Strengthening the Global Semiconductor Supply Chain in an Uncertain Era
Third BCG x SIA report focuses on the global semiconductor supply chain

3 thought leadership reports on critical policy-related issues for the semiconductor industry
Objectives of this report

1. Provide a robust fact base of reference about the semiconductor value chain

2. Educate the public on the global nature of the semiconductor value chain: why it is like this and the value it creates

3. Discuss the key risks and challenges that the semiconductor value chain faces, and the broad policy directions to address them
All types of semiconductors are indispensable in today’s economy, powering all sorts of electronic devices.

Global Semiconductor Sales by Application Market, 2019 (%)

<table>
<thead>
<tr>
<th>Application</th>
<th>2019 Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile phones</td>
<td>32%</td>
</tr>
<tr>
<td>Consumer Electr.</td>
<td>33%</td>
</tr>
<tr>
<td>PCs</td>
<td>18%</td>
</tr>
<tr>
<td>ICT Infrastructure²</td>
<td>18%</td>
</tr>
<tr>
<td>Industrial Automotive</td>
<td>64%</td>
</tr>
<tr>
<td>DAO§</td>
<td>28%</td>
</tr>
<tr>
<td>Logic</td>
<td>46%</td>
</tr>
<tr>
<td>Memory</td>
<td>22%</td>
</tr>
<tr>
<td>Logic</td>
<td>18%</td>
</tr>
<tr>
<td>Memory</td>
<td>28%</td>
</tr>
<tr>
<td>Overall</td>
<td>28%</td>
</tr>
</tbody>
</table>

1. Discrete, analog and optoelectronics and sensors  
2. Information and Communications Technology infrastructure, including data centers and communication networks  
Sources: SIA WSTS, Gartner

$412B  
Global 2019 sales
Semiconductor consumption is global. The US accounts for ~25% of consumption, but drives 33% of demand.

**GLOBAL SEMICONDUCTOR SALES BY GEOGRAPHIC AREA, 2019 (%)**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>US</th>
<th>China</th>
<th>Taiwan S. Korea</th>
<th>Japan</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Buyer (=&quot;demand&quot;) Headquarters of the electronic device maker</td>
<td>33%</td>
<td>26%</td>
<td>9%</td>
<td>11%</td>
<td>10%</td>
</tr>
<tr>
<td><strong>B</strong> Shipment destination Where the device is manufactured/assembled</td>
<td>19%</td>
<td>35%</td>
<td>15%</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td><strong>C</strong> End use (=&quot;consumption&quot;) Location of the end users that purchase the devices</td>
<td>25%</td>
<td>24%</td>
<td>2%</td>
<td>6%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Other 22%

Sources: BCG analysis with data from SIA WSTS, Gartner, IDC
The semiconductor value chain includes seven differentiated activities:

1. **Pre-competitive Research** (15-20% of total industry R&D)
   - R&D: 53%
   - CAPEX: 13%
   - Value Add: 50%

2. **Design**
   - R&D: 13%
   - CAPEX: 64%
   - Value Add: 24%

3. **Front End**
   - Wafer fabrication
   - R&D: 3%
   - CAPEX: 13%
   - Value Add: 6%

4. **Back End**
   - Assembly, packaging & test
   - R&D: 3%
   - CAPEX: 13%
   - Value Add: 6%

5. **EDA & Core IP**
   - EDA: 3%
   - Core IP: <1%
   - Value Add: 4%

6. **Equipment**
   - Equipment: 9%
   - Value Add: 3%
   - Materials: 11%

7. **Materials**
   - Materials: 1%
   - Value Add: 6%
   - Add: 5%

**Sources:** BCG analysis using data from Capital IQ (company financial reports) and Gartner (total market sizes)

**Global 2019 sales**
- **R&D**: $92B
- **CAPEX**: $108B
- **Value Add**: $290B

**Percentage of industry total, 2019**
- **R&D**: 53%
- **CAPEX**: 13%
- **Value Add**: 50%
- **EDA & Core IP**: 3%
- **Equipment**: 9%
- **Materials**: 1%
The semiconductor industry ranks high simultaneously in both R&D and capital intensity.

