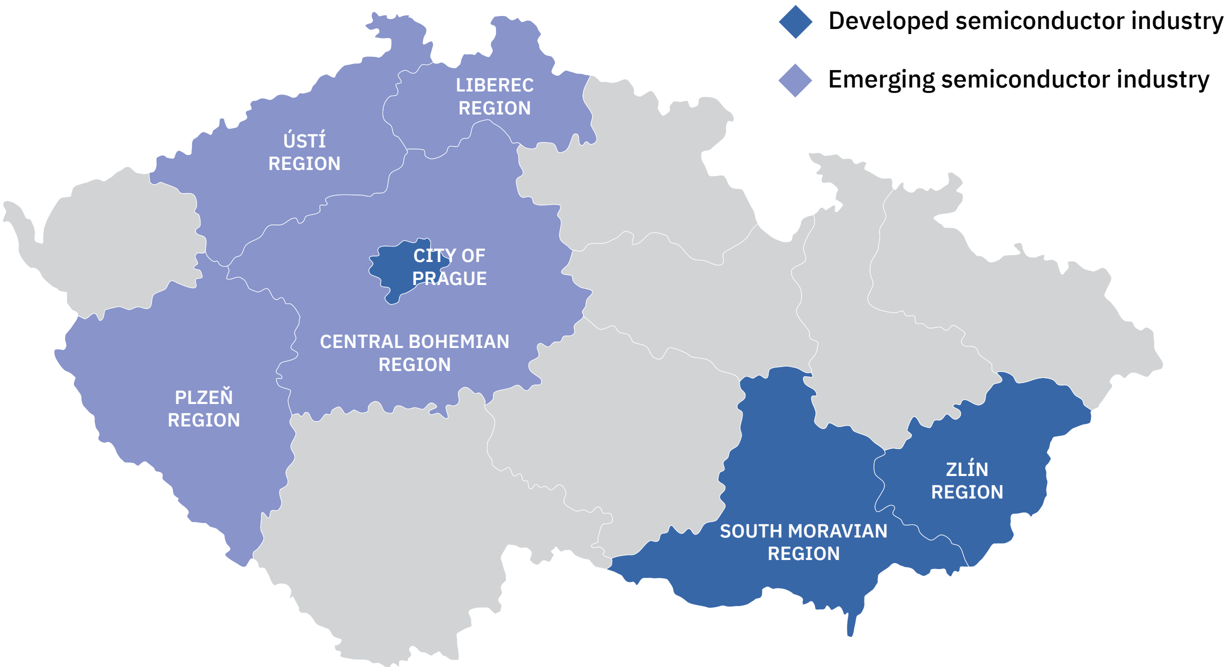
Source: fDiMarkets report 2024

Figure 8: Foreign Investment in the Semiconductor Industry in Czechia

Project date	Investing company	Country of origin	Destination city	Activity	Jobs created	Capital investment (USD million)
II 2024	Analog Bits	USA	Prague	Research and development	78	35.10
IX 2021	onsemi (ON Semiconductor)	USA	Rožnov pod Radhoštěm	Manufacturing	200	300.00
III 2019	onsemi (ON Semiconductor)	USA	Unspecified	Research and development	185	70.00
VIII 2018	Allegro MicroSystems	Japan	Prague	Research and development	24	9.10
XII 2013	AdvanIDe (Advanced ID Electronics)	Sweden	Prague	Sales, marketing and support	15	4.19
V 2012	onsemi (ON Semiconductor)	USA	Unspecified	Research and development	92	51.30
VIII 2007	Texas Instruments	USA	Prague	Sales, marketing and support	13	3.10
IV 2007	onsemi (ON Semiconductor)	USA	Brno	Education and training	1	0.23
XII 2006	AMI Semiconductor (AMIS)	USA	Brno	Manufacturing	10	0.90
IV 2006	Silicon & Software Systems (S3)	Ireland	Prague	Research and development	92	51.30
II 2004	AVX	Japan	Uherské Hradiště	Manufacturing	280	24.90
XII 2003	onsemi (ON Semiconductor)	USA	Unspecified	Manufacturing	362	31.90

Source: fDiMarkets report 2024

Figure 9: The Semiconductor Sector in the Regions of Czechia



Source: CzechInvest, authors' own analysis

Analysis of the Economic Indicators of Czech Semiconductor Companies

In the first part of the analysis, the basic economic characteristics for 121 companies involved in the semiconductor industry were identified. Figure 10 shows the distribution of the set of companies by size and also by the location of their owner. Almost two-thirds of the companies (76) are domestically owned, i.e. Czech-owned, and the vast majority are small and medium-sized enterprises. One quarter (30) of all companies have a European owner (excluding Czech ownership), exclusively from Western European countries. Most often from Germany (10), Luxembourg (6) and France (3). A total of 11 companies have a US owner, and these are most often large companies. The smallest group, perhaps somewhat surprisingly, consists of companies with an Asian owner, either from Japan or South Korea.

Half of the companies (i.e. 60) have fewer than 50 employees, there are 36 medium-sized enterprises and 25 large companies with more than 250 employees in our sample.

Figure 10: Companies Involved in the Semiconductor Industry by Size and Owner's Region

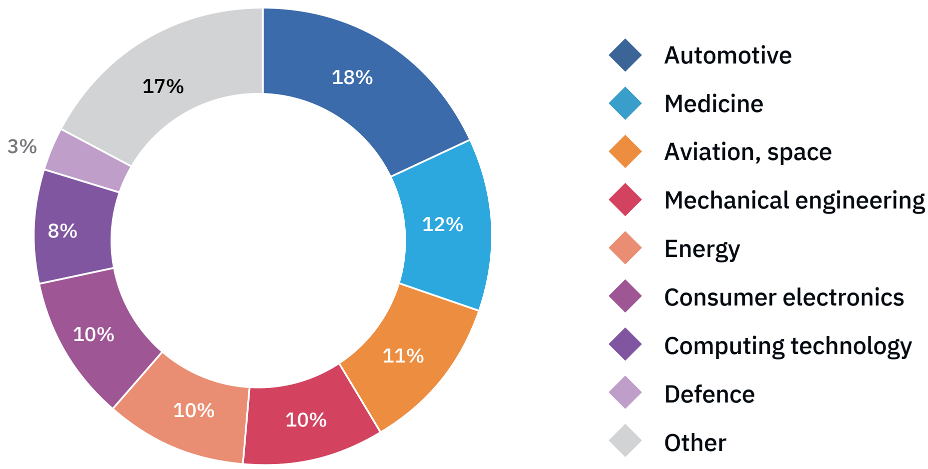
Company size	Owner's region				Total
	Czechia	Europe	USA	Asia	
Small	48	10	1	1	60
Medium	23	9	3	1	36
Large	5	11	7	2	25
Total	**76**	**30**	**11**	**4**	**121**

Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

Almost all companies specify the key sectors their products target on their websites. Some companies specialise primarily in supplying semiconductors to only one sector — often automotive, medicine/medical technology or energy. Other companies have a wide range of customers from different industrial sectors. Only a limited number of companies explicitly mentioned the semiconductor industry on their websites, and it was usually included in the "other" category along with ecology, urban infrastructure or the mining industry, etc. (17% in total). However, most companies see products for the semiconductor industry as a component for another/end-use sector.

Almost a fifth of companies (18%) supply their products to the automotive industry, often including optoelectronic and autonomous systems, power and sensing technologies, parking or temperature sensors, headlights, etc. The second most frequently mentioned sector is medicine or medical technology (12%), for which various types of medical electronics, laser equipment, radio frequency solutions for magnetic resonance imaging, components for electron microscopes, etc. are supplied. This is followed by the aerospace sector, to which 11% of the companies in our sample supply semiconductor components or products. These include onboard computers, testing and inspection equipment, components for satellites, etc. The structure of companies by target sectors for semiconductor applications is shown in Figure 11.

Figure 11: Target Industries of Companies involved in the Semiconductor Industry



Source: authors' own analysis

As mentioned in the Methodology chapter, one of the objectives of this mapping was to determine in which manufacturing segments of the semiconductor value chain companies are represented in Czechia and what their structure is.

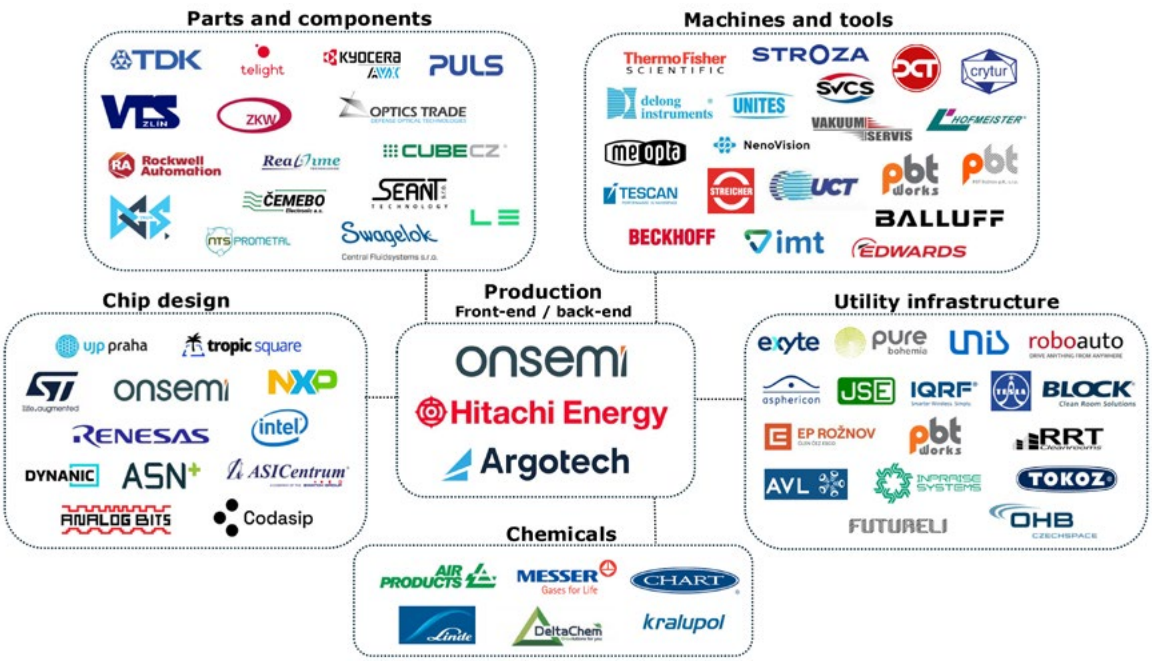
Roughly two-thirds of the companies (78) in the sample are directly involved in the semiconductor industry, while the remaining 43 are mostly direct users of semiconductor products. The most frequently represented manufacturing segment is “facility production” (21 companies), i.e. manufacturers of various technologies and equipment for the production of microelectronics, cleanrooms, etc. Similarly, “equipment (machinery)” with 19 companies, followed by “parts and components” with 17 companies and “design (chips)” with 12 companies. Six companies were identified in the “chemicals and raw materials” category, while the least represented are “backend manufacturing”, with two representatives, and “frontend manufacturing” with only 1 company. However, it should be emphasised that the production portfolio of many companies operating in the semiconductor industry is broader, i.e. these companies also manufacture products other than semiconductor-related products. One example is Linde Gas, which supplies various gases to many industries (food, healthcare...).

