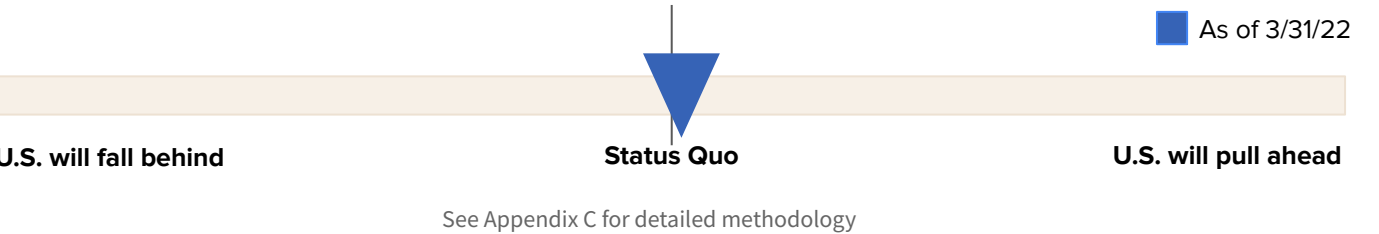


A monthly forecast update highlighting a strategic question from INFER.

Will the U.S. regain and retain a two-generation lead in microelectronic technology?



HIGHLIGHTS THIS MONTH

INFER data from 8 forecasting questions (2 highlighted below) on microelectronics suggest that there is significant uncertainty about whether the U.S. will regain a leadership role in microelectronics.

Will the U.S. Congress pass a tax credit for semiconductor manufacturing and / or design before 1 January 2023?

↑

77% chance

Up 16% from 2/6/22

RATIONALE SUMMARY SUPPORTING CURRENT FORECAST: Economic risk of not passing both manufacturing and design credits is too great. In the final version of the bill, lobbyists pushing for design credits will be successful.

See more details on Page 4

What is percentage of SMIC revenue from 28 nm chips or smaller over the next three years?

Time Period	Forecast	Change since 2/6/22
2022 H1	16%	+1% ↑
2022 H2	18%	unchanged
2023 H1	19%	unchanged
2023 H2	22%	+2% ↑
2024 H1	23%	-1% ↓
2024 H2	24%	-2% ↓
2025 H1	33%	unchanged

RATIONALE SUMMARY: Demand for smaller chips will increase more rapidly due to advances in AI, 5G technologies.

See more details on Page 12

INCLUDED IN THIS REPORT



Forecaster Location:	
USA	54%
Canada, UK, EU, AUS	25%
South East Asia	7%
Central & South America	13%
Other	1%

Overview

The invention of semiconductor technology by U.S. scientists led to the birth of Silicon Valley in the 1950s, which helped the U.S. become the dominant force in semiconductor research and manufacturing, but that dominance has been slipping for decades. Only 12% of semiconductor chips are produced in the U.S., down from 37% in 1990, according to the Semiconductor Industry Association.¹