### R&D AS % OF Revenues, 2019

- **Design**: 12%
- **Manufacturing**: 6%
- **Rest of value chain**: 4%

### Capital Expenditure as % of Revenues, 2019

- **Design**: 26%
- **Manufacturing**: 20%
- **Rest of value chain**: 2%

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1. Includes EDA and Core IP, Equipment and Materials
2. Includes Wafer Fabrication and Assembly & Test

**Sources**: BCG analysis based on Capital IQ data
Need for deep technology expertise and massive scale has resulted in a complex global semiconductor supply chain structure.
Example: EUV technology essential for < 10 nm manufacturing was developed through several decades of global R&D collaboration

Development of early concept demo
- Early 80s
  - Early demo of EUV concept
  - 2-mirror/3-mirror imaging system demo

Development of key EUV technology
- Early 90s
  - Imaging system demo
  - Soft-X-ray source and liquid-droplet system
  - Exposure wavelength determination
  - Reflective imaging system
- Late 90s to early 00s
  - MOS device demo
  - EUV light source development
- Present
  - EUV commercial prototype development
  - Prototype for research institute
  - EUV for commercial production in use (2018)

GLOBAL R&D NETWORKS
- Currently a global network of 5,000 specialized suppliers enables EUV commercial use
- % of supplier base
  - EU 46%
  - Japan 27%
  - % of supplier base

Source: EUV lithography book; ASML; ASML; BCG analysis
Technology complexity and need for scale have also led to emergence of business models focused on a specific layer of the value chain.

**Integrated Device Manufacturers (IDMs)**
- **Design**
  - Intel, Samsung, Micron, Texas Instruments, NXP, Infineon, SK hynix, KIOXIA, ANALOG DEVICES, ST, and Renesas

**Layer Specialization**
- **Fabless design**
  - Qualcomm, NVIDIA, Broadcom, AMD, and MediaTek
  - IDMs rely on foundries for a portion of their manufacturing needs
- **Foundries**
  - UMC, Samsung, and SanDisk
  - IDMs rely on OSATs for a portion of their assembly & testing needs
- **Outsourced Assembly & Testing (OSATs)**
  - JRC, TSMC, and SMIC

**Capacity (2019)**
- Logic: 21%
- Memory: 98%
- DAO¹: 94%
- Overall: 67%

**Sales (2019)**
- Logic: 53%
- Memory: 98%
- DAO¹: 75%
- Overall: 71%

1. Discrete, analog and optoelectronics and sensors

Sources: BCG analysis with data from SIA WSTS, Gartner, SEMI
Regions specialize in different activities of the supply chain: US leads in R&D-intensive activities; Asia leads in the most capital-intensive.

**Regional Shares by Activity in the Value Chain vs. R&D and Capex Intensity, 2019 (%)**

Capex as % of revenues, 2019

- Materials
- Logic (fabless + Intel)
- Manufacturing equipment
- Assembly, packaging & testing (OSAT)
- Wafer fabrication (foundry + IDM)
- EDA & Core IP
- DAO (IDM + fab-lite)

**R&D as % of revenues, 2019**

- US
- China
- East Asia (Japan, S. Korea and Taiwan)
- Europe
- Other

**Overall share of value added**

- Other
- Europe
- Japan
- S. Korea
- Taiwan
- China
- US

**Semiconductor consumption**

- Other
- Europe
- Japan
- S. Korea
- Taiwan
- China
- US

1. Majority of Intel's Capex assumed to be for wafer fabrication and not included here. Majority of Intel's R&D assumed to be for design and included here.

NOTE: Regional breakdown calculated as: EDA, design, manufacturing equipment and raw materials based on company revenues and company headquarters location. Wafer fabrication and assembly packaging & testing based on installed capacity and geographic location of the facilities. Sources: BCG analysis with data from Gartner, SEMI, IHS Markit.
10 of the top 20 semiconductor design firms are headquartered in the US. Over 50% of the world's semiconductor design engineers are based in the US.

