

Semiconductor Industry: Strong Growth Prospects Justify Premium Valuation



Executive Summary

01

Semiconductor industry: A key growth driver of global economy

- Semiconductor, a critical component in electronic devices, is an essential part of the value chain in most industries.
- Sales are driven by rapidly growing demand from end-user segments, such as technology and communications, and exponential growth in the number of transistors housed in integrated circuits.
- Capacity grew steadily by 4% annually over the past two decades. However, demand has outpaced growth in supply, resulting in shortage.

02

Semiconductor supply chain highly concentrated, specialized and globally integrated

- Semiconductors are one of the most complicated products to design and manufacture. It requires very high R&D spending and upfront capital investment.
- No company, nation or even region is vertically integrated across the value chain. The US is by far the leader in design; fabrication, on the other hand, is highly concentrated in Asia, with the market leaders being Taiwan's TSMC and South Korea's Samsung.

03

High structural growth and profitability key positives

- Semiconductor manufacturers showed strong resilience to the sharp economic decline witnessed in 2020, contrary to their performance in previous downturns.
- Short supply of semiconductors, coupled with the emergence of the new coronavirus variant, has catapulted technology to the top again—the sector recorded highest shareholder return since early March 2020.

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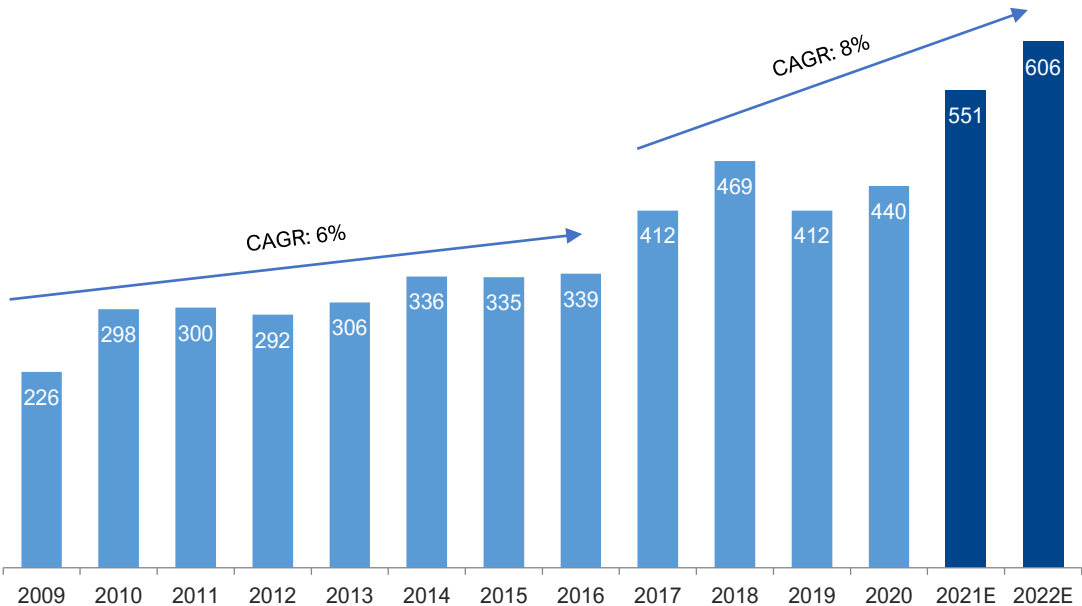
Fabless IC players lead the industry

- Fabless ICs continue to dominate the chips segment. Some of the market leaders in fabless ICs are Qualcomm, Broadcom, NVIDIA and AMD.
- Foundries and other vendors that cater to fabless players also stand to benefit from the secular growth trend.
- Due to these reasons, fabless IC players command higher valuation than other players in the industry.

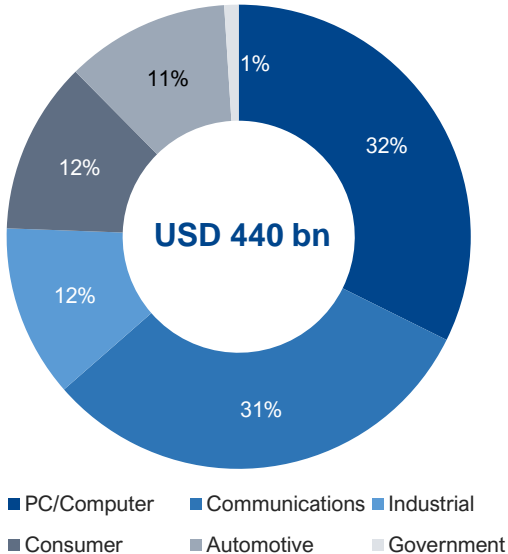
Robust growth in global semiconductor industry set to continue

- Semiconductors are the core building blocks of electronic devices, systems and applications, such as smartphones, automobiles, industrial equipment, smart home devices, personal computers, cloud computing, artificial intelligence (AI), quantum computing, data networking, and 5G wireless infrastructure.
- Semiconductors are the fourth most traded product in the world (both imports and exports), after crude oil, refined oil and cars.
- The World Semiconductor Trade Statistics (WSTS) forecasts the market to grow to USD606 billion by 2022, driven by growth in the computer and communications segments.

Global Semiconductor Market Size (USD bn)



Semiconductor Demand Share by End Use (2020)