Figure 12: Distribution of Companies by Manufacturing Segment

Category	Manufacturing segment	Small		Medium		Large		Total
		Domestic	International	Domestic	International	Domestic	International	
Supply chain	Facilities	9	4	3	1	1	3	21
	Equipment (machinery)	7	2	5	1	1	3	19
	Parts and components	4	3	3	2	1	4	17
	Design (chips)	4	1	1	4	0	2	12
	Chemicals and raw materials	1	0	1	2	0	2	6
	Backend manufacturing	1	0	0	0	0	1	2
	Frontend manufacturing	0	0	0	0	0	1	1
Total semiconductor supply chain		26	10	13	10	3	16	78
User/customer		22	2	10	3	2	4	43

Source: authors’ own analysis, CzechInvest, Dun&Bradstreet

Figure 13: Diagram of the Semiconductor Manufacturing Chain in Czechia



Source: CzechInvest, authors’ own analysis

Based on an analysis of their websites, we can say that all companies in the sample are engaged in research or development, and it is therefore clear that companies whose production is linked to the semiconductor industry recognise the need for continuous innovation and investment in research and development. Companies often document their specific research activities and participation in R&D projects on their websites. Although the CSO provides data on companies' research and development only in anonymised form and also does not cover all companies in Czechia, and therefore not all those in our sample either, CSO data make it possible to monitor trends in research and development, not only in the growth in the number of companies involved in R&D, but also in the level of expenditure.

The following table provides information on research and development in 75 companies from our sample (in 2023) for which the CSO obtained the necessary data. However, this does not mean that the remaining companies do not carry out R&D; they were simply not included in the CSO mapping. It is evident that over the 14—year period in question, not only has the number of registered entities active in R&D increased, but above all so has the number of employees involved in R&D. Expenditure has also risen significantly, more than doubling over the period under review.

Figure 14: Research and Development in Companies Involved in the Semiconductor Industry

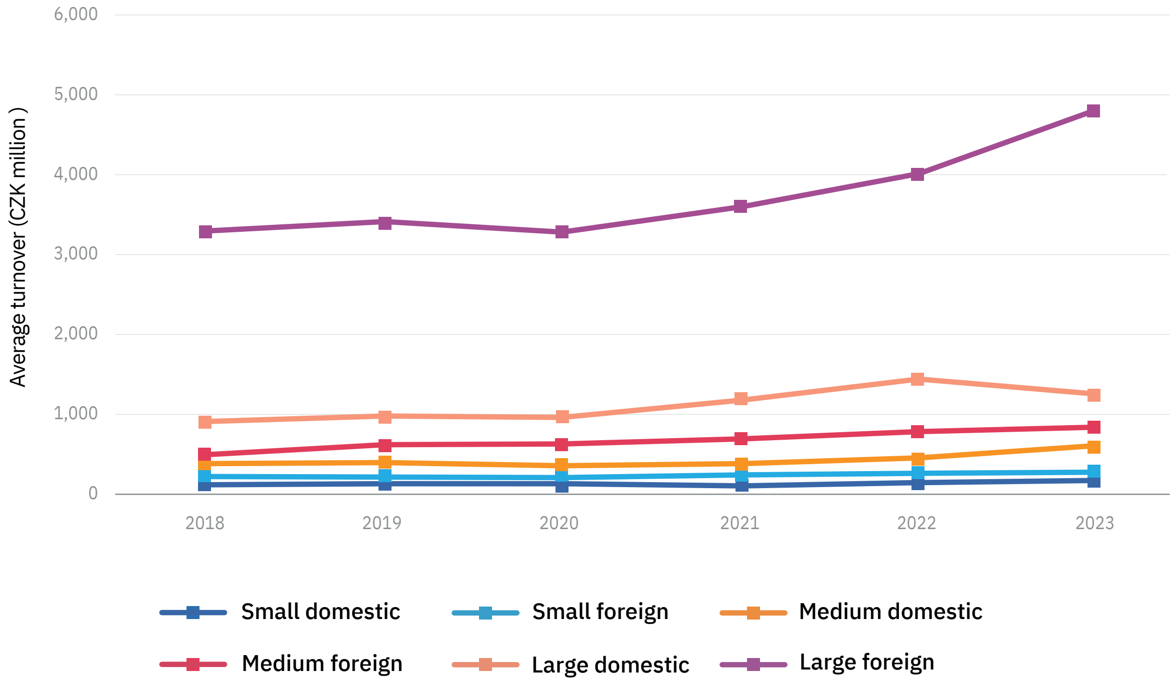
	2010	2011	2012	2013	2014	2015	2016
Number of entities conducting R&D	39	41	43	42	45	48	50
R&D employees (natural persons as at 31 December)	3,162	3,424	3,703	3,478	3,571	4,134	3,863
Total R&D expenditure (CZK million)	3,951	4,482	5,108	5,492	5,984	5,915	5,309
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Number of entities conducting R&D	51	54	56	61	65	65	75
R&D employees (natural persons as at 31 December)	4,004	3,619	3,948	4,136	4,249	4,541	4,928
Total R&D expenditure (CZK million)	5,870	5,537	6,270	6,219	6,861	7,737	9,423

Source: authors' own analysis, CSO 2025

In the next step, the set of companies was analysed on the basis of economic indicators. The data were analysed over the six-year period from 2018 to 2023 to reflect development trends and eliminate the distortion that would arise from analysing economic indicators for one specific year, as these indicators inevitably fluctuate over time. The following analyses are calculated only for manufacturers, i.e. the 78 companies from the compiled sample; customers are not included.

The development of turnover between 2018 and 2023 is similar for both domestic and foreign companies. However, foreign companies achieve higher turnover in all size categories, except for large companies, but the differences are not particularly significant. Large foreign companies are the key and most prominent players in this sector, so this difference is not surprising.

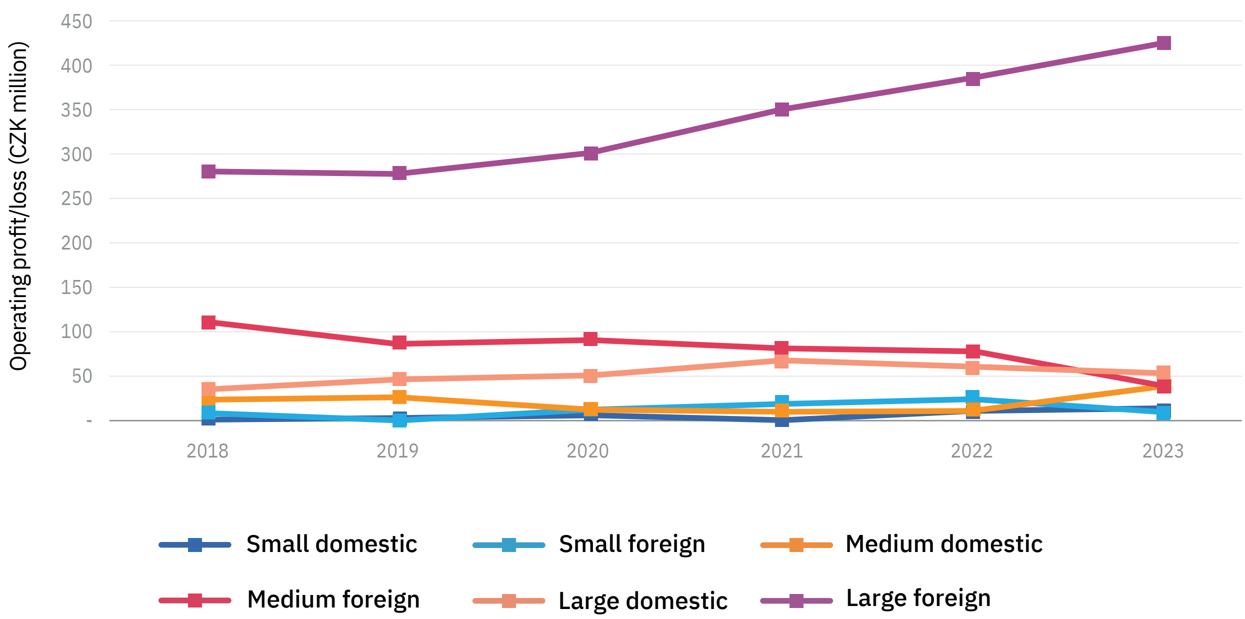
Figure 15: Average Annual Turnover of Companies by Size and Ownership



Source: authors' own analysis, CzechInvest, Dun&Bradstreet

A very similar trend to turnover is evident in the average profit/loss of the companies surveyed, with small differences for small and medium-sized enterprises and again a clear difference between large domestic and foreign companies. Here, too, foreign companies achieve significantly higher values compared with domestic ones, which have even lower operating results than medium-sized foreign companies for most of the period.