**Estimated location of semiconductor design engineers from top global companies, 2020.**

- **Americas:** 78% Domestic, 51% Regional, 10 company HQ
- **EMEA:** 8% Domestic, 7% Regional, 3 company HQ
- **Asia:** 11% Domestic, 6% Regional, 2 company HQ
- **Rest of Americas:** 0% Domestic, 1% Regional, 0 company HQ
- **Rest of APAC:** 0% Domestic, 5% Regional, 0 company HQ
- **RoW (Middle East + Africa):** 0.3% Domestic, 4% Regional, 1 company HQ

**Legend:**
- Domestic company share of total hired engineers
- Regional share of total hired engineers
- # of top 20 company HQ

Note: Total number of design related positions are approximated based on publicly available profiles in LinkedIn for top 10 fabless and top 10 IDM players, number can be underestimated for certain regions (e.g., China) due to availability of publicly available data.

Sources: BCG analysis.
Manufacturing economics are significantly more favorable in Asia, with government incentives driving 45-70% of the cost advantage.

**Estimated 10-year Total Cost of Ownership (TCO) of Reference Fabs by Location (US indexed to 100)**

<table>
<thead>
<tr>
<th>Location</th>
<th>TCO of US TCO Gap</th>
<th>% of US TCO Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advanced Logic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>100</td>
<td>70%</td>
</tr>
<tr>
<td>Other Asia location</td>
<td>78</td>
<td>78 +29%</td>
</tr>
<tr>
<td>China</td>
<td>63</td>
<td>63 +23%</td>
</tr>
<tr>
<td><strong>Advanced Memory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>100</td>
<td>57%</td>
</tr>
<tr>
<td>Other Asia location</td>
<td>79</td>
<td>79 +27%</td>
</tr>
<tr>
<td>China</td>
<td>66</td>
<td>66 +20%</td>
</tr>
<tr>
<td><strong>Advanced Analog</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Asia location</td>
<td>n.a.</td>
<td>n.a. +47%</td>
</tr>
</tbody>
</table>

What drives the higher TCO of US-based fabs vs. other locations:

- Government incentives
- Labor
- Construction
- Utilities

1. TCO includes capital expenditure (upfront land, construction and equipment) + 10 years of operating expenses (labor, utilities, materials, taxes)
2. Refers to Taiwan and South Korea for logic, South Korea and Singapore for memory
3. With technology sharing agreements that give access to additional incentives such as equipment lease back with advantageous terms

Source: BCG analysis
As a result of geographic specialization, no single country/region has a fully self-sufficient supply chain.

Regional Shares by Activity in the Value Chain, 2019 (%)

1. Other includes Israel, Singapore and the rest of the world.

NOTE: Regional breakdown calculated as: EDA, design, manufacturing equipment and raw materials based on company revenues and company headquarters location.
Wafer fabrication and assembly packaging & testing based on installed capacity and geographic location of the facilities.
Sources: BCG analysis with data from Gartner, SEMI, IHS Markit.

Size of base proportional to estimated share of the activity in the total industry value added.

Global Semiconductor Consumption

EDA & Core IP (fabless + Intel)
Logic (IDM + fab-lite)
DAO (IDM + fab-lite)
Memory (IDM)
Manufacturing equipment
Materials
Wafer fabrication
Assembly & testing

Other
Europe
Japan
S. Korea
Taiwan
China
US

25%
24%
6%
22%
20%
6%
25%
A large web of global trade flows supports the geographic specialization in the semiconductor value chain

Major Semiconductor Trade Corridors (2019, $ Billion)

- Width of arrow represents size of trade flows in 2019
- Color of arrow represents 2014-2019 CAGR in trade

- US
- China
- South Korea
- Japan
- Taiwan
- India
- EU
- Others

Global trade of semis in 2019

- ~$1.7T
- Most traded product in the world in 2019 only after crude oil, refined oil and automotive
- 20% of semiconductor global trade enabled by WTO’s ITA agreement signed in 1997 and expanded in 2015
- China at the center of global semiconductor trade due to its leadership in electronics manufacturing

1. HS codes 8541, 8542, minus HS 854140, excludes semiconductor equipment
2. Includes both exports and imports. Note: Significant disparities in reported data by each country. Importer data used where possible; Source: IHS Global Trade Atlas, UN Comtrade; BCG analysis
The global structure of the semiconductor supply chain delivers enormous value that ultimately benefits electronic device makers and end users.