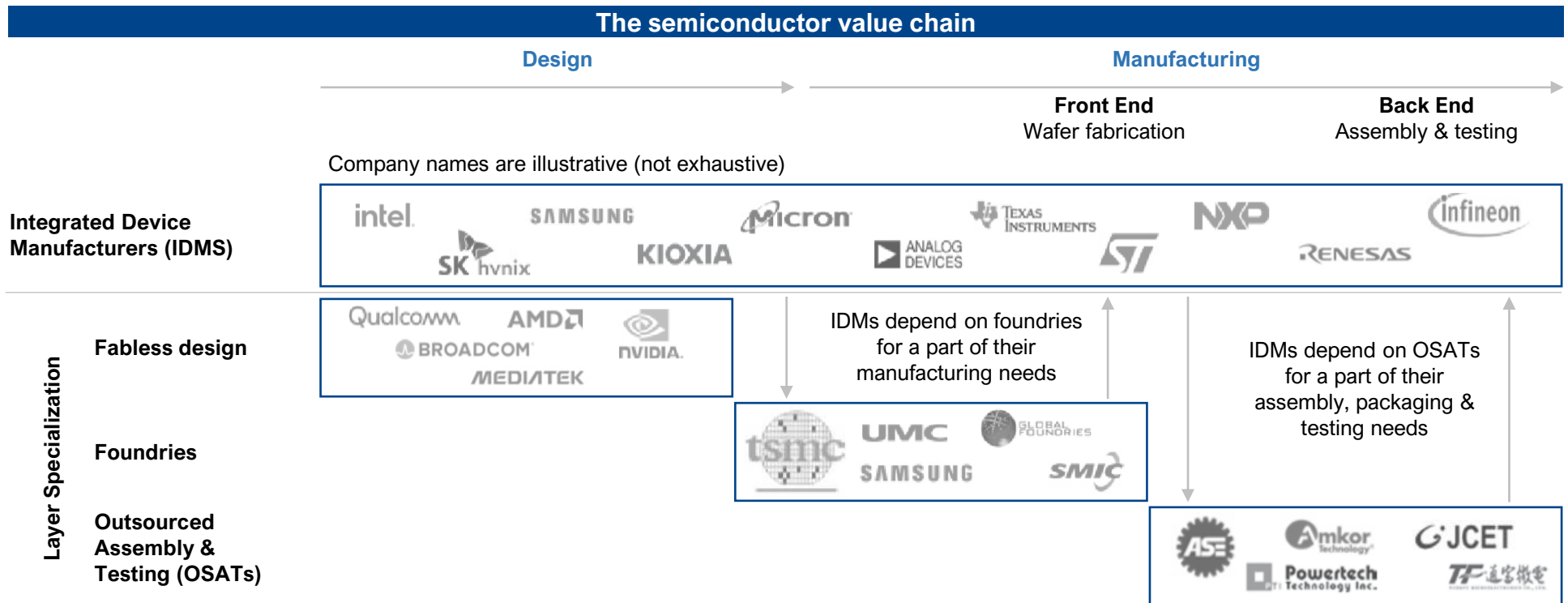


Source: World Semiconductor Trade Statistics

Semiconductor value chain highly specialized and concentrated in each phase

The semiconductor value chain comprises three broad phases: 1) Design; 2) Fabrication; and 3) Assembly and Testing.

- Integrated design manufacturers (IDMs) are involved in the first two phases and represent about half the semiconductor market.
- The US is the market leader in design (led by firms such as Qualcomm, Broadcom, Nvidia and AMD), followed by Taiwan (some of the top companies are Mediatek, Novatek and Realtek).
- Fabrication is highly concentrated, with the market leaders being Taiwan's TSMC (55% share), followed by Samsung, UMC, and GlobalFoundries (17%, 7% and 5%, respectively).

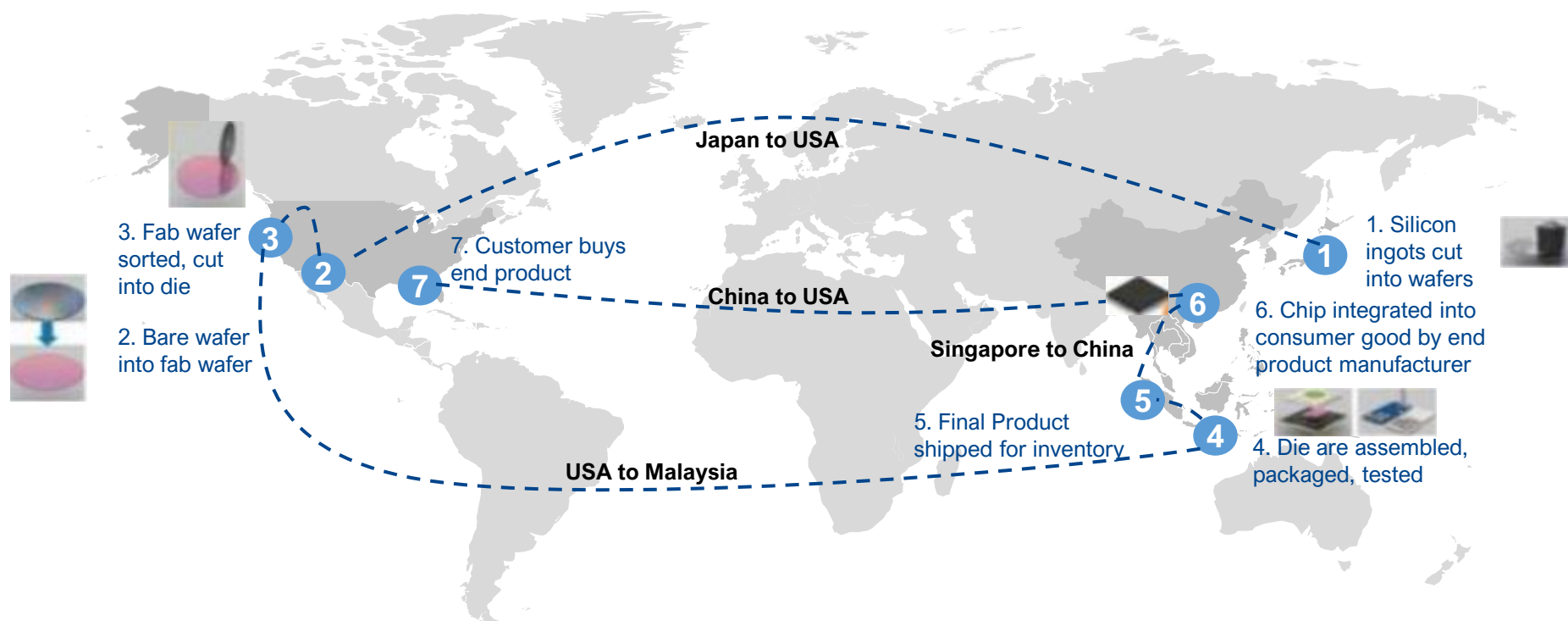


Sources: BCG analysis with data from SIA WSTS, Gartner

Semiconductor supply chain geographically dispersed

- Semiconductor design and manufacturing is a highly complex process. Manufacturing takes about three months and covers around 400–1,200 steps, which include the product's passage through international borders 70 or more times before reaching the end-user customer.
- No company, nation or even region is vertically integrated across all the phases. While this gives scope for innovation and efficiency in the supply chain, it renders it highly vulnerable too.