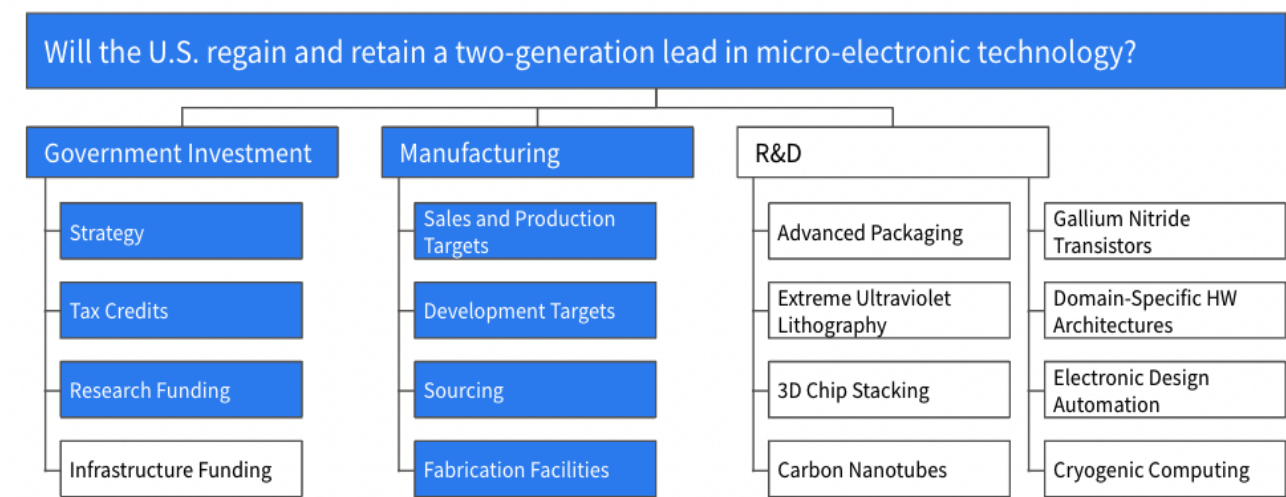
Today, the most advanced microchips in the world are made by Taiwan, showing how a lack of national prioritization and investment in microelectronics has caused the U.S. to lose its lead in microelectronic technology. Given such low integrated circuit production in the U.S., a vast majority is now sourced from East Asia, which has created supply chain vulnerabilities and geopolitical risks that could compromise multiple technologies and platforms.² Having the ability to manufacture advanced chips makes countries less vulnerable to supply chain disruptions and ensures they can continue utilizing the most advanced technological systems. U.S. reliance on East Asian, and especially Taiwanese chips, make the geopolitical jousting across the Taiwan straits and in the South China Sea especially problematic³, and China’s reliance on foreign sources has heightened the technological impact of U.S. export controls and sanctions.⁴

Tracking U.S. Progress With INFER

To begin understanding if the U.S. will regain and retain a two-generation lead in microelectronic technology, the National Security Commission on Artificial Intelligence (NSCAI) suggested three factors are pivotal: the amount and scope of U.S. Government investment, growing manufacturing capacity and capability, and new research and development⁵.

Building on these factors, we are identifying forecast questions that inform our assessment of the United States’ ability to regain a leadership role in the field. These questions are published for crowdsourced forecasting on inferpublic.com. (See Appendix-B to learn more about who is in our forecaster pool.)

The blue areas below represent topics where we are currently collecting forecasts and are discussed in this report, while the white areas are topics that are in development and will be covered in the future.



¹ <https://news.mit.edu/2022/us-leadership-microelectronics-semiconductors-0119>
² <https://www.nytimes.com/2022/01/26/us/politics/computer-chip-shortage-taiwan.html>
³ <https://www.reuters.com/investigates/special-report/taiwan-china-chips/>
⁴

<https://www.scmp.com/tech/tech-war/article/3159828/us-china-tech-war-semiconductor-troubles-cloud-beijings-efforts-self>
⁵ “Chapter 13: Microelectronics,” National Security Commission on Artificial Intelligence Final Report
<https://reports.nscai.gov/final-report/chapter-13/>

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Will the U.S. Congress pass a tax credit for semiconductor manufacturing or design before 1 January 2023?

The Facilitating American-Built Semiconductors (FABS) Act, introduced in June 2021, would create a tax credit for investment in semiconductor manufacturing, and possibly semiconductor design.⁶

Based on 135 forecasts by 64 forecasters:

Possible Answer	INFER % Chance
Yes, tax credit for both manufacturing and design	39%
Yes, tax credit only for manufacturing	34%
Yes, tax credit only for design	4%
No tax credit	23%