**Hypothetical Scenario**
- Every region would need to develop its own fully self-sufficient value chain

- Local semiconductor manufacturing capacity (both front-end and back-end) to match domestic semiconductor consumption
- 1-3 local suppliers for:
  - EDA and core IP
  - 14 major semiconductor product groups typically provided by different vendors
  - 7 major types of manufacturing equipment typically provided by different vendors
  - 7 major families of materials

**Potential Impact on the Industry**
Assuming execution feasibility, and not considering cost of failed investments and potential overcapacity

- $900-1,225B upfront investments (capex & R&D)
- $45-125B incremental annual operating costs
- +35-65% increase in overall semiconductor prices

Sources: BCG analysis
All regions benefit from the efficiencies of the global value chain

**INCREMENTAL COST TO COVER 2019 DEMAND WITH FULLY “SELF-SUFFICIENT” LOCALIZED SEMICONDUCTOR SUPPLY CHAINS**

<table>
<thead>
<tr>
<th>% of global semiconductor consumption</th>
<th>Upfront investment ($ Billion)</th>
<th>Incremental annual cost ($ Billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32%² Americasia²</td>
<td>350-420</td>
<td>5-15</td>
</tr>
<tr>
<td>24%</td>
<td>175-250</td>
<td>10-30</td>
</tr>
<tr>
<td>20%</td>
<td>25-80</td>
<td>5-20</td>
</tr>
<tr>
<td>25%³ EMEA³</td>
<td>350-475</td>
<td>25-60</td>
</tr>
<tr>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sources:** BCG analysis

1. Calculated as the estimated semiconductor content in electronic devices sold to end users in each geography in 2019
2. Includes Canada, Latin America
3. Includes Middle East and Africa

Note: Range defined primarily by number of local companies assumed to be required to meet the local needs in each activity of the value chain: from just 1 player to supply the entire local market to 3 players typically found in the current global market structure.
## Five key vulnerabilities identified in the semiconductor supply chain

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Description</th>
<th>Current examples</th>
</tr>
</thead>
</table>
| **High geographic concentration of some activities** | Single points of failure which may be disrupted by natural disasters, infrastructure failures, cyberattacks or geopolitical frictions | • Wafer fabrication  
• Assembly, packaging & testing  
• Some specialty materials |
| **Geopolitical frictions** | Broad export controls over inputs or technologies with no viable alternative suppliers in other countries | • US-China frictions  
• Japan – S. Korea frictions |
| **National self-sufficiency policies** | National industrial policies that seek broad import substitution or broadly discriminate against foreign suppliers, leading to distortion in global competition and risk of overcapacity | • China policies in pursuit of “self sufficiency” across the semiconductor value chain |
| **Talent constraints** | Current growth in talent pool of Science & Engineering graduates is insufficient to meet the industry demand for technical talent | • All countries, but US in particular given leadership in R&D intensive activities and reliance on attracting & retaining global talent |
| **Stagnation in funding of basic research** | Government programs and funding play a critical role in basic research, which is essential for the semiconductor industry | • US government-funded R&D in semiconductors has stagnated and is below overall level across all sectors |
50+ points of high geographical concentration across the supply chain (but not all with the same level of associated risk)