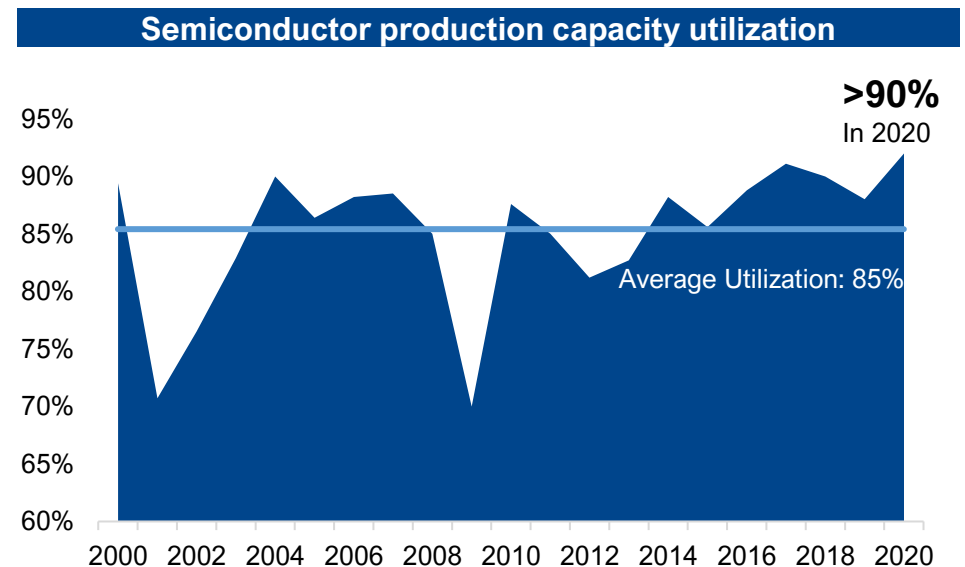
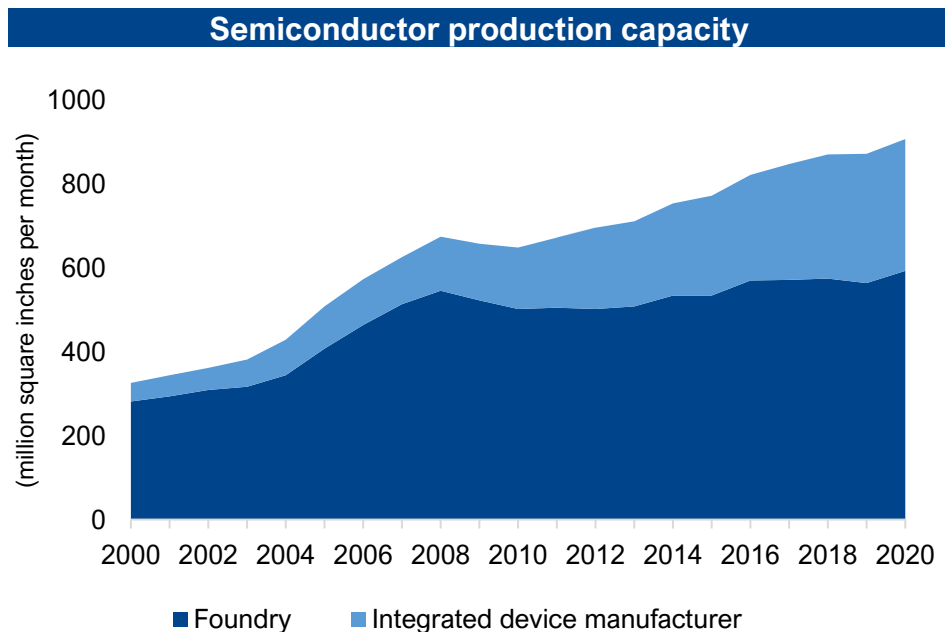
Semiconductor Supply Chain



Source: BCG analysis with data from SIA WSTS, Gartner

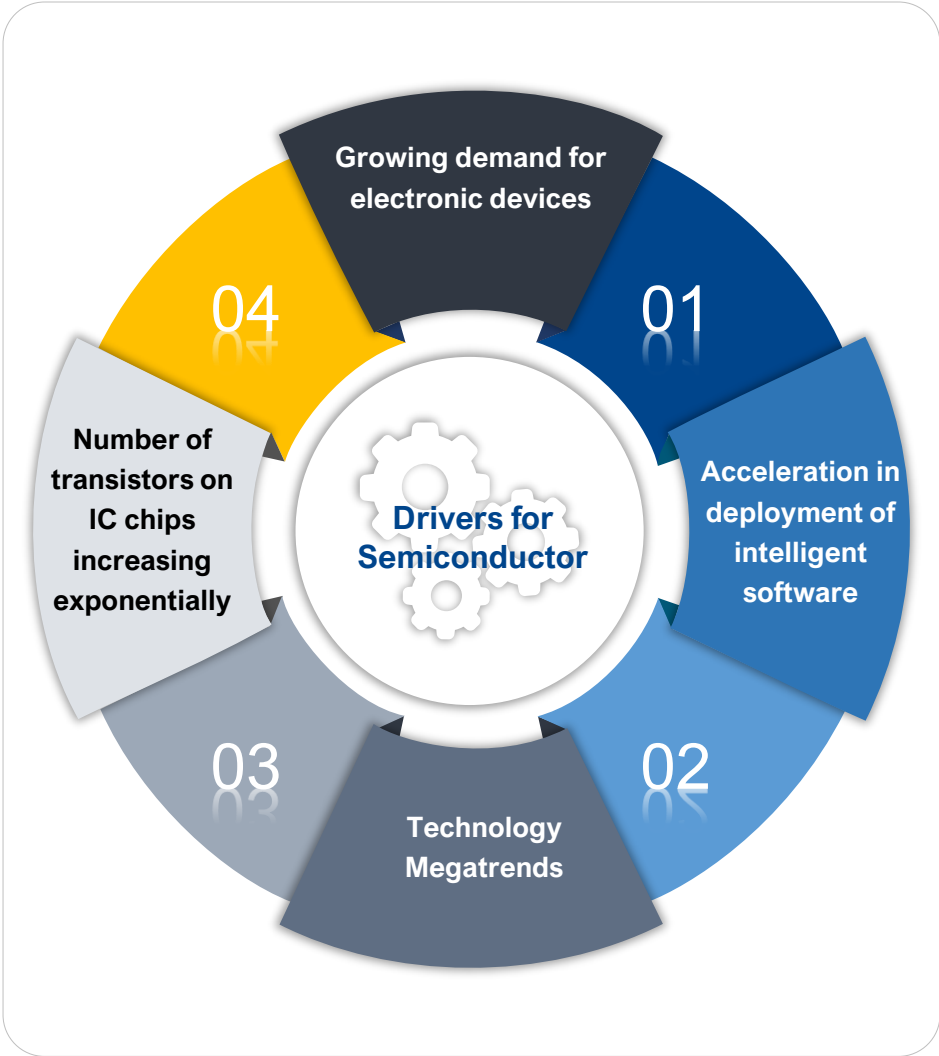
An average 4% increase in semiconductor production capacity over the past two decades, while utilization remains high

- The semiconductor industry has achieved greater scale through consolidation in recent years. Overall production capacity has expanded modestly by around 4% annually since 2000, in line with sales.
- Utilization level has been consistently high (at or above 80%) in the past decade. However, significant swings in demand caused by the COVID-19 pandemic has pushed utilization to more than 90% so far in 2021. This is considered full utilization, since exceeding the level often leads to disproportionately longer lead times. Therefore, while the semiconductor industry's production capacity has increased by nearly 180% since 2000, total capacity is nearly exhausted at the current high utilization rate.
- To meet the higher demand and increasing capacity, industry players have increased capital expenditure to USD150 billion in 2021 and higher than that in 2022. However, a new semiconductor manufacturing facility would require at least 2–3 years to start production.