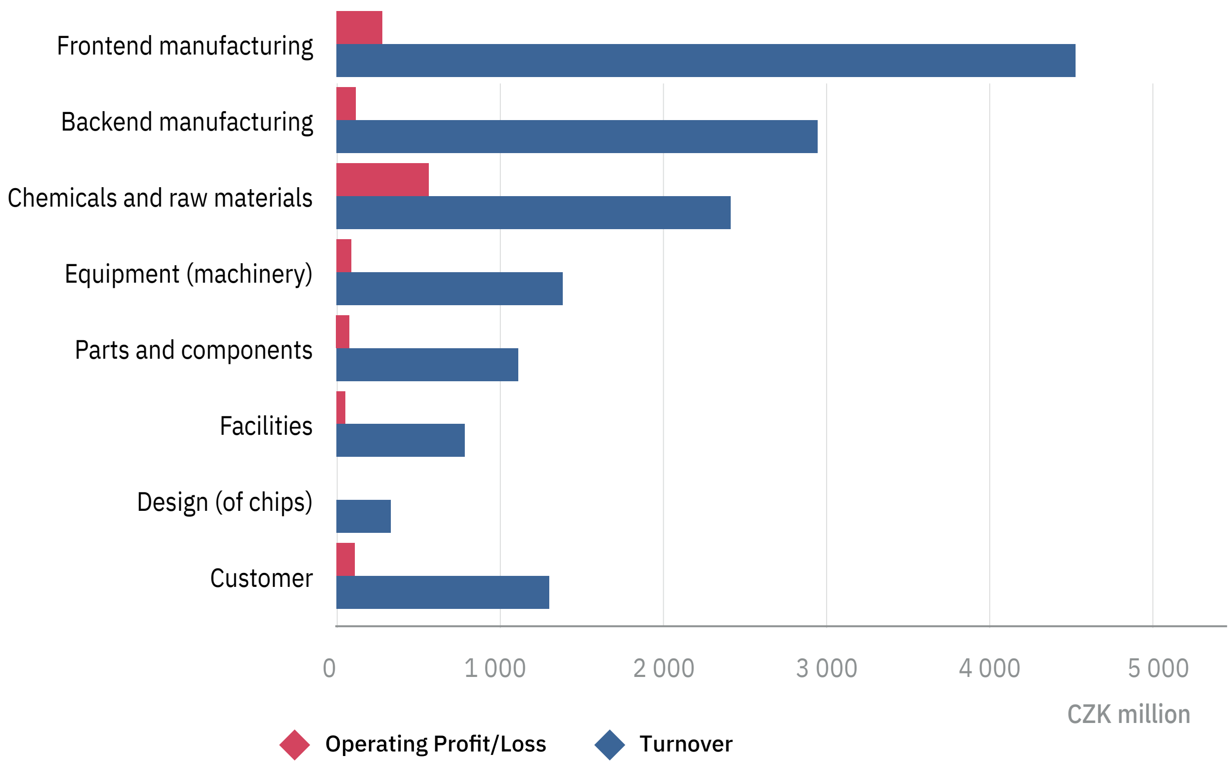
Figure 16: Operating Profit/Loss of Companies by Size and Ownership



Source: authors' own analysis, CzechInvest, Dun&Bradstreet

When comparing companies by turnover and operating results across the manufacturing segments of the semiconductor industry, the dominance of companies focused on frontend and backend manufacturing is evident, which corresponds to the main players in the Czech semiconductor industry. These are mostly large foreign-owned companies. The next group with the highest turnover comprises suppliers of chemicals and raw materials. These are mostly medium-sized and large foreign-owned companies, which, however, also supply companies in many other sectors. By a greater margin, these are companies focused on the production of equipment for the semiconductor industry, mainly machinery. Customers of companies in the semiconductor industry also achieve similar values. The segment with the lowest average turnover and operating profit/loss is design (chips), which is dominated by small and medium-sized, predominantly foreign-owned enterprises.

Figure 17: Average Operating Profit/Loss and Average Turnover by Companies' Manufacturing Segment

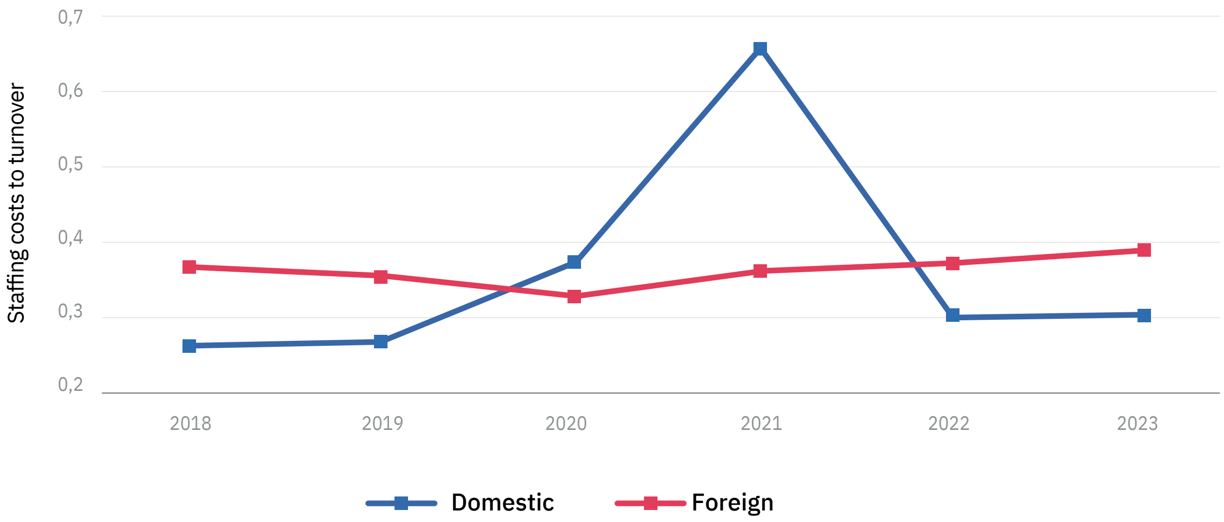


Source: authors' own analysis, CzechInvest, Dun&Bradstreet

The contribution of companies to the host economy or region is demonstrated by retained value indicators, in particular the share of staffing costs in turnover according to company ownership and company segment.

Figure 18 shows that the development and level of staffing costs differ between domestic and foreign companies. For foreign companies, the value is almost identical throughout the period 2018 to 2023, while for domestic companies there is a significant increase in 2020 and particularly in 2021, followed by a decline in 2022 back to levels similar to 2018 and 2019. There may be several reasons for this, one of the most significant is probably a reduction in turnover during the Covid-19 pandemic, while maintaining the level of staffing costs (e.g. through efforts to retain employees and state support). Another reason may be higher investment in human resources among small, domestically owned companies, which is common for this type of company, most often start-ups and newly established businesses. At first glance, however, it is clear that before and after the Covid, the share of staffing costs in turnover is consistently higher for foreign-owned companies.

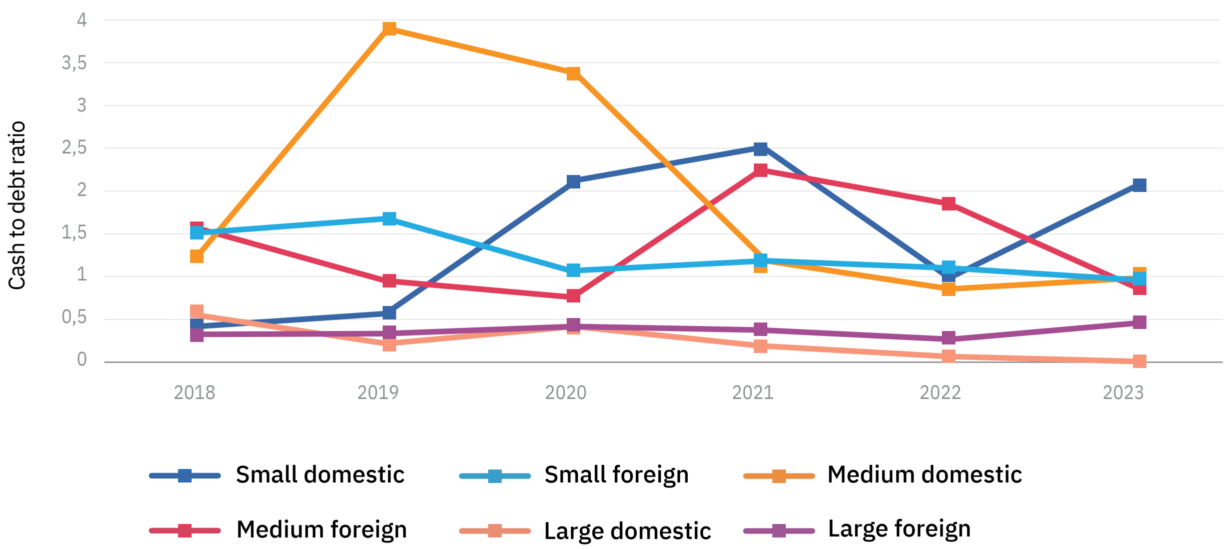
Figure 18: Average Share of Staffing Costs in Turnover by Company Ownership



Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

The *Cash to Debt Ratio*, one of the basic indicators of companies' financial health, was calculated for each firm. Figure 19 shows that this indicator fluctuates least over time for large companies, regardless of ownership. At the same time, these companies have the lowest ratio of cash resources available to cover their own debts, i.e. they carry out their activities drawing on a significant proportion of external resources. The ratio indicator considerably for small and medium-sized enterprises, but in general it is evident that the highest cash-to-debt ratio is reported by domestic, i.e. Czech, companies.