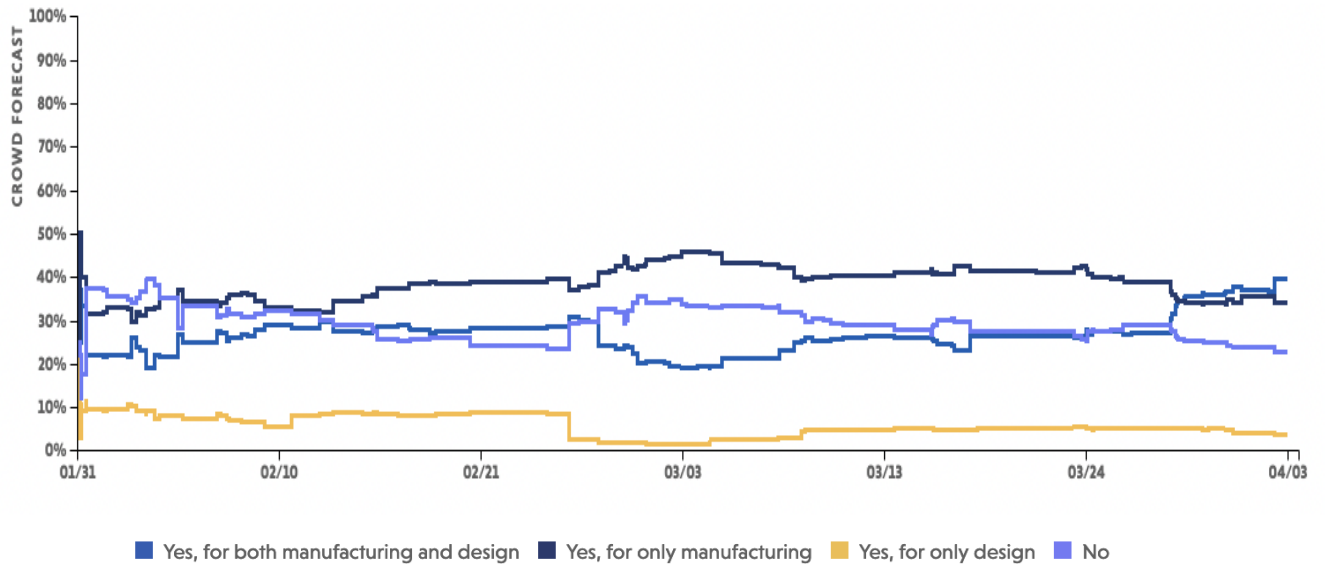
Summary of Forecaster Rationales [\(See Live Forecasts and Rationales\)](#)

A tax credit for both manufacturing and design will pass:	Only a tax credit for manufacturing will pass:	No tax credit will pass:
<ul style="list-style-type: none">▪ The economic risk of not passing credits for both manufacturing and design is too great. In the final version of the bill, lobbyists pushing for design credits will ultimately be successful.▪ In an election year, politicians will make every effort to appeal to as many possible constituencies as they can, and providing tax credits is a great way to do so.▪ The latest iteration of the FABS Act introduced in the House in late March would include credits for both.	<ul style="list-style-type: none">▪ Forecasters that assign higher probabilities to passage of a manufacturing credit cite the larger impact that manufacturing will have on voters, therefore incentivizing politicians to pass manufacturing credits as opposed to design, especially in an election year.▪ Manufacturing is more tangible and politicians are better able to direct manufacturing to their individual states.▪ The Biden Administration continues to show a strong desire to work with private industry in semi-conductor manufacturing development.	<ul style="list-style-type: none">▪ Many of those who forecast nothing will pass cite a lack of true bipartisan support in Congress, with other issues taking priority as the midterms approach.▪ The Republicans will do everything within their power to block any such legislation, not wanting to give the Biden Administration any kind of win or momentum heading into the midterms.▪ The crisis in Ukraine has slowed globally supply as well as stalled any bills that were potentially going to get passed in 2022.