Sources: HIS-Omdia; Mckinsey analysis

Drivers for semiconductor market

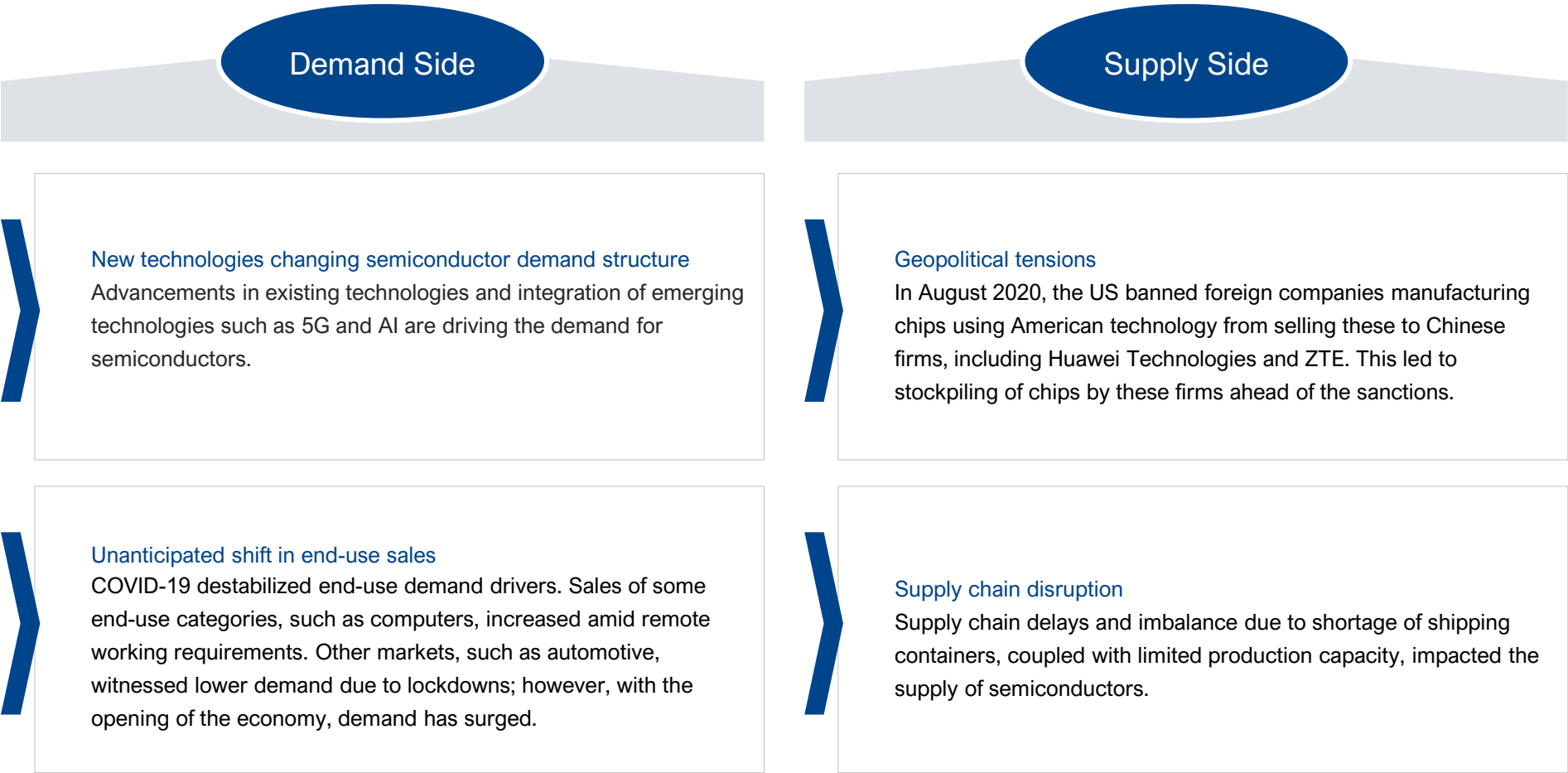


- 1 Semiconductors are the core building blocks of electronic devices and systems. Amid the growing demand for smart electronics devices, the growth in demand for semiconductors is expected to remain robust.
- 2 High growth in the deployment of intelligent software is increasingly transforming a wide variety of business functions across sectors. Semiconductors enable the functionality that software delivers.
- 3 Several megatrends, including IoT, 5G, cloud, AI and next-generation automotive, are reshaping nearly every industry. These depend on advances in semiconductor technology across multiple innovation vectors.
- 4 The number of transistors in ICs has doubled in approximately 1.5 years and quadrupled in 3 years. One microchip contains more than 10 billion transistors.

Source: Aranca research

Chip shortage in last two years driven by demand and supply-side factors

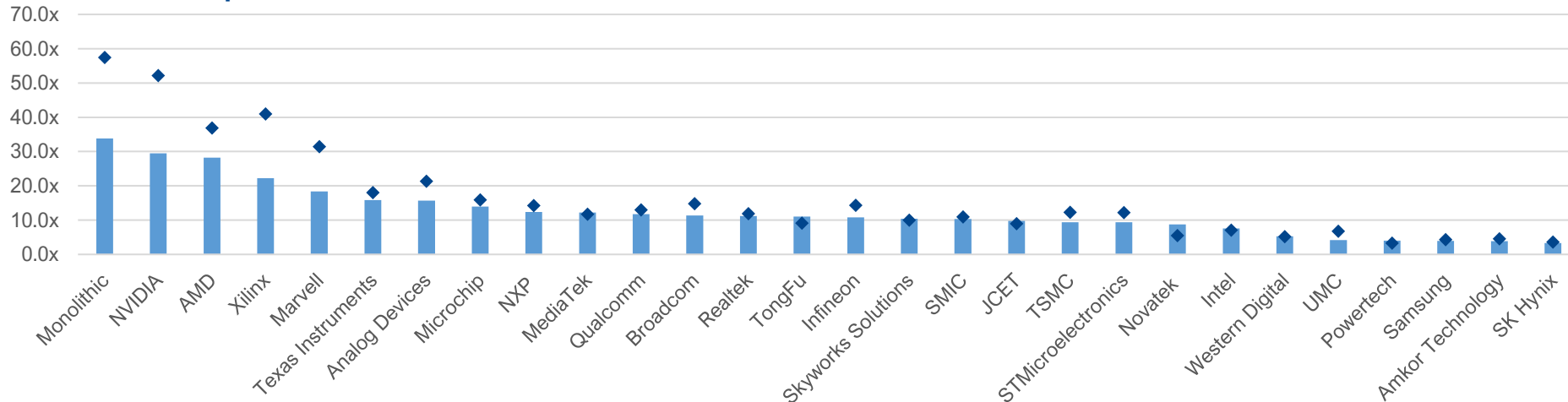
Unanticipated rising demand for semiconductors amid COVID-19, coupled with supply disruptions, triggered a rippling supply-demand imbalance across the world.