Figure 19: Development of the Cash-to-Debt Ratio by Ownership and Size of Companies Involved in the Semiconductor Industry

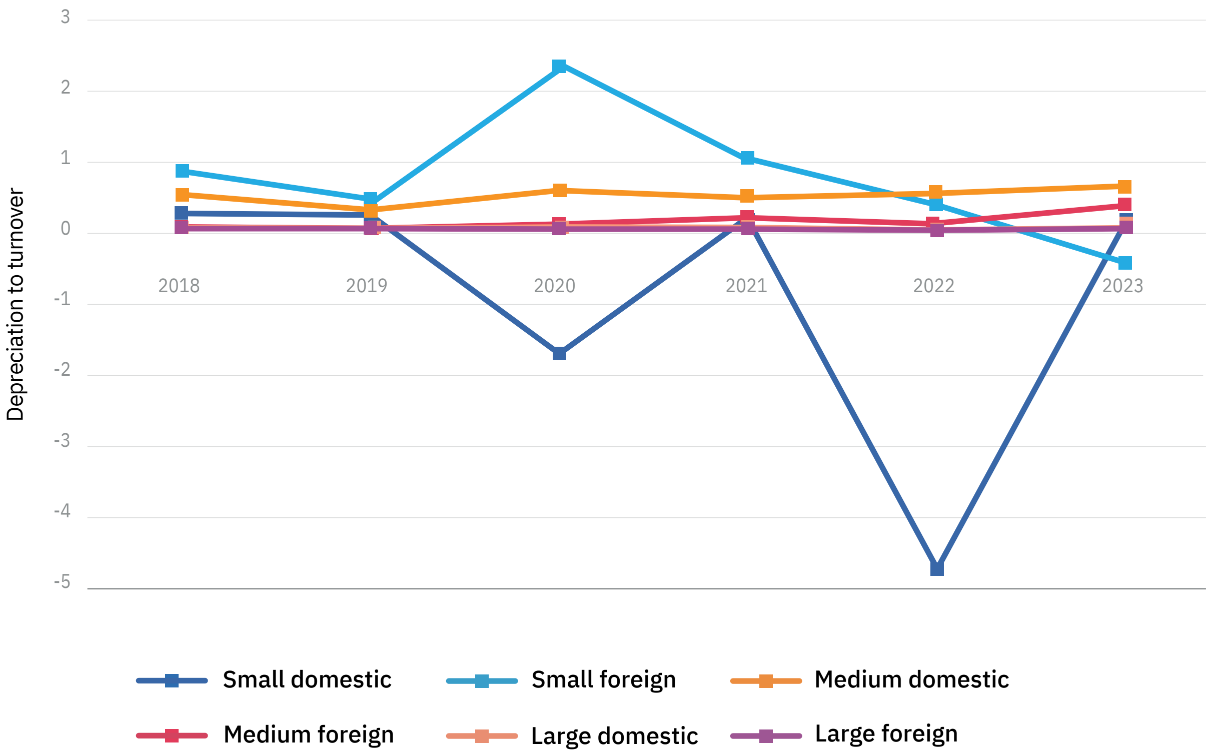


Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

The intensity with which companies invest in new machinery and technology was monitored using the *Depreciation to Revenue Ratio*, i.e. the ratio of depreciation to turnover. This indicator therefore reflects how much of their revenues companies allocate to the renewal of fixed assets.

Figure 20 shows that most companies exhibit very similar values, which remain almost constant over time. The indicator fluctuates most for small companies, although with a different trend depending on ownership. While the values for foreign companies are mostly positive, domestic companies also show negative values, which may be due to several causes, but one of the most common is the sale or liquidation of assets. On the basis of this result, it cannot therefore be argued that domestic companies invest a greater share of funds in technology and infrastructure than foreign companies, and the potential impact on the host region is similar across all types of company. However, larger fluctuations over time can be expected for small companies.

Figure 20: Development of the Cash-to-Debt Ratio by Ownership and Size of Companies Involved in the Semiconductor Industry



Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

Figure 21: Top Ten Companies by Average Turnover in 2021—2023

Company ranking	Company name	Turnover (CZK)	Ownership	Company size	Manufacturing segment
1	**Thermo Fisher Scientific Brno s.r.o.**	21,007,305,333	foreign	large	equipment (machinery)
2	**Linde Gas a.s.**	7,316,411,000	foreign	large	chemicals and raw materials
3	**ON SEMICONDUCTOR CZECH REPUBLIC, s.r.o.**	5,402,771,667	foreign	large	frontend manufacturing
4	**Hitachi Energy Czech Republic s.r.o.**	4,865,802,000	foreign	large	backend manufacturing
5	**Edwards, s.r.o.**	4,709,364,667	foreign	large	facilities
6	**Meopta — optics, s.r.o.**	4,090,959,000	foreign	large	equipment (machinery)
7	**KYOCERA AVX Components s.r.o.**	3,957,121,333	foreign	large	parts and components
8	**UCT Fluid Delivery Solutions s.r.o.**	3,323,945,667	foreign	large	parts and components
9	**Chart Ferox, a.s.**	2,639,075,000	foreign	large	chemicals and raw materials
10	**AIR PRODUCTS spol. s.r.o.**	2,593,731,500	foreign	medium	chemicals and raw materials

**of the 78 manufacturers involved in the semiconductor supply chain*

Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

Figure 22: Top Ten Domestic Companies by Average Turnover in 2021—2023 (in CZK)

Company ranking	Company name	Turnover (CZK)	Company size	Manufacturing segment
1	**PULS Investment s.r.o.**	2,432,074,333	large	parts and components
2	**KRALUPOL a.s.**	1,338,473,333	medium	chemicals and raw materials
3	**EP Rožnov, a.s.**	1,139,675,667	medium	facilities
4	**Delta Chem s.r.o.**	694,752,000	small	chemicals and raw materials
5	**TOKOZ a.s.**	658,714,667	large	facilities
6	**CRYTUR, spol. s.r.o.**	628,440,000	large	equipment (machinery)
7	**UNIS, a.s.**	539,208,333	medium	facilities
8	**PBT Rožnov p.R., s.r.o.**	340,117,333	medium	equipment (machinery)
9	**DELONG INSTRUMENTS a.s.**	339,376,667	medium	equipment (machinery)
10	**IMT Technologies & Solutions s.r.o.**	272,455,333	medium	equipment (machinery)

**of the 78 manufacturers involved in the semiconductor supply chain*

Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

Figure 23: Top Ten Companies* by Average Operating Profit/Loss in 2021—2023

Company ranking	Company name	Operating profit/loss (CZK)	Ownership	Size	Manufacturing segment
1	**Linde Gas a.s.**	2,401,035,333	foreign	large	chemicals and raw materials
2	**Thermo Fisher Scientific Brno s.r.o.**	959,595,667	foreign	large	equipment (machinery)
3	**Meopta — optics, s.r.o.**	737,851,333	foreign	large	equipment (machinery)
4	**AIR PRODUCTS spol. s.r.o.**	589,667,500	foreign	medium	chemicals and raw materials
5	**UCT Fluid Delivery Solutions s.r.o.**	452,013,333	foreign	large	parts and components
6	**Messer Technogas s.r.o.**	419,316,000	foreign	medium	chemicals and raw materials
7	**Edwards, s.r.o.**	340,504,667	foreign	large	facilities
8	**ON SEMICONDUCTOR CZECH REPUBLIC, s.r.o.**	331,466,667	foreign	large	frontend manufacturing
9	**Chart Ferox, a.s.**	250,565,667	foreign	large	chemicals and raw materials
10	**Hitachi Energy Czech Republic s.r.o.**	191,297,667	foreign	large	backend manufacturing

**of the 78 manufacturers involved in the semiconductor supply chain*

Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

Figure 24: Top Ten Domestic Companies* by Average Operating Profit/Loss in 2021—2023 (in CZK)

Company ranking	Company name	Operating profit/loss (CZK)	Size	Manufacturing segment
1	**Delta Chem s.r.o.**	118,837,333	small	chemicals and raw materials
2	**PULS Investment s.r.o.**	116,815,667	large	parts and components
3	**EP Rožnov, a.s.**	116,315,000	medium	facilities
4	**KRALUPOL a.s.**	72,751,333	medium	chemicals and raw materials
5	**DELONG INSTRUMENTS a.s.**	69,468,667	medium	equipment (machinery)
6	**CRYTUR, spol. s.r.o.**	57,483,667	large	equipment (machinery)
7	**OPTICS TRADE, spol. s r.o.**	47,944,500	medium	parts and components
8	**LAMBERT ELECTRONIC s.r.o.**	30,706,000	medium	parts and components
9	**DCT Czech s.r.o.**	30,465,000	medium	equipment (machinery)
10	**PBT Rožnov p.R., s.r.o.**	23,525,667	medium	equipment (machinery)

**of the 78 manufacturers involved in the semiconductor supply chain*

Source: authors' own analysis, CzechInvest, Dun&Bradstreet, Hoovers

Evaluation of Interviews

Semi-structured interviews were conducted in a total of 33 companies operating in the semiconductor industry, representing 42% of the 78 companies identified as operating in the semiconductor industry. The interviewers sought to conduct interviews in all companies whose involvement in the semiconductor industry is significant. Due to the uneven regional distribution of companies across Czech regions, a concentration of visited companies is also evident in the Zlín Region (12), the South Moravian Region (8) and the City of Prague (8). In the other regions, only managers of one or two companies were interviewed.

Nature of companies' involvement in the semiconductor industry

At the beginning of the interview, respondents were asked to specify the company's product or product portfolio related to the semiconductor industry. Products included various types of detectors, particle imaging cameras, telecommunications equipment, integrated circuits for electronic or mechanical devices, machines for chip manufacturing and inspection, etc. Respondents were also asked to indicate whether these products constituted the company's main or rather supplementary production programme. For two thirds of the companies, production related to the semiconductor industry is the main or essential activity, confirming the appropriateness of the selection of companies by the interviewers.

It was not only companies directly involved in the semiconductor production chain as manufacturers or suppliers that were contacted, but also the most significant users of semiconductor components, most often chips. Respondents, usually senior managers of the companies approached, answered the question of what role their company plays in the supply chain. A total of 16 companies were part of the supply chain, 10 companies were part of the supply chain while also being users of semiconductor components (chips), and the remaining 6 companies were only users. The final company approached is a major supplier of chemicals for various industrial sectors and therefore constitutes a specific type.

Figure 25: Role of the Semiconductor Industry in the Company's Production Programme and the Company's Position within the Semiconductor Value Chain

Position in the semiconductor value chain	Role of the semiconductor industry in the company's production programme			
	Core/main	Supplementary	Other	Total
Part of the supply chain	9	7	–	16
The user of semiconductor components (chips) is also part of the supply chain	9	1	–	10
User of semiconductor components (chips)	2	4	–	6
Other – chemical supplier	–	–	1	1
Total	**20**	**12**	**1**	**33**

Source: authors' own analysis, interviews

Most companies for which production for the semiconductor supply chain is critical and which form a direct part of that supply chain occupy the position of second- or third-tier suppliers. In three cases, these are manufacturers of cleanroom or manufacturers of machinery and lines for the semiconductor industry, which can be considered first-tier manufacturers.