**Value Chain Activities Where One Single Region Accounts for ~65% or More of Global Share**

**Design**
- EDA & Core IP
  - EDA
  - IP (Arm architecture)

**Front End**
- Wafer fabrication
  - Logic: leading nodes (< 10nm)
  - Logic: mature nodes (>= 10nm)
  - Memory

**Manufacturing**
- Logic: leading nodes (< 10nm)
- Logic: mature nodes (>= 10nm)
- Memory

**Back End**
- Assembly & Test
  - Outsourced Assembly and Test (OSAT)

**Equipment & Tools**
- 23 equipment types, i.e. doping, process control
- 12 equipment types, i.e. photoresist processing
- 3 equipment types, i.e. EUV lithography

**Materials**
- Select examples (not exhaustive):
  - Photoresist, photomask
  - Silicon wafers
  - Packaging substrates
  - Specialty gases (in aggregate)

Sources: BCG analysis with data from Gartner, SEMI, UBS; SPEEDA

1. For Design, EDA & Core IP, Equipment & Tools and Raw Materials: global share measured as % of revenues, based on company headquarters location. For Manufacturing (both Front End and Back End) measured as % of installed capacity, based on location of the facility.

GEOGRAPHIC CONCENTRATION

US
China
Taiwan
South Korea
Japan
EU
UK
East Asia + China concentrate ~75% of the wafer fabrication capacity; in particular, ~90% of advanced logic capacity <10 nm is located in Taiwan.

**Breakdown of the Global Wafer Fabrication Capacity by Region, 2019 (%)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Memory</th>
<th>Logic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>&lt; 10 nm</td>
<td>92%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>&gt; 45 nm</td>
<td>23%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>DAO¹</td>
<td>19%</td>
<td>17%</td>
<td>1%</td>
</tr>
<tr>
<td>&gt; 45 nm</td>
<td>9%</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>22%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>12%</td>
<td>16%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>19%</td>
<td>17%</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>4%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>% of global capacity</td>
<td>33%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

1. Discrete, analog and optoelectronics and sensors
2. Other includes Israel, Singapore and the rest of the world

Sources: BCG analysis with data from SEMI fab database.
Impact of disruptions in semiconductor manufacturing have a multiplier effect downstream in the electronics supply chain

**Example: Logic**

Taiwan alone concentrates ~40% of the world's total logic production capacity, including >90% of the capacity for advanced processors.

A hypothetical disruption of Taiwan-based manufacturing capacity due to a natural disaster, infrastructure failure or geopolitical conflict could put at risk:

- $40B revenue for Taiwanese foundries
- $80B revenue loss for global fabless companies
- $500B revenue loss for electronic device OEMs

**Example: Memory**

S. Korea concentrates ~44% of the world's total memory production capacity.

The ongoing Japan-S. Korea tensions restricted Japanese exports of 3 materials used to produce memory - if sustained over time, this could put at risk:

- $0.4B revenue for Japanese suppliers
- $65B revenue risk for Korean semi companies
- $750B revenue risk for electronic device OEMs

In addition to economic impact, a disruption of supply of semiconductors used in "critical applications" could also have severe implications for national security.
A new $50B federal incentive program will enable establishing a minimum viable capacity to cover the US consumption from critical applications.

**US ANALYSIS: BREAKDOWN OF TOTAL US SEMICONDUCTOR CONSUMPTION, 2019**

- **Memory:** 28%
- **Advanced logic:** 34%
- **DAO:** 15%
- **Other logic:** 23%

**$107B**
25% of global semiconductor sales

**Total US consumption as % of global semiconductor sales**
- 25%
- 18%
- 7%

- **Industrial & ICT infra**
  - 100%
  - 25%
  - 18%

- **Consumer**
  - 7%
  - 27%

**Critical applications**
- 7%

**Total US consumption**
- Full manufacturing self-sufficiency
  - ~980+410
  - ~60 new fabs

**Other applications**
- Minimum viable capacity
  - ~230+95
  - ~15 new fabs

**Includes:**
- Defense & Aerospace
- Telecom networks
- Energy, security and medical equipment
- Data centers of Government and essential sectors (telecoms, energy & utilities, healthcare and financial services)