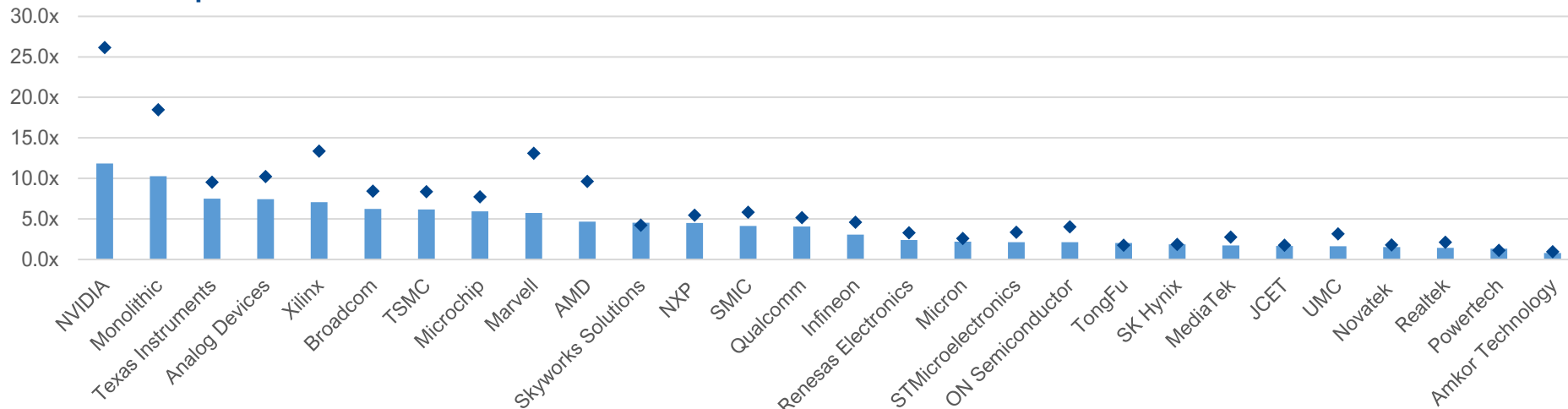
Source: Aranca research

Valuation of the sector is high, even based on 2022 estimates, with average EV-to-EBITDA ratios at 15.4x, more than five-year average of 12.2X

