

Germany in the semiconductor supply chain: vulnerable on the imports side

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Authors: Gianni Pasqual, telephone +49 (0)69 7431-55074, gianni.pasqual@kfw.de
Dr Katrin Ullrich, +49 (0)69 7431-9791, katrin.ullrich@kfw.de

There is more to the semiconductor value chain than the production of microchips

The international semiconductor value chain is geared to efficiency. It comprises more than contract manufacturing of the most advanced microchips in Taiwan, which is often under the microscope. According to the [EU Commission](#), Europe has significant market share in machines used in the manufacture of semiconductors (21%) and materials and wafers (14%), while its shares are comparatively low in semiconductor design (8%) manufacture in a narrower sense (7%), the two stages with the highest value added.

The question arises how resilient these international supply and value chains are, among other things given the risk of geoeconomic fragmentation. Germany's direct integration into international trade provides a first indication of how vulnerable the country is in the semiconductor supply chain.

Germany is more than a net importer of semiconductors

The composition of a country's international trade is, of course, determined by its position in the value chain. For Germany, it pays to look at the detail (see table):

- In 2023, the category of memories and processors had both the highest trade value (sum of exports and imports) and the highest net import value by which imports exceeded exports. This was mainly attributable to the subcategories of processors and circuits. But in individual subcategories such as integrated multi-component integrated circuits, which are used in many areas such as automation, the automotive industry, micro- and optoelectronics, Germany exported more than it imported.

- In semiconductor devices, which had the second-highest trade value, net imports were driven by solar cells and panels. Within this group, however, transistors (used as electronic switches, among other things) with a dissipation rate of more than 1 Watt had the highest trade value. Here as well, Germany exported than it imported.
- Medium technology machines is generally a strength of the German economy. Indeed, Germany has an export surplus in all subgroups of machines for the manufacture of semiconductors and similar devices. But the trade value is significantly lower than that of the other two groups of products.

Semiconductor import markets are more concentrated and dominated by non-European supplier countries

More highly concentrated markets are typically assumed to be more high-risk because there are fewer alternatives to turn to in case of a disruption in supply or demand. For Germany, country concentration is on average higher for imports than for exports in four of the six overarching groups of products (see figure). In two of these groups – semiconductor devices and solid-state data storage devices – Germany also has substantial net imports. A closer look confirms the high import concentration. In 44 of the 54 categories of goods examined, the import markets are more concentrated than the export markets (see table).

If we additionally take into account the degree of concentration, we see on average a high concentration of machines on both the exports and the imports side (HHI > 2000), which likely reflects the heavy specialisation.

Overall, this again illustrates the vulnerability of the imports side in detail.

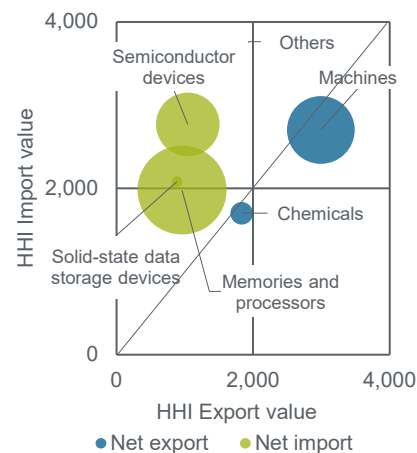
While there is a high concentration on the exports side in only seven groups of products, on the imports side it is 28 groups of products.

Furthermore, in imports the share of the largest, predominantly non-European import partner is often larger than the total import share coming from other EU countries. In exports, on the other hand, other EU countries are often the main target in the aggregate or even as individual countries. Machines and chemicals are again the exception since the production of semiconductors is concentrated in Asia.

On the imports side of the semiconductor supply chain, Germany's protection from geopolitical risks through the European internal market and short transport routes due to regional interlinkages therefore has only limited effect. It is therefore justified to shine a particular spotlight on the resilience of supply chains.