Respondents were asked to specify the production segment within the semiconductor industry in which they operate. Several respondents mentioned more than one segment, so the resulting value is higher than the number of companies visited.

Figure 26: Activities of Companies across Manufacturing Segments of the Semiconductor Industry

Manufacturing segment	Number of companies
Equipment (machinery)	13
Design (of chips)	8
Parts and components	8
Inspection and metrology	6
Frontend manufacturing	5
Backend manufacturing	2
Semiconductor wafer production	2
Facilities	2
Chemicals	1
Outside the semiconductor industry	6
Total	53

Source: authors' own analysis, interviews

Companies that are also or only users of semiconductor components apply them mainly in the automotive industry, aerospace, medical technology and telecommunications technologies.

Main perceived risks and opportunities in the semiconductor industry

One important theme of the semi-structured interviews was the risks and opportunities arising from the specific positions of the interviewed companies in the supply chain.

The main **risks** cited by company management were as follows:

- lack of qualified/specialist human resources,
- long and demanding development of new related technologies,
- dependence on SE Asia and Europe's lack of self-sufficiency,
- highly expensive production of specific chips,
- various geopolitical risks,
- dependence on specific chip suppliers (risk for users).

No clear differences were identified in the perceived risks across different types of companies. The most frequently mentioned risk — the lack of human resources — was reported by the management of both domestic and foreign companies, as well as small and large companies.

On the other hand, the most frequent **opportunities** they mentioned included:

- moving up the supply chain towards more complex products and systems, i.e. products with higher added value (functional upgrading),
- in-house development of design and technological solutions,
- overall company growth in terms of the number of employees and contracts,
- expansion of activities abroad (Germany),
- technological advancement, the integration of artificial intelligence and the use of new materials,
- the use of potential investment opportunities,
- reduced dependence on existing chip suppliers (users).

Companies see the most significant opportunity in the development and production of more sophisticated and complex systems, an ambition shared by both domestic and foreign companies.

Involvement of semiconductor companies in the global division of labour

A total of 15 companies (out of the 33 surveyed) did not list customers from Czechia among their main markets, which corresponds to the very high globalization of this sector. In these cases, the main markets consisted mainly of customers from Western Europe, the USA, Canada, Japan, China and SE Asia, and in one case also Africa and Latin America. Other companies have their main sales in Czechia, but they also have important customers on international markets — again primarily in European countries, as well as in the USA, Canada, China, India, South East Asia and Australia.

When company representatives were asked to name their main customers, large companies were mentioned most frequently, such as CEZ, Škoda Auto, Continental, Advacam, Siemens, CEPS, Thermo Fisher, ON Semiconductor and Hitachi, as well as various research organisations and ministries to which companies supply next-generation communication networks, particularly in the field of critical infrastructure.

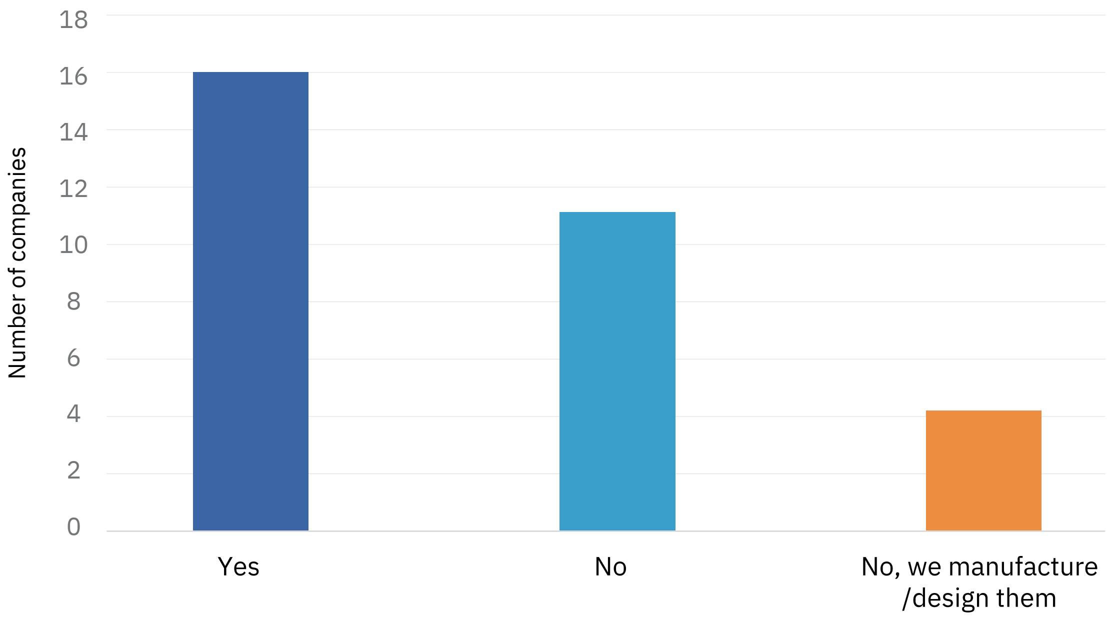
Approximately two-thirds of companies have a stable customer portfolio, while the remaining third must continuously engage in acquiring and retaining clients.

The situation is very similar in terms of supplier markets and companies. Eleven of the surveyed companies have no primary suppliers in Czechia. These companies have their key suppliers in Western Europe, the USA, Canada, Japan, China, Israel and Taiwan. Other companies list Czechia first, followed by the countries mentioned above. These findings further confirm the high degree of internationalisation of production in the semiconductor industry.

Around half of the 33 companies mentioned specific suppliers, with only ON Semiconductor, TSMC and Intel mentioned more than once. Other suppliers mentioned individually included Wittig Electronic, PBT Works, Essemtec, Marvell and Analog Devices. Some respondents explicitly stated that this information was confidential and declined to disclose specific supplier companies.

A total of 16 companies (out of the 33 surveyed) purchase chips, 4 companies either manufacture or design them directly, 11 companies do not purchase chips, and the remaining 2 did not answer the question. If companies purchase chips, they mostly source them from suppliers in Czechia, USA and Canada, Western Europe, and less frequently from Taiwan, Great Britain, Japan, China, Israel and other European countries (Slovakia, Poland, Norway, Switzerland, etc.). The responses show that most companies buy chips from several countries, reflecting the fact that there are many different types of chips and that companies producing them often specialise in only certain types or groups. Only four companies reported a dominant supplier from a single country, namely Czechia (1), Taiwan (1) and the USA (2).

Figure 27: Does Your Company Purchase Chips?



Source: authors' own analysis, interviews

In eight cases companies purchase purely standard commercially available chips, seven companies purchase either commercial or specialised chips according to specific customer requirements, and three companies focus purely on a specific type of chips, such as those for radiation-intensive environments. Other company representatives did not answer this question.

Qualifications and availability of human resources

Respondents listed a relatively wide range of professions that companies need and will need in the next five years. During the 13 interviews, companies particularly emphasised the need for software engineers proficient in machine learning, embedded software, or software/firmware. Similarly, companies require specialists in electrical engineering (11), systems engineers/designers (10), process engineers (6), application engineers (5) and analogue engineers (4). The need for data specialists, logistics experts and testing experts was also mentioned several times.

In some cases, however, companies face difficulties in recruiting and retaining highly skilled blue-collar workers. One manager commented: *"We have no problem recruiting university graduates; many of our long-term employees are graduates of the Faculty of Mathematics and Physics at Charles University or the University of Chemistry and Technology. The problem is with highly skilled workers. Although they earn around CZK 70 thousand, they don't want to work two shifts".*

Other managers described a different experience: *"There is a long-term shortage of qualified employees in Czechia. Universities are producing to few designers specialising in analogue and digital chip design. This small number of qualified professionals is absorbed by all chip design companies, which is why we have had to resort to recruiting people from outside the EU."*

Only in one of the 33 companies visited did not perceive a shortage of skilled professionals or anticipate any workforce problems.

Closely related to the necessary professions are the competencies that companies consider to be crucial in the near future. Company management consistently agreed on the need for expertise in artificial intelligence, data analysis, system architectures, HW/SW integration, skills related to security and reliability, knowledge of applications, etc. They are also aware of the importance of covering most of these competencies. However, they do not perceive any major differences between the need for professions and competencies in the short and long term and expect current needs to remain similar in five years or more.

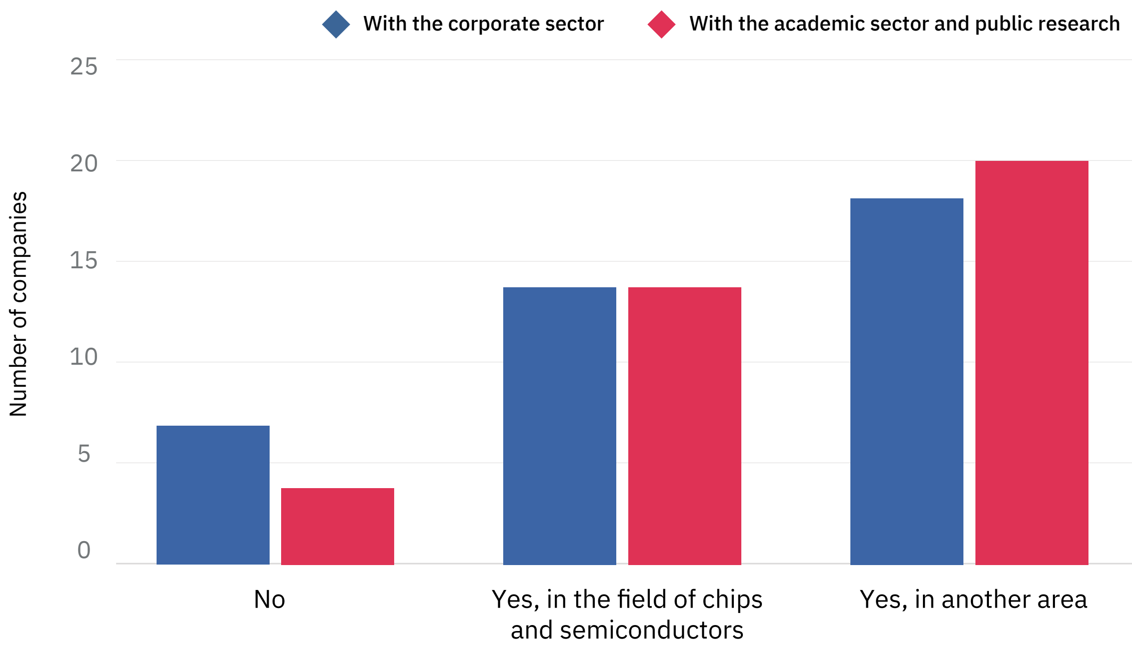
Research and development and the role of the National Competence Centre

A total of eight companies (out of 33 surveyed) cooperate in research and development with the corporate, academic and public sectors in the field of chips and semiconductors as well as in other areas. In these cases, the main academic partners include CTU, Charles University, Brno University of Technology, the University of West Bohemia, Palacký University and VSB — Technical University of Ostrava, as well as universities abroad, such as Arizona State University. Corporate partners include ON Semiconductor, Thermo Fisher and the public research organisations CEITEC, HiLase and the Czech Academy of Sciences. In three cases, respondents declined to give the specific names of the organisations they work with.