EV / EBITDA Multiple



EV / Sales Multiple



■ 5 Years Average ◆ Current

Source: Aranca research; Companies sorted in descending order of 5-year average

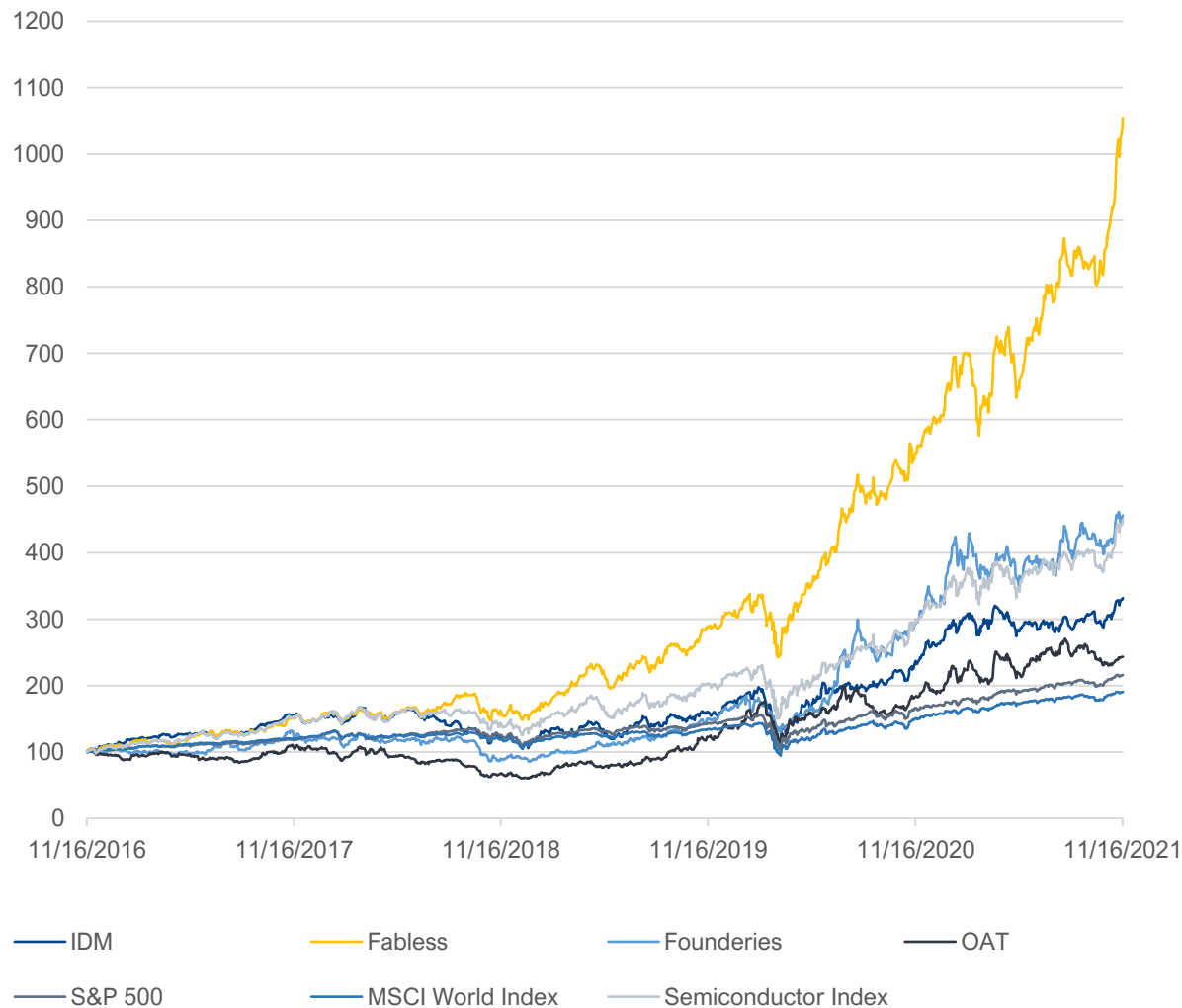
Semiconductor: Peer Analysis

Company	Country	Last Fiscal Year	Size (in USD mn)		Share Price					Trading Multiple				Operational KPIs			
			EV	Market Cap	Curr	CMP	%52 weeks	%52 weeks	52 weeks	EV/EBITDA		P/E		Rev 3 yrs CAGR	EBITDA 3 yrs CAGR	EBITDA	
							High	Low	Return	FY 21E	FY 22E	FY 21E	FY 22E			Margin - 3 yrs avg	Net Debt / EBITDA
Integrated Device Manufacturer																	
Samsung Electronics	Korea; Repub	Dec-20	323,755	401,639	KRW	71,300	25.3%	8.4%	12.6%	4.6x	4.2x	11.9x	10.8x	-0.4%	-4.3%	29.3%	(1.6x)
Intel Corp	United States	Dec-20	208,519	202,850	USD	50	27.0%	10.5%	6.1%	6.6x	7.1x	9.5x	13.5x	7.5%	12.2%	47.3%	0.3x
Texas Instruments	United States	Dec-20	177,472	179,515	USD	194	3.9%	23.2%	23.4%	18.6x	17.9x	24.5x	23.7x	-1.1%	-0.4%	47.7%	0.0x
Analog Devices	United States	Oct-21	103,062	98,270	USD	183	4.6%	33.6%	34.0%	19.2x	18.0x	24.3x	21.6x	5.5%	2.4%	42.2%	1.6x
Micron Technology	United States	Sep-21	94,501	96,358	USD	86	11.2%	35.5%	34.4%	5.4x	4.6x	9.8x	7.9x	-3.0%	-12.9%	47.7%	(0.1x)
SK Hynix	Korea; Repub	Dec-20	74,912	65,835	KRW	114,000	22.9%	28.2%	20.2%	3.9x	3.5x	8.6x	7.7x	1.9%	-7.6%	51.9%	0.6x
Infineon Technologies	Germany	Sep-21	63,111	59,099	EUR	40	8.3%	40.9%	37.1%	14.0x	12.8x	26.4x	23.8x	13.3%	13.1%	25.3%	1.0x
NXP Semiconductors	Netherlands	Dec-20	67,077	59,553	USD	224	2.1%	46.4%	42.9%	16.0x	14.2x	21.1x	18.7x	-2.4%	-5.9%	29.8%	2.2x
Microchip Technology	United States	Mar-21	54,776	46,831	USD	84	3.6%	30.8%	27.0%	16.6x	15.6x	19.1x	17.3x	11.0%	11.1%	35.4%	4.0x
STMicroelectronics	Switzerland	Dec-20	43,307	43,740	EUR	43	7.1%	52.3%	31.8%	13.1x	11.3x	24.6x	20.5x	7.0%	10.2%	25.7%	(0.3x)
Renesas Electronics	Japan	Dec-20	30,446	24,634	JPY	1,442	9.4%	54.0%	54.0%	10.7x	9.2x	18.7x	15.2x	-2.8%	2.9%	25.7%	3.7x
Skyworks Solutions	United States	Oct-21	26,837	25,622	USD	155	24.1%	13.6%	11.1%	10.4x	9.6x	13.4x	12.0x	9.7%	8.3%	39.2%	0.6x
ON Semiconductor	United States	Dec-20	28,896	27,151	USD	63	1.6%	122.4%	119.2%	15.0x	12.7x	12.6x	19.4x	-1.8%	-4.5%	28.2%	2.3x
Western Digital	United States	Jul-21	23,614	18,383	USD	59	24.6%	31.9%	31.4%	5.5x	4.9x	6.8x	6.1x	-6.4%	-25.5%	13.2%	2.2x
Fabless Companies																	
NVIDIA	United States	Jan-21	826,046	834,400	USD	334	3.7%	188.6%	149.3%	60.4x	49.9x	76.9x	64.2x	19.7%	19.1%	33.2%	(0.8x)
Broadcom	United States	Nov-20	261,671	232,292	USD	564	2.2%	43.7%	44.9%	16.0x	14.9x	20.2x	18.2x	10.6%	15.0%	45.7%	3.0x
Qualcomm	United States	Sep-21	209,120	205,789	USD	184	2.7%	50.4%	27.2%	13.2x	12.4x	17.1x	15.8x	14.1%	28.7%	28.4%	0.3x
Advanced Micro Devices	United States	Dec-20	192,229	195,524	USD	162	0.4%	123.3%	74.7%	46.6x	38.3x	61.4x	48.6x	22.9%	97.8%	13.0%	(1.2x)
Marvell Technology	United States	Jan-21	65,931	61,786	USD	75	1.4%	97.8%	62.8%	42.0x	29.4x	52.0x	38.8x	7.2%	0.8%	17.2%	0.7x
MediaTek	Taiwan	Dec-20	53,556	57,885	TWD	1,010	13.1%	49.5%	52.2%	12.9x	11.1x	15.2x	14.3x	10.6%	46.1%	13.0%	(3.4x)
Xilinx	United States	Apr-21	55,848	57,776	USD	233	0.5%	108.4%	60.4%	47.8x	41.6x	63.5x	57.0x	8.5%	2.8%	30.9%	(1.8x)
Will Semiconductor	China	Dec-20	37,663	37,690	CNY	275	20.2%	35.5%	28.0%	41.5x	32.7x	52.3x	40.7x	102.0%	160.7%	12.4%	0.3x
Monolithic Power Systems	United States	Dec-20	25,269	26,011	USD	564	2.7%	87.2%	77.4%	68.3x	54.7x	78.3x	66.3x	21.5%	25.2%	21.0%	(3.2x)
Novatek Microelectronics	Taiwan	Dec-20	8,836	10,204	TWD	466	28.4%	57.2%	62.4%	5.1x	5.5x	7.5x	8.1x	19.3%	35.8%	17.1%	(1.4x)
Realtek Semiconductor	Taiwan	Dec-20	8,747	10,210	TWD	555	13.7%	44.5%	48.3%	13.0x	11.9x	17.2x	15.7x	23.1%	30.7%	12.8%	(2.9x)
Foundries																	
TSMC	Taiwan	Dec-20	542,948	556,719	TWD	596	12.7%	23.4%	25.6%	14.2x	11.7x	26.2x	21.8x	11.1%	11.6%	64.8%	(0.5x)
SMIC	China	Dec-20	34,324	32,853	HKD	21	33.2%	18.1%	-1.4%	11.6x	10.5x	14.7x	17.6x	8.0%	14.6%	35.9%	(3.9x)
Globalfoundries	United States	Dec-20	39,397	37,516	USD	71	n.a.	n.a.	n.a.	23.6x	15.0x	n.m.	40.1x	n.a.	n.a.	10.1%	4.4x
United Microelectronics	Taiwan	Dec-20	27,213	28,470	TWD	64	13.3%	56.2%	58.8%	7.8x	6.7x	14.4x	12.2x	5.8%	5.5%	38.0%	(0.4x)
Outsourced Assembly & Testing Companies																	
ASE Technology Holding	Taiwan	Dec-20	22,731	15,836	TWD	102	24.3%	34.1%	36.3%	5.6x	5.3x	9.4x	8.7x	18.0%	16.4%	18.1%	1.7x
JCET Group Co	China	Dec-20	9,624	9,119	CNY	32	33.8%	7.8%	-26.3%	9.9x	9.0x	21.4x	20.0x	3.5%	11.3%	16.0%	2.0x
Amkor Technology	United States	Dec-20	5,774	5,482	USD	22	24.0%	55.6%	53.2%	4.5x	4.2x	9.4x	9.2x	6.3%	3.9%	19.1%	0.3x
TongFu Microelectronics Co	China	Dec-20	4,784	4,205	CNY	20	35.6%	16.5%	-24.1%	10.5x	8.7x	30.0x	25.1x	18.2%	20.0%	17.8%	0.7x
Powertech Technology	Taiwan	Dec-20	3,652	2,746	TWD	99	16.9%	8.4%	10.4%	3.6x	3.3x	8.7x	8.0x	8.5%	7.7%	32.5%	0.5x
Average										18.2x	15.4x	25.4x	22.6x	11.4%	16.7%	28.8%	0.3x
Median										13.0x	11.5x	19.1x	17.9x	8.5%	11.1%	27.1%	0.3x