**10-year investment** in new fabs for onshore coverage in 2030 ($B)
- Private sector + Gov. incentives

**GEOGRAPHIC CONCENTRATION**
- ~60 new fabs
- ~230+95
- ~15 new fabs

**Minimum viable capacity**
- $45B already available (state & local)
- $50B of new federal incentives

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1. Total Cost of Ownership - includes capex and 10 years of opex, before government incentives
Sources: BCG analysis
Impact of US restrictions to trade with China on the US semiconductor industry could be much higher than the "Made in China 2025" plan alone

**Global Semiconductor Market Share (%)**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Perpetuation of status quo</th>
<th>Technology decoupling</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Near term</strong></td>
<td><strong>Long term</strong></td>
<td><strong>Near term</strong></td>
</tr>
<tr>
<td>China</td>
<td>14</td>
<td>31+</td>
</tr>
<tr>
<td>Europe &amp; Others</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>South Korea</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Japan</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>US</td>
<td>(No further direct impact)</td>
<td></td>
</tr>
</tbody>
</table>

**Restrictions on Chinese access to US technology**

**Global Semiconductor Market Share (%)**

<table>
<thead>
<tr>
<th>2018 Baseline</th>
<th>Expected impact of Made in China 2025(^1)</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>US market share loss</td>
<td>To China</td>
<td>To other countries</td>
<td>China's self-sufficiency in semiconductor design(^2)</td>
</tr>
<tr>
<td>US</td>
<td>48</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Europe &amp; Others</td>
<td>24</td>
<td>7-10</td>
<td>23-24</td>
</tr>
<tr>
<td>South Korea</td>
<td>10</td>
<td>14-15</td>
<td>9-10</td>
</tr>
<tr>
<td>Japan</td>
<td>4</td>
<td>7-10</td>
<td>4-10</td>
</tr>
<tr>
<td>US</td>
<td>(No further direct impact)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: BCG analysis and estimates using data from Gartner and company reports, Morgan Stanley, IC Insights

1 Assuming that Chinese share gains come at the expense of foreign suppliers proportionally to the current shares in each product line
2 Calculated as China supply (revenues of Chinese fabless design + IDM companies) over China demand (value of semiconductors in end devices designed by Chinese device makers)
The historical growth rate of the total global talent pool is likely insufficient to meet the industry demand for talent.

**ANNUAL GRADUATES IN SCIENCE AND ENGINEERING (millions)**

### First university degrees
- **Europe**: +2.5%
- **Japan**: -4.4%
- **S. Korea**: +2.4%
- **Taiwan**: +4.9%
- **China**: +11.0%
- **US**: +2.7%

### Doctoral degrees
- **Europe**: +3.8%
- **Japan**: +0.4%
- **S. Korea**: +5.1%
- **Taiwan**: +6.0%
- **China**: +10.4%
- **US**: +2.9%

**Sources**: BCG analysis with data from US National Center for Science and Engineering Statistics (NCSES)
Government has a critical role in R&D - particularly in basic research. US Government participation in semiconductor research is trailing behind.

Total US R&D Investment across All Sectors, 2018

Comparison of US Federal Government Share in Total R&D Investment, 2018

*Sources: BCG analysis with US National Science Foundation and OECD data, SIA*
Policies in pursuit of blanket “self-sufficiency”, with staggering cost and questionable feasibility, are not the answer...

... INSTEAD, TARGETED POLICIES THAT:

- Improve global resiliency by promoting a more geographically diversified global manufacturing footprint
  - Construction of new semiconductor manufacturing capacity in US, Europe (e.g. minimum viable capacity for consumption from critical applications)
  - Supplier/plant diversification of location for key materials
- Expand market access and promote open trade, while also balancing the needs of national security
  - Levelled playing field and IP protection
  - International collaboration in research and global technology standards
  - Clear, stable policy framework for targeted controls on semiconductor trade
- Stimulate basic research in semiconductors with appropriate government-funded programs
- Invest further in Science & Engineering education, complemented with immigration policies that enable the US to continue attracting world-class talent
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