Figure: Groups of products belonging to the semiconductor value chain

Market concentration (avg. Herfindahl-Hirschman Index – HHI) and foreign trade balance (in USD million), 2023



Sources: Destatis, KfW Research

Table: Key figures of foreign trade of goods in the semiconductor value chain from Germany's perspective, 2023

	Goods number	Description	Trade value	Trade balance	Market concentration (Herfindahl-Hirschman Index – HHI)		Shares (in per cent)					
			In USD million	In USD million	Exports	Imports	Exports to the EU	Main destination country	Imports from the EU	Main supplier country		
Semiconductor devices	WA85412900	Transistors with a dissipation rate >=1 W	6,991	533	673	1,229	62.4	12.7	China	24.6	22.7	China
	WA85414300	Photo elements, assembled in modules or made up into panels	4,910	-2,593	817	7,623	77.3	18.2	Austria	7.4	87.1	China
	WA85411000	Diodes excl. photosensitive or light-emitting diodes	2,692	62	634	2,332	62.7	12.1	Netherlands	18.1	45.0	China
	WA85414100	Light-emitting diodes (LEDs)	1,942	187	489	2,400	58.5	11.5	Malaysia	4.9	34.4	China
	WA85414900	Photosensitive semiconductor devices, n.e.s.	1,451	-210	615	1,589	65.7	15.5	Netherlands	9.1	24.0	China
	WA85412100	Transistors, dissipation rate <1W	726	104	1,118	3,223	42.9	29.1	China	5.6	51.7	China
	WA85416000	Set or mounted piezo-electric crystals	629	140	789	1,555	37.5	17.0	China	22.5	24.0	Japan
	WA85413000	Thyristors, diacs and triacs	496	52	616	2,083	44.3	11.7	China	66.3	33.9	Hungary
	WA85415100	Semiconductor-based transducers	241	194	2,708	895	6.4	45.3	Taiwan	33.0	18.8	Taiwan
	WA85415900	Semiconductor elements, n.e.s.	209	97	1,263	1,117	53.0	24.0	Netherlands	26.3	21.8	The Philippines
	WA85419000	Parts of diodes, transistors	205	-52	1,267	3,179	31.5	28.4	China	21.5	53.9	China
	WA85414200	Photo elements, neither assembled in modules nor made up into panels	181	-128	1,573	5,983	74.6	37.1	Spain	11.9	76.5	China
	Total		20,674	-1,614								
	Average				1,047	2,767						
Memories and processors	WA85423190	Processors and controllers	22,207	-764	664	1,320	55.6	14.7	Taiwan	14.1	28.6	Taiwan
	WA85423990	Circuits, electronic, integrated	16,320	-2,155	482	1,067	50.0	9.7	Hungary	24.7	17.8	Taiwan
	WA85423911	Multi-component integrated circuits MCOs, n.e.s.	2,255	114	977	1,513	38.4	25.6	China	12.6	29.1	The Philippines
	WA85423111	Processors, multi-component integrated circuits MCOs	1,306	-22	854	1,690	71.7	21.6	Portugal	7.5	23.6	China
	WA85423390	Amplifiers, electronic integrated circuits, n.e.s.	1,249	73	826	1,386	48.7	16.6	Taiwan	9.7	27.3	Malaysia
	WA85423919	Integrated circuits according to note 12b, n.e.s.	661	-54	829	1,546	71.0	14.2	Netherlands	4.6	27.2	Malaysia
	WA85423239	Dynamic read/write memories >512 Mbit	639	-23	1,092	2,374	75.1	17.2	UK	2.2	36.0	Korea
	WA85423119	Processors as specified in note 12 (b) (3), n.e.s.	489	-26	766	1,273	74.5	17.0	Poland	23.8	27.4	Taiwan
	WA85423290	Memories in the form of multiple combinations	468	-142	1,078	2,858	84.8	24.4	Netherlands	5.3	48.6	Thailand
	WA85423275	Other programmable read-only memories	285	-12	675	1,570	79.4	13.7	Netherlands	14.2	27.1	Thailand
	WA85423269	Flash E2PROMS >512 Mbit	236	5	1,560	2,694	85.0	33.3	Hungary	2.1	37.8	Taiwan
	WA85423261	Flash E2PROMS <512 Mbit	202	-46	505	3,174	73.6	10.4	Hungary	5.2	53.1	Taiwan
	WA85423245	Static random access memories, cache RAMs	215	-97	1,630	2,739	81.6	36.8	Netherlands	1.9	41.6	Taiwan
	WA85429000	Parts of electronic integrated circuits	196	0	975	743	36.5	21.8	China	40.9	12.7	Japan
	WA85423231	Dynamic random access memories <=512 Mbit	93	-25	785	3,927	81.8	16.8	Hungary	3.1	54.6	Taiwan
	WA85423219	Memories according to note 12 (b) (3), n.e.s.	86	16	2,032	2,256	86.7	37.7	Poland	10.8	41.1	Taiwan