Source: Aranca research; Companies sorted in descending order of EV for every category

Fabless IC players outperform market due to higher structural growth and profitability

Total Shareholder Return (November 16, 2016 = 100)



- Total shareholder return in the semiconductor industry has been higher than the broader market since March 2020.
- Amid the pandemic-led shift in consumer behavior, demand for mobiles, notebooks, servers, cars, smart homes, gaming, wearables, and Wi-Fi access points increased significantly; this, in turn, boosted the demand for semiconductor chips.
- While profits in the semiconductor industry have been strong over the years, growth across sub-segments has been broadly balanced.
- However, from 2018, the disparity between fabless players and others has become prominent.
- IDM sales fell by 20% in 2019, whereas sales of fabless IC suppliers fell just 1%.
- Sales of fabless IC companies climbed by 24% in 2020, whereas IDM sales increased by just 8%, widening the gap.

Source: Aranca research; OAT - Outsourced Assembly & Testing Companies; Semiconductor Index - PHLX Semiconductor Index

Semiconductor industry witnessing massive consolidation, mainly led by fabless ICs

- In the last decade, a wave of consolidation swept across the semiconductor sector, fueled by rising demand for mobiles, notebooks, servers, cars, smart homes, gaming, wearables, and Wi-Fi access points.
- The fabless subsegment witnessed the highest consolidation, followed by IDMs.
- The median EV/Revenue for transactions was 2.82x, whereas the median EV/EBITDA stood at 18.71x.
- The largest deal of the decade was the Xilinx AMD transaction that took place in 2020.
- The Xilinx transaction is not only AMD's largest ever, but also the semiconductor industry's second-largest since 2000. More than 50% M&A deals took place in the US and China, given the large presence of major semiconductor companies in these countries.
- In 2015, the M&A market was the most active in terms of deals. The average EV/Revenue multiple was 3.4x in 2015, while the EV/EBITDA multiple stood at 19.8x.

Most Active Strategic Buyers

Fabless semiconductor companies (such as Broadcom, Nvidia, AMD) and IDMs (such as Intel and Analog Devices) have made significant transactions in this space in the past decade

Notable Transactions

Advanced Micro Devices Inc.'s USD36.78 billion purchase of programmable hardware company Xilinx Inc. was the most expensive deal, followed by nine other deals over the USD10-billion mark.

Deal Criteria

Most of these deals are majority stake transactions and have taken place in the US and China. Deal sizes ranged from USD500 million to USD36 billion.

Deal Multiples

In the past 10 years, EV/Revenue multiples ranged from 0.4x to as high as 15.5x for the acquisition of US-based Inphi Corporation by IDM Marvell Technology Inc.

Source: Aranca Research

Selected precedent M&A transactions (1/2)

Last 10 years	EV (\$m)	EV/Rev (x)	EV/EBITDA (x)
High	33,693	15.50x	127.85x
Mean	5,377	3.82x	23.19x
Median	2,262	2.82x	18.71x
Low	444	0.41x	3.74x