If companies only work with the corporate sector in the semiconductor industry, their main partners include IMT, Diveli and Unites. In other areas, respondents did not specify names.

On the other hand, if companies cooperate on semiconductor R&D only with academic and public research partners, these include the University of Chemistry and Technology Prague, CTU, the University of Hradec Králové, Brno University of Technology, the Institute of Physics of the Czech Academy of Sciences and CESNET. For research and development in other areas, partners again include Brno University of Technology, as well as Masaryk University Brno, CEITEC, Comenius University in Bratislava and CESNET.

Figure 28: Cooperation in Research and Development*



**Some companies reported more than one option, i.e. they collaborate with the corporate and academic sectors in the field of chips, but only with the corporate sector in other areas.*

Source: authors' own analysis, interviews

Examples of specific research projects include:

- new technological platforms for producing power semiconductor modules to improve energy efficiency in industry,
- development of innovative packaging solutions for optoelectronic components,
- software development,
- development of instrumentation for the semiconductor industry,
- development of low-loss power supplies for furnaces,
- development projects related to solar cells.

In a total of three cases companies do not collaborate on research and development and conduct their research independently.

Needs related to access to advanced pilot lines and equipment, including chip manufacturing infrastructure — as expected, for example, from the National Competence Centre — vary among the companies surveyed. Eight companies stated that they require small batch production or prototyping, and five indicated the need to use external services, as specified below.

Most, however, stated that such facilities were not relevant for the company (e.g. they do not manufacture chips) or that these needs do not currently exist.

Companies were also asked whether they have specific projects and initiatives could benefit from such approaches; the answers are summarised in the table below.

Figure 29: Existence of Specific Projects That Could Benefit from Access to Pilot Lines Provided by the National Competence Centre

Existence	Number of companies
Yes	8
No	16
No, but relevant in the future	8
No response	1
Total	**33**

Source: authors' own analysis, interviews

In five out of the eight cases where respondents answered "yes", they also mentioned specific projects:

- development of proprietary chip design,
- advanced semiconductor devices based on wide-bandgap materials,
- PL4 WBG — silicon carbide technology,
- European projects focused on the use of GaN and SiC materials within Horizon Europe/ Chips JU,
- preparation of samples and subsequent testing and validation of proprietary technologies.

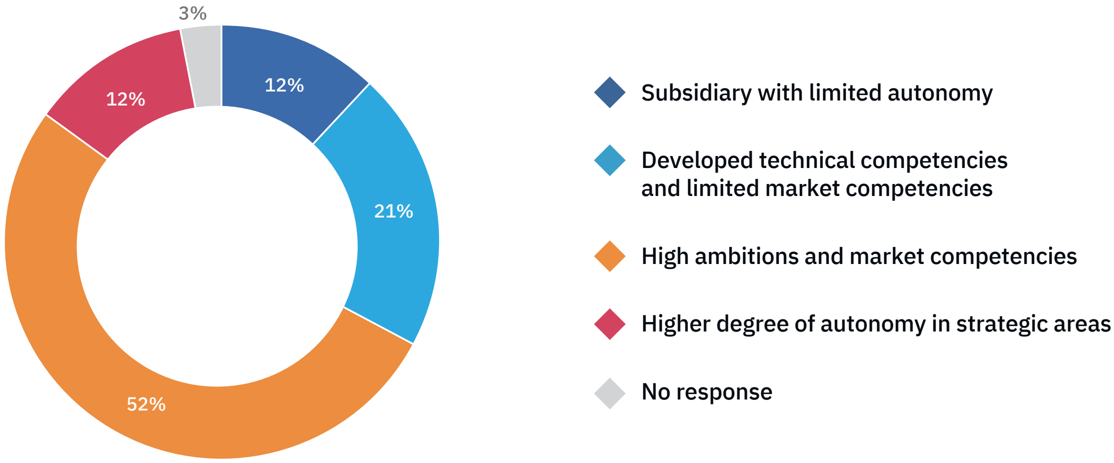
When asked what type of support they would consider valuable for the effective use of the National Competence Centre for chip design and manufacturing, the most frequent response was support for collaboration, market knowledge and analysis of key players (11 companies). Another topic mentioned was support for graduate training in technological fields and the preparation of potential employees (4 companies). Several respondents also mentioned small-scale production, investment support and metrology and testing services. One respondent openly stated that they were sceptical about the concept of competence centres.

In general, the strategy and ambitions of most companies are as follows:

- To maintain their position as a global/European leader in their specialty and remain a quality and reliable supplier.
- Invest in company growth, increase production capacity, acquire new technologies and expand the workforce.
- Shift towards more complex manufacturing with higher added value (functional upgrading), penetrate further into the semiconductor value chain (or other sectors — intersectoral upgrading).
- Maintain and deepen established partnerships and cooperation, including in R&D (with universities, municipalities, etc.).

The type of strategic management within companies is very important in terms of its impacts and benefits for regional development. Ideally, companies should be autonomous in strategic management while also possessing advanced technical competencies. The chart below (Figure 30) categorises the surveyed companies according to their strategic management. It is clear that approximately 12% of companies do not decide independently about their future direction, but are subject to decisions made by the parent company.

Figure 30: Types of Companies by Their Strategic Management



Source: authors' own analysis, interviews

Companies face various challenges in pursuiing their visions. The main challenges identified by company management include:

- insufficient skilled labour and talent (6),
- an unstable business environment in the current geopolitical situation (5),
- competition from Asia (3),
- finding new customers (2),
- establishing themselves abroad (2),
- expanding development activities (2).

However, other obstacles were also mentioned, such as rapidly changing trends, the mindset of people and institutions, and heavy reliance on the supply chain.

Respondents identified *artificial intelligence* (mentioned in 14 cases) and *robotization/automation* (in 7 cases) as the key technological trends that will affect companies in the near future (within approximately the next five years). The need to implement *sustainable production and sustainable materials* (decarbonisation, renewable energy energy sources, etc.) was also mentioned several times. In semiconductor component manufacturing technologies, respondents expect a transition to silicon carbide-based semiconductors and other technological modifications, such as the use of thinner wafers.

Research, development and innovation

For a long time, developments in the semiconductor industry have closely followed the predictions of Moore's Law, which states that the number of transistors on a chip doubles every 18 to 24 months (Miller, 2024). However, current lithography technologies, where chip interconnections reach widths of only a few nanometres, are approaching quantum limits. The concept, known as "More than Moore", focuses on miniaturising components that have not yet reached such small structures, such as analogue circuits, passive components, photonic elements, sensors and radio-electronic components, and integrating them into digital microelectronic chips. However, another breakthrough in chip technology is quantum technologies, which transform the perception of quantum effects in extremely miniaturised elements from a hindrance into a potential advantage.

Globally, we can see very high R&D expenditure in the semiconductor industry. Relative to revenues, these expenditures exceed those of sectors such as pharmaceuticals or software development. Funding is primarily directed towards basic research and research related to suppliers of equipment and materials for the production of semiconductor components. Public support for research and development in value-chain segments closest to bringing final products to market negligible. Most of the monitored areas experienced a decline in financial allocations in 2021 and 2022. The research and development activities of companies were described in more detail in the previous chapter.

Academic institutions

Chip design is carried out by teams at the Faculty of Electrical Engineering of CTU (Department of Microelectronics), Faculty of Nuclear Sciences and Physical Engineering at CTU (CAPADS workplace), the Faculty of Information Technology at CTU (Department of Digital Design), the Faculty of Electrical Engineering and Communication at Brno University of Technology (Institute of Microelectronics), the Faculty of Information Technology at Brno University of Technology and the Faculty of Informatics at Masaryk University. Within the Czech Academy of Sciences, this research is conducted primarily at the Institute of Physics. The Institute of Photonics and Electronics of the CAS previously worked in this field but now focuses mainly on other topics. The Institute of Scientific Instruments of the Czech Academy of Sciences has long been developing and methodologically advancing electron lithography technologies for creating structures on chips and the fabrication of prototype chips. The Department of Electron Optics develops electron microscopy techniques for inspecting semiconductor structures, while the Department of Coherence Optics develops optical methods for wafer surface metrology.