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	WA85423310	Amplifiers, multicomponent integrated circuits MCOs	36	-8	816	1,240	76.5	17.3	Austria	14.2	27.3	Mexico
	WA85423211	Memories for multicomponent integrated circuits MCOs	34	18	1,101	2,681	64.9	16.7	Netherlands	5.5	42.1	Taiwan
	WA85423255	UV erasable, programmable read-only memories	5	-1	615	1,527	47.0	12.8	USA	15.7	26.3	USA
	Total		46,982	-3,149								
	Average				961	1,978						
Machines	WA84869000	Parts and accessories for machines of the semiconductor industry, n.e.s.	2,306	573	2,376	1,705	62.6	45.2	Netherlands	29.2	33.8	USA
	WA84862000	Machines for the manufacture of semiconductor devices	1,870	125	1,238	1,891	23.7	25.1	China	11.7	35.4	Japan
	WA84861000	Machines for the manufacture of boules or wafers	1,030	664	1,892	2,537	23.1	37.1	China	4.3	41.9	Japan
	WA84864000	Machines specified in note 11 C to chapter 84	755	369	1,882	1,808	17.1	34.5	China	21.8	30.2	USA
	WA84561110	Machine tools operated by lasers, printed circuits	64	44	1,548	4,671	21.0	35.3	USA	74.6	66.1	Slovenia
	WA84863000	Machines for the manufacture of flat panel displays	48	47	2,015	3,589	10.6	31.3	China	39.1	43.7	USA
	WA84561210	Light and photon beam machine tools, circuits	0	0	10,000		100	100	Poland			
	Total		6,074	1,824								
	Average				2,993	2,700						
Chemicals	WA38180090	Chemical elements and compounds doped for use in electronics	366	121	1,802	1,768	18.5	25.8	Japan	10.1	28.0	Japan
	WA38180010	Silicon doped for use in electronics	1,388	84	1,869	1,632	13.4	31.2	Taiwan	14.0	31.0	Japan
	Total		1,754	205								
	Average				1,836	1,700						
Solid-state data storage devices	WA85235110	Solid-state data storage devices, unrecorded	1,255	-207	614	2,363	63.5	12.7	Poland	2.6	36.8	China
	WA85235190	Solid-state data storage devices, recorded	1,013	128	1,193	3,620	32.6	30.2	USA	11.3	58.6	China
	WA85235200	Smart cards	602	15	481	990	46.0	11.2	Austria	40.9	22.8	China
	WA85235910	Semiconductor media, unrecorded	56	13	1,186	1,139	41.5	30.6	USA	37.3	20.2	Czech Republic
	WA85235990	Semiconductor media, recorded, n.e.s.	50	4	961	2,292	43.2	25.7	Hong Kong	71.7	44.9	Poland
	Total		2,976	-47								
	Average				887	2,081						
Other	WA90314100	Optical instruments for inspecting semiconductor wafers or devices	427	155	1,622	3,480	10.5	28.6	China	4.1	55.1	Singapore
	WA84141015	Vacuum pumps for the manufacture of semiconductors	52	-34	1,506	5,237	49.4	27.4	France	3.0	68.9	Japan
	WA39231010	Boxes of plastic for the conveyance of semiconductor wafers	40	-17	998	1,076	53.1	18.3	Switzerland	35.6	19.4	China
	WA70200005	Quartz reactor tubes and holders	34	16	1,478	2,564	26.8	32.3	China	1.2	40.7	China
	WA39201023	Polyethylene film of a thickness of >=20 micrometres but <=40 micrometres used in the manufacture of semiconductors	19	-15	1,022	1,333	82.8	21.1	Netherlands	98.3	23.7	Austria

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WA39199020	Self-adhesive polishing pads for the manufacture of wafers	15	-10	3,516	4,179	86.8	58.1	France	8.9	55.1	USA
WA59119091	Self-adhesive circular polishing pads for the manufacture of wafers	7	-1	894	2,677	61.6	20.8	Austria	34.2	34.3	Japan
WA84431940	Printing machinery i.a. for use in the production of semiconductors	4	2	1,594	9,130	68.8	24.4	Italy	4.5	95.5	Japan
WA90112010	Photomicrographic microscopes for wafers or reticles	2	1	3,115	3,018	6.0	47.4	Singapore	1.1	41.3	Japan
Total		600	96								
Average				1,750	3,633						

Legend: Trade balance positive, negative; HHI<1000, >2000; EU trade share > share of largest non-EU trading partners, share of largest trading partner non-EU member > EU trade share; trading partner EU member. Sources: Destatis, KfW Research