Date	Target	Target Description	Acquirer	EV (\$USDmm)	EV/Revenues (x)	EV/EBITDA (x)
30 Aug 21	DSP Group	A fabless semiconductor company that provides wireless chipset solutions.	Synaptics Incorporated	445	3.5x	127.9x
11 Jun 21	Magnachip Semiconductor Corporation	Designs, manufactures, and supplies analog and mixed-signal semiconductor platform solutions for communications, IoT, consumer, industrial, and automotive applications.	Multiple	1,418	2.8x	29.6x
26 Mar 21	Magnachip Semiconductor Corporation	Designs, manufactures, and supplies analog and mixed-signal semiconductor platform solutions for communications, IoT, consumer, industrial, and automotive applications.	Wise Road Capital	1,217	2.4x	26.7x
08 Feb 21	Dialog Semiconductor	Develops and distributes highly integrated, mixed signal integrated circuits for personal, portable, hand-held devices, low energy short-range wireless, backlighting and LED solid-state lighting, and industrial and automotive applications worldwide.	Renesas Electronics Corporation	5,826	4.2x	22.3x
29 Oct 20	Inphi Corporation	Provides high-speed analog and mixed signal semiconductor solutions for the communications and computing markets.	Marvell Technology	9,276	15.5x	87.1x
27 Oct 20	Xilinx, Inc.	Designs, develops, and markets programmable devices and associated technologies worldwide.	Advanced Micro Devices	33,693	11.3x	35.4x
13 Jul 20	Maxim Integrated Products	Designs, develops, manufactures, and markets a range of linear and mixed-signal integrated circuits in the United States, China, rest of Asia, Europe, and internationally.	Analog Devices	21,230	9.7x	26.1x
24 Jun 20	Tianjin Zhonghuan Electronic and Information (Group)	Manufactures semiconductor materials, chip components, and LED lights.	TCL Technology Group Corporation	5,625	1.6x	13.3x
03 Jun 19	Cypress Semiconductor	Designs, develops, manufactures, markets, and sells embedded system solutions worldwide.	Infineon Technologies AG	10,067	4.1x	20.4x
11 Mar 19	Mellanox Technologies	A fabless semiconductor company that designs, manufactures, markets, and sells interconnect products and solutions.	NVIDIA Corporation	6,901	6.3x	28.7x
10 Sep 18	Renesas Electronics America	Designs, develops, manufactures, and markets a range of semiconductor solutions in the United States.	Renesas Electronics Corporation	7,236	8.3x	33.7x
01 Mar 18	Microsemi Corporation	Designs, manufactures, and markets analog and mixed-signal semiconductor solutions in the United States, Europe, and Asia.	Microchip Technology Incorporated	10,078	5.5x	18.2x
20 Nov 17	Cavium, Inc.	Designs, develops, and markets semiconductor processors for intelligent and secure networks in the United States and internationally.	Marvell Technology	6,691	7.0x	37.1x
22 Sep 17	Imagination Technologies Group	Creates and licenses processor solutions for graphics, video and vision processing, general purpose and embedded processing, and multi-standard communications in the United Kingdom and internationally.	Canyon Bridge Capital Partners	789	4.0x	35.0x
28 Aug 17	IXYS	An integrated semiconductor company that designs, develops, manufactures, and markets semiconductor products worldwide.	Littelfuse	700	2.2x	15.7x
06 Jun 17	JA Solar Holdings	Designs, develops, manufactures, and sells solar power products based on crystalline silicon technologies worldwide.	Jinglong Group	1,267	0.4x	4.5x

Source: S&P Capital IQ, Arranged in descending order of Transaction Date. Considered only majority stake transactions with size above \$500m

Selected precedent M&A transactions (2/2)

Last 10 years	EV (\$m)	EV/Rev (x)	EV/EBITDA (x)
High	33,693	15.50x	127.85x
Mean	5,377	3.82x	23.19x
Median	2,262	2.82x	18.71x
Low	444	0.41x	3.74x

Date	Target	Target Description	Acquirer	EV (\$USDmm)	EV/Revenues (x)	EV/EBITDA (x)
29 Mar 17	Exar Corporation	Designs, develops, and markets high performance analog mixed-signal integrated circuits and sub-system solutions for the industrial and embedded systems, high-end consumer, and infrastructure markets worldwide.	MaxLinear	456	2.9x	31.3x
23 Jan 17	SK Siltron	Manufactures and sells wafers for semiconductors in South Korea and internationally.	SK Inc.	1,541	2.2x	12.4x
26 Jul 16	Linear Technology Corporation	Designs, manufactures, and markets a line of analog integrated circuits worldwide.	Analog Devices	13,316	9.4x	19.4x
26 May 16	Siliconware Precision Industries	Provides semiconductor packaging, wafer bumping, wafer sort, assembly, and testing services in North America, China, Taiwan, Europe, and internationally.	ASE Technology Holding	4,959	2.0x	6.5x
21 Jan 16	ChipMOS TECHNOLOGIES (Bermuda)	Provides semiconductor testing and assembly services in Taiwan, Singapore, the United States, Japan, South Korea, Hong Kong, and other countries.	ChipMOS TECHNOLOGIES	655	1.1x	3.9x
14 Dec 15	Inotera Memories	Manufactures and sells semiconductor products in Taiwan, the United States, Singapore, and Japan.	Micron Semiconductor Taiwan	5,107	2.4x	3.7x
01 Jun 15	Altera Corp.	Designs and sells programmable logic devices (PLDs), HardCopy application-specific integrated circuit (ASIC) devices, power system-on-chip devices (PowerSoCs), pre-defined design building blocks, and associated development tools.	Intel Corporation	15,840	8.3x	27.4x
28 May 15	Broadcom Corporation	Provides semiconductor solutions for wired and wireless communications.	Broadcom Inc.	32,969	3.9x	18.4x
01 Mar 15	Freescale Semiconductor	Provides high performance mixed signal and standard product solutions worldwide. It offers semiconductors and system solutions for the automotive, identification, mobile, consumer, computing, wireless infrastructure, and lighting and industrial applications, as well as software solutions for mobile phones.	NXP Semiconductors	16,601	3.6x	16.1x
15 Oct 14	CSR Limited	A fabless semiconductor company that designs and develops semiconductor integrated circuits primarily in Asia, the Americas, and Europe.	Qualcomm Global Trading	2,294	2.9x	35.2x
20 Aug 14	Infineon Technologies Americas Corp.	Designs, manufactures, and markets power management semiconductors worldwide.	Infineon Technologies	2,412	2.2x	13.8x
16 Dec 13	LSI Corporation	Designs, develops, and markets storage and networking semiconductors worldwide.	Avago Technologies Wireless (U.S.A.) Manufacturing	5,944	2.5x	18.0x
02 Jul 12	Micron Memory Japan, G.K.	Manufactures and sells of mobile DRAM for use in mobile phones and tablets in Japan.	Micron Technology	2,520	0.6x	6.0x

Source: S&P Capital IQ, Arranged in descending order of Transaction Date. Considered only majority stake transactions with size above \$500m



500+

Strong, professional team across multi-disciplinary domains

2500+

Global clients

120+

Sectors and sub-sectors researched by our analysts

80+

Countries where we have delivered projects

ABOUT ARANCA



Business Research & Advisory

CXOs in Strategy, SBUs, Sales, Marketing, CI/MI, Innovation



Valuation & Financial Advisory

CFOs in Startups, PE/VC Firms, Corporate M&A Teams, Mid-market Companies



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Connect with our Team



Gaurav Bansal

Manager, Investment Research

+91.124.668 9999

gaurav.bansal@aranca.com



Vishal Kumar

Manager, Investment Research

+91.124.668 9999

vishal.kumar@aranca.com



Raashi Shah

Senior Analyst, Investment
Research

+91.22.3937.9999

raashi.shah@aranca.com



**Anurag
Bhagchandani**

Senior Analyst, Investment
Research

+91.22.3937.9999

anurag.bhagchandani@aranca.com

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