Figure 31: SWOT analysis

Strengths

- Geographical proximity to major chip hubs in Europe
- Tradition of semiconductor component manufacturing
- Developed research, development and manufacturing:
  1. Power electronics
  2. Integrated circuit design
  3. Electron/ion microscopes
  4. Optoelectronics
  5. Radiation-hardened electronics
  6. Software tools
- Developed electron microscopy sector

Weaknesses

- Shortage of human resources (in the education system and the labour market)
- Insufficient funding for higher education
- Negatively perceived migration policy
- Insufficiently innovative environment

Opportunities

- Shortening of supply chains
- Efficient use of European initiatives
- Leveraging major semiconductor investments in neighbouring Member States
- Leveraging spillover effects linked to investments in major semiconductor regions
- Leveraging strong diplomatic relations with countries with strong technology sectors
- Effective use of European and cross-border initiatives

Threats

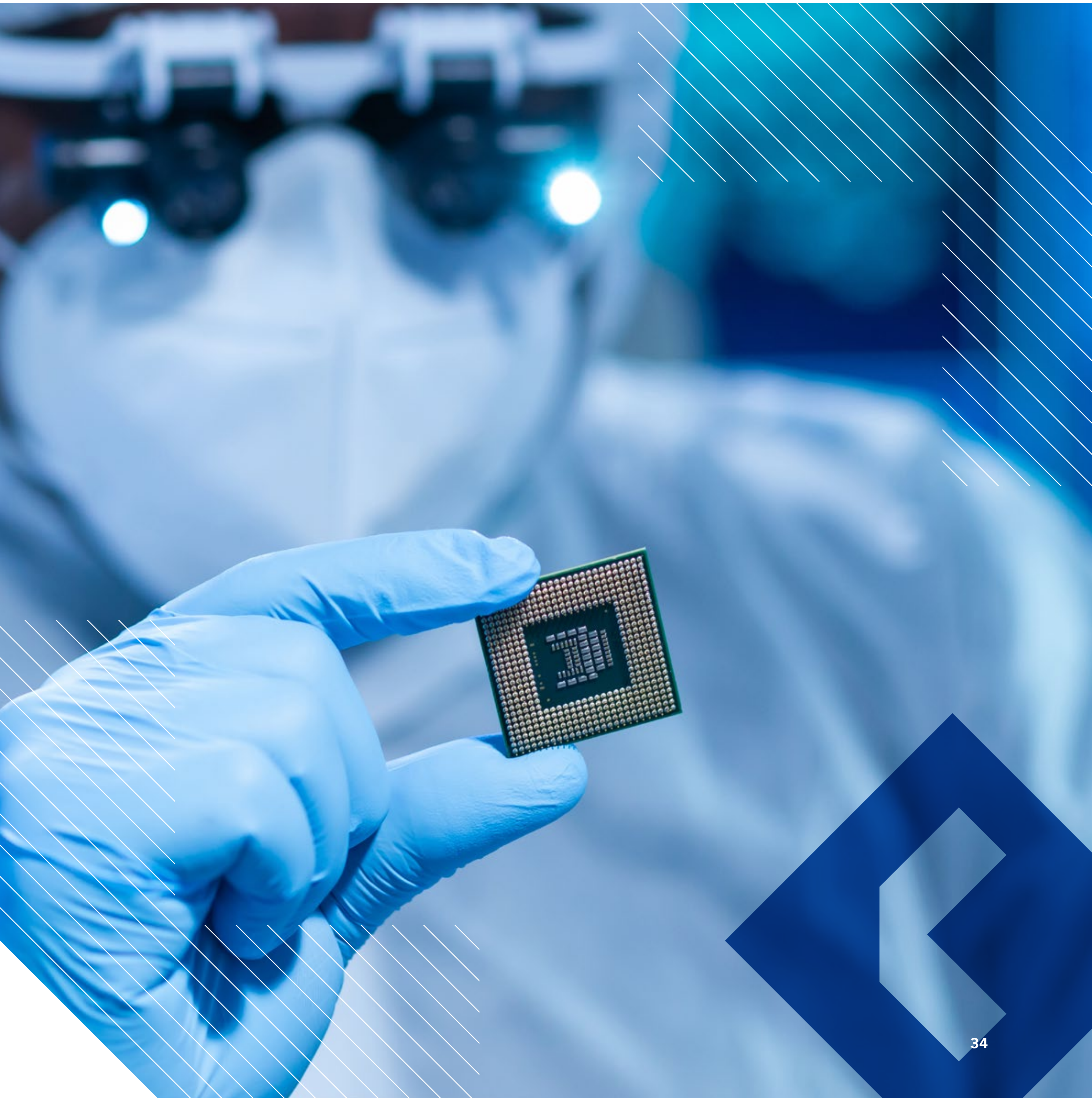
- Declining ability to attract investment in the technology sector compared with international competition
- Reduced attractiveness of the Czech Republic for international cooperation due to:
  1. Lack of resources for national co-financing
  2. Insufficient awareness of the semiconductor sector among economic diplomats
  3. Declining performance in research, development and innovation
- Outflow of human capital abroad
- Outflow of experts from the education system due to possible insufficient funding
- Outflow of foreign investment to other jurisdictions due to subsidy competition
- Disruptions in semiconductor supply chains and their impact on the functioning of the sector due to insufficient diversification of input sources
- Loss of sector competitiveness as a result of illegitimate transfers of intellectual property
- Contamination of the sector by high-risk entities and the subsequent reduction of its role in the global supply chain

Source: National Semiconductor Strategy 2024

The Czech semiconductor ecosystem stands at the threshold of significant development, supported by the ambitious goals of the National Semiconductor Strategy. The sector is also listed among the priorities of the Economic Strategy of the Czech Republic. The implementation of measures defined in the European Chips Act by the end of 2026 also represents a key step making the Czech semiconductor industry competitive at the global level.

Objectives of the National Semiconductor Strategy:

1. Implement the measures defined in the European Chips Act by the end of 2026.
2. Increase the share of semiconductor technologies in Czech exports by 200% by the end of 2029 compared with 2022.
3. Ensure at least CZK 300 million per year for semiconductor research and development by the end of 2029.
4. Ensure that by the end of 2029, there will be at least 9,000 specialists working in the semiconductor industry in the Czech economy.
5. By the end of 2029, increase the financial value of semiconductor component production in Czechia by at least 300% compared with 2022.



Conclusion

Semiconductors are a key technology of the 21st century, forming the basis of modern digital devices and information technologies that are used in virtually every sector of the modern economy. Czechia has a long history of semiconductor production and research dating back to the socialist era. Following the political transformation in 1989, the semiconductor industry underwent a major restructuring, bringing an influx of foreign investors and the establishment of new companies.

The global semiconductor industry is characterised by a high degree of specialisation amongst companies, regions or countries in particular stages of the production of specific types of semiconductor products, as well as a manufacturing companies' strong dependence on a small number of suppliers of critical technologies, equipment and raw materials often located on other continents. Semiconductor manufacturing is therefore an industry with an extremely high level of globalisation. Geopolitical tensions, trade disputes and the concentration of production in only a few countries therefore represent significant risks. Technological innovations and government programmes such as the US Chips Act and the European Chips Act therefore aim to strengthen domestic production and reduce dependence on foreign suppliers.

The European Union is a major net importer of semiconductors, with a significant proportion of imports coming from China and Taiwan. European companies play a key role in the global semiconductor supply chain, particularly in the supply of machinery (the company Dutch ASML is a world leader in photolithography) and certain materials. However, Europe's share in chip manufacturing and design remains weaker.

The analysis of the semiconductor value chain in Czechia was carried out using a combination of quantitative and qualitative approaches. The analysis focused on 121 companies involved in the semiconductor industry in Czechia, examining their economic characteristics, ownership structures and their contributions to the host economy. Roughly two-thirds of the companies (78) in the sample are directly involved in the semiconductor industry, with the remaining 43 companies represent significant users of semiconductor products. The analysis also assesses the financial health of these companies and their investment activities.

In the first part of the analysis, the basic economic characteristics for 121 companies involved in the semiconductor industry were identified. Almost two-thirds of the companies (76) are domestically owned, i.e. Czech-owned, and the vast majority are small and medium-sized enterprises. One quarter (30) of all companies have a European owner (excluding Czech ownership), exclusively from Western European countries. Most often from Germany (10), Luxembourg (6) and France (3). A total of 11 companies have a US owner, and these are most often large companies. The smallest group, perhaps somewhat surprisingly, consists of companies with an Asian owner, either from Japan or South Korea.

Companies involved in the semiconductor industry (78 companies) specialise in semiconductors for various target sectors such as automotive, medical technology, aviation and aerospace. Production segments include the manufacture of equipment and machinery, parts and components, chip design, chemicals and raw materials, backend manufacturing and frontend manufacturing. Almost a fifth of companies (18%) supply products to the automotive industry, often including optoelectronic and autonomous systems, power and sensing technologies, parking or temperature sensors, headlights, etc. The second most frequently mentioned sector is medicine or medical technology (12%), where companies supply various medical electronics, laser equipment, radiofrequency solutions for magnetic resonance imaging and components for electron microscopes. This is followed by the aerospace sector, to which 11% of the companies in our sample supply semiconductor components or products.

Research and development are key activities for companies in this sector, confirming the need for continuous innovation and investment. Data from the Czech Statistical Office show that both the number of entities conducting R&D and R&D expenditure have increased significantly over the last 14 years. In 2023, 75 companies were registered as conducting R&D in the semiconductor industry, almost double the number in 2010. R&D expenditure almost tripled during the period under review.

Economic indicators such as turnover and operating profit show the dominance of large foreign companies in the semiconductor industry. Companies engaged in frontend and backend manufacturing achieve the highest turnover and operating results. The average annual turnover of companies by size and ownership shows that foreign companies achieve higher turnover across size categories. Large foreign companies are therefore the key and most significant players in this sector.

Companies face various challenges such as a shortage of qualified labour, an unstable business environment, competition from Asia and the need for continuous innovation. Key technology trends for the next five years include artificial intelligence, robotics/automation and sustainable manufacturing. Companies perceive the need for expertise in artificial intelligence, data analysis, system architectures, HW/SW integration, safety and reliability skills and application knowledge.

Czechia has a long history of semiconductor manufacturing, dating back to the mid-20th century. Today, the country is a major player in several segments of the global semiconductor market, with companies such as Hitachi and Onsemi ranking among global leaders and investing significantly in the development and production of new technologies. A unique feature of the Czech semiconductor industry, with significant future potential, is the high level of localisation of suppliers within the power chip production chain. The Czech semiconductor value chain also excels in the production of highly specialised machinery and equipment for the manufacture of integrated circuits, as well as in chip design. A strategic objective for supporting the semiconductor industry in Czechia should therefore focus primarily on further developing the production chain in the power chip industry and supporting companies producing highly specialised machinery and equipment for the semiconductor industry, as well as those specialising in chip design.

The Czech semiconductor industry has great potential to contribute to European efforts to strengthen global competitiveness and self-sufficiency in this strategic sector, both through the further expansion of global semiconductor companies located in Czechia and through Czech companies that have successfully entered several important segments of the global semiconductor industry.
One essential prerequisite for the further development of the semiconductor industry in Czechia in the current period of geopolitical tension is to strengthen cooperation between research organisations, universities and private companies both within Czechia and internationally (particularly within the EU), as well as targeted public support for companies based on a strong understanding of their needs, challenges and opportunities.

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Annexes

1. Interview questionnaire

Structured interview

The following questionnaire has been compiled in order to effectively identify your needs, establish cooperation and prepare services for end users according to their current requirements:

1. What role does the semiconductor value chain play in your company's **production programme**?

- Is it new, supplementary, essential, etc.?
- What is your specific focus?
- Is it a final product?

Is your company:

a) Part of the semiconductor manufacturing supply chain? If so, in which segment(s)?

- facilities (microelectronics production plants and buildings, including media distribution, waste and chemical management, cleanroom production, air conditioning, etc.),
- equipment (machines),
- advanced process control,
- chemicals,
- parts and components,
- design (of chips),
- inspection and metrology,
- semiconductor wafer production,
- mask production,
- frontend manufacturing (production of microchips, circuits and transistors on semiconductor wafers),
- backend manufacturing (separation of semiconductor wafers into individual chips, packaging, integration into systems, etc.).

b) A user of semiconductor components for various applications in other value chains? If so, in which area(s)?

- Automotive industry,
- aviation, aerospace and space,
- medical technology,
- (cyber)security,
- defence,
- computing and communication technologies,
- metrology,
- other — please specify.

c) Both a supplier and a user? Specify according to the segmentation in points 1a and 1b.

2. What is the current situation in this area within your company?

- What do you see as the main opportunities?
- What are the main risks for your company?

3. What is your company's position in the value chain (if the company is a supplier)? (note: if the company is a user of semiconductor components, proceed to question 6).

4. Where are your main markets? Who are your main **customers** (if the company is a supplier)? Is it a long-term cooperation or do you have to compete for new customers?

5. Are your **key suppliers** from Czechia, EU countries or outside the EU? (dependence on suppliers from third countries) /applies to answer 1a/.

If your company is a user of semiconductor components, **is it dependent on chip suppliers**?

- Where do you source your chips from? (dependence on suppliers from third countries)
- What type of chips do you need? (standard commercially available chips, specialised chips based on specific company requirements, or do you design/manufacture chips yourself?)

6. What do you see as the main risks for your company arising from your position in the supply chain? (applies to both types of companies; for users, specifically identify dependence on chip suppliers)

7. If your company is a user of semiconductor components, what are your main challenges:

a) In the availability of qualified labour?

How many employees do you lack in the following junior and senior positions (segmentation according to the Skills Observatory[1]):

- software engineers: embedded software, software/firmware, machine learning,
- systems engineers/designers,
- analogue engineers/designers,
- process engineers,
- data specialists,
- maintenance technicians,
- machine learning specialists (machine learning engineers),
- advanced systems architecture designers,
- system testing engineers,
- advanced analogue designers, particularly with strong programming skills,
- application engineers — specialists in specific application areas (automotive industry, etc.),
- senior managers,
- supply chain/logistics specialists,
- new emerging job profiles[2]?

b) In expertise in key areas?

Do you need tosupplement the training of existing staff or do you need new experts in the following areas? (segmentation according to the Skills Observatory):

- System architectures. Knowledge of system architectures: SoC, SiP, complex ASICs and the ability to design them.
- Data analysis. Increasingly required in industry.
- Artificial intelligence/machine learning.
- Analogue design.
- Knowledge of applications (application specifics, interconnection of components, materials, design constraints).
- Quality — skills related to reliability.
- Safety-related skills.
- Hardware/software integration.
- Knowledge of new materials for process and materials engineers.
- Other missing competencies or qualifications.

c) Which professions and competencies do you see as key for your activities in the medium and long term (5 years and more)? (open question)

(d) In access to advanced pilot lines and facilities, including chip manufacturing infrastructure?

Do you need:

- Small-series production or prototyping?
- Use of external services (outsourced development)?
- Anything else?

[1] The Skills Observatory working group was established within the EU Chips Skills Alliance to monitor trends in skills and emerging job profiles in microelectronics.

[2]
- Microelectronics Design Engineer => Focuses on the development and design of system, from the highest packaging level down to the integrated circuit level. Possesses system-level understanding with knowledge of analogue and digital circuits and the integration of technological processes. Has a broad understanding of the fundamentals of microelectronic sensors.
- Smart Manufacturing Engineer in Microelectronics => Designs, plans and oversees the manufacturing and assembly of electronic devices and products, such as integrated circuits, automotive electronics and smartphones in environments aligned with the requirements of Industry 4.0.
- Materials Engineer for Microelectronics => Designs, develops and oversees the production of materials required for microelectronics and microelectromechanical systems (MEMS) and is able to apply them in these devices, instruments and products.
- Microelectronics Maintenance Technician => Responsible for preventive and corrective maintenance in semiconductor manufacturing.

8. If your company is a supplier, what are the needs:

a) In the availability of qualified labour?

- how many specialists are you missing?
- in what areas of expertise? Please specify (see segmentation in Question 9)

b) In access to advanced pilot lines and facilities (infrastructure)?

- Use of external services (outsourced development).
- Other needs.

9. Are there specific projects or initiatives in your company that could benefit from **access to pilot lines and/or a design platform** provided by the National Competence Centre?

Pilot lines:

1. Advanced sub-2nm state-of-the-art system-on-chip technology. This pilot line will focus on the development of state-of-the-art technology for advanced semiconductors of 2 nm and below, which will play a critical role in applications ranging from computing and communications devices to transportation systems and critical infrastructure.

2. Advanced fully depleted silicon-on-insulator technologies targeting 7 nm — This transistor architecture is a European innovation and offers significant advantages for high-speed and energy-efficient applications. The roadmap towards 7nm will pave the way for a new generation of high-performance semiconductor devices with low power consumption.

3. Heterogeneous system integration and assembly with the following consortium: Heterogeneous integration is becoming an increasingly attractive technology for innovation and performance improvement. It involves the use of advanced packaging technologies and new techniques to combine semiconductor materials, circuits or components into a single compact system.

4. Advanced semiconductor devices based on wide-bandgap materials — The focus will be on materials that allow electronic devices to operate at much higher voltages, frequencies and temperatures than standard silicon-based devices. Wide-bandgap and ultra-wide bandgap semiconductors are essential for the development of highly efficient power electronics and lighter and cheaper radio-frequency electronics.

a) If so, please briefly describe them.

b)If not, would this be relevant for you in the future?

10. Does your company already cooperate with academic (educational and research) institutions and other industrial partners in joint research and development:

a) in general?

b) in the field of chips and semiconductors?

- How?
- With whom?
- How satisfied are you?
- What are your future plans in this regard?
- Are you considering new models of cooperation?

11. What additional support or external services would you consider valuable for your company in effectively using the National Competence Centre for chip design and manufacturing?

12. What is **your company's the strategy and ambition**? Where do you want to move in the future?

The aim is to determine whether the company:

- is a subsidiary with limited autonomy,
- has a higher degree of autonomy in strategic areas,
- has developed technical competencies but limited market competencies,
- has high ambitions and market competencies.

13. What are the main **challenges** your company faces in achieving its **business vision**?

14. What technological trends will influence your company in the future, over the next 5 years?

Background information on the national competence centre for chips and semiconductors

The questionnaire aims to assess the specific needs and interests of companies as potential users of the resources and opportunities offered by the National Competence Centre for Chips and Semiconductors. This centre (a non-profit organisation) is currently being prepared under Pillar 1 of the Chips for Europe Initiative under the European Chips Act. The project is scheduled to start in January 2025 following approval and funding by the European Commission.

The main role of the centre is to:

- Provide users (SMEs and start-ups, as well as academic institutions) with access to design platforms and pilot lines.
- Guide users to infrastructure and break down barriers for fabless companies.
- Ensure links to the European network of competence centres.
- Build a communication, information and advisory centre to support the development of semiconductor technologies.
- Connect the industrial ecosystem of collaborating companies and research organisations in Czechia and link it to the pan-European network.
- Intensify technology transfer between academia and industry.
- Support the creation and growth of existing Czech and other European SMEs in the semiconductor industry (particularly in design and instrumentation).
- Increase human capacity, identify and develop talent and enhance skills and competencies within the semiconductor ecosystem, particularly in microelectronics, to ensure a sufficient supply of qualified labour for companies.

These services will be offered free of charge to SMEs and start-ups (large companies will pay market price). The consortium consists of partners from academia, industry and the public sector.

This national centre focuses on several areas in which the Czech semiconductor value chain is strong:

1. Wide-bandgap semiconductors — such as silicon carbide or gallium nitride — for power electronics including new semiconductor structures.
2. Design tools such as processor design using **RISC-V technology** (an open standard reduced instruction set)[3] and EDA (Electronic Design Automation): implementation, demonstration, differentiation, customisation, use cases (AI/ML, security, automotive), and Cheri memory architecture.
3. Analytical tools for design verification and prototyping (e.g. using microscopic and spectroscopic methods), as well as tools for quality management and production efficiency in chip manufacturing.
4. Artificial intelligence in semiconductor manufacturing processes and applications, e.g. in cybersecurity, biomedical and space chips, the transition from automation to autonomy, and smart sensors.
5. Adaptive, self-learning technologies (a foundation for autonomous systems), low-power AI for applications such as future generations of IoT and energy grids, the aerospace and automotive industries, and customised chips.

However, these core competencies will not be the only ones defining the scope for cooperation between the national competence centre and end users (your company), as each national competence centre will be connected to the European network of competence centres in other Member States. This ensures complementarity and synergy of competencies in semiconductor technologies across the EU, as well as links to pilot lines and the design platform.

[3] RISC refers to processors with a reduced instruction set architecture, whose design focuses on a simple, highly optimised set of machine instructions, as opposed to architectures with a large number of specialised instructions.