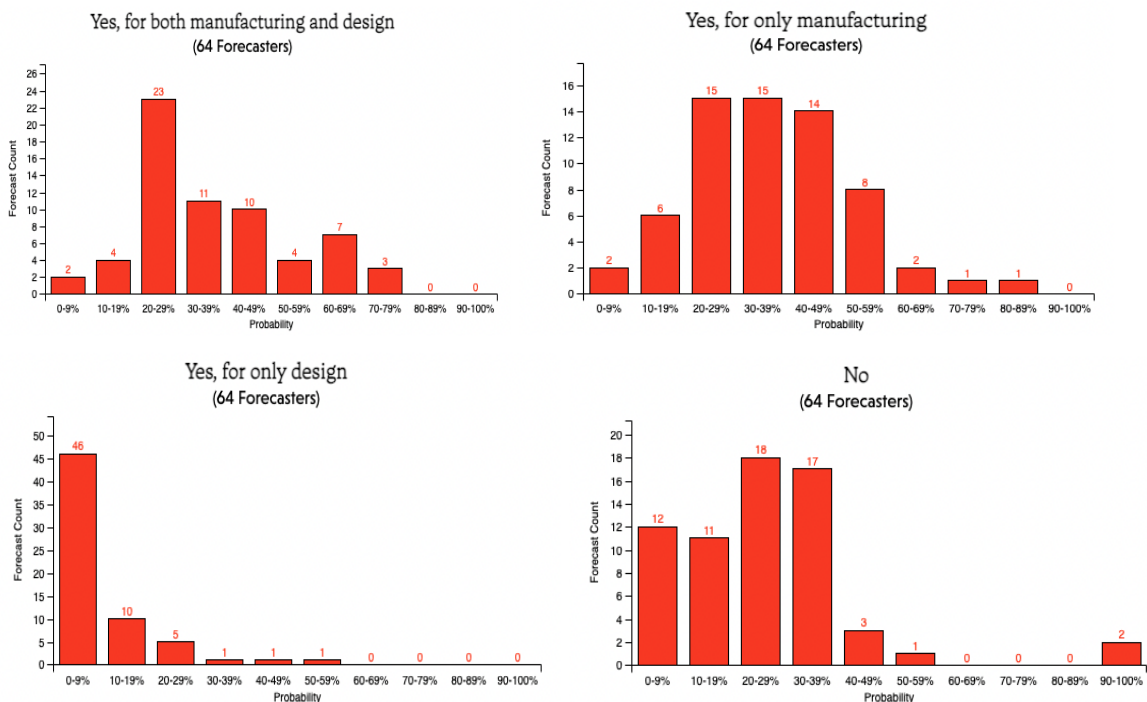
⁶ <https://www.congress.gov/bill/117th-congress/senate-bill/2107/text?r=68&s=1>

Will the U.S. Congress pass a tax credit for semiconductor manufacturing or design before 1 January 2023?

Consensus Trend



Forecast Distributions (See the most up-to-date distributions [here](#).)



Will the U.S. President sign legislation which appropriates funds for the Advanced Packaging Manufacturing Program during FY'22?

The U.S. House of Representatives and Senate have each passed bills that allocate \$2.5 billion in funding for the Advanced Packaging Manufacturing Program. Congressional leaders in both houses of Congress must now work to reconcile the two bills before sending them to the President to be signed.

Based on 83 forecasts by 52 forecasters:

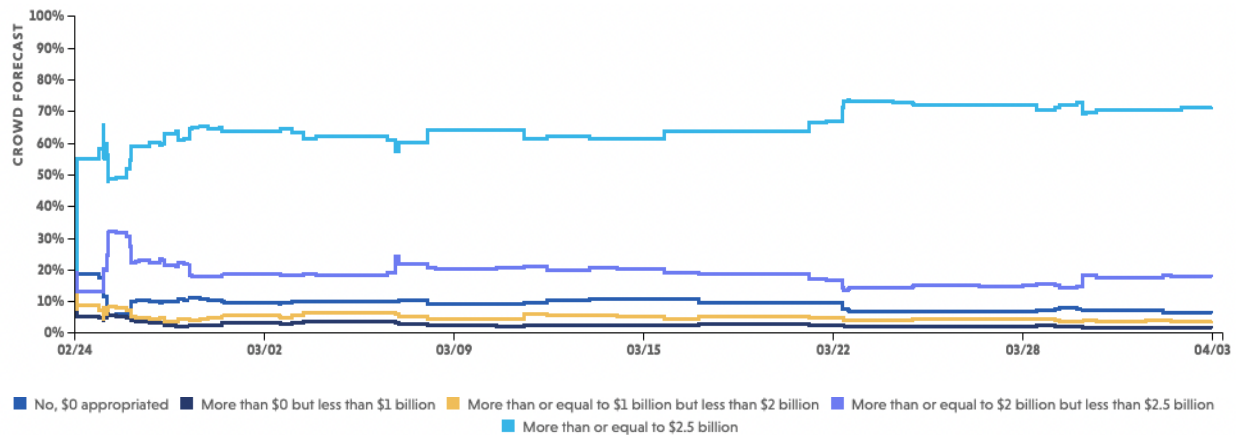
Possible Answer	INFER % Chance
No, \$0 appropriated	6%
More than \$0 but less than \$1 billion	1%
More than or equal to \$1 billion but less than \$2 billion	4%
More than or equal to \$2 billion but less than \$2.5 billion	18%
More than or equal to \$2.5 billion	71%

Summary of Forecaster Rationales [\(See Live Forecasts and Rationales\)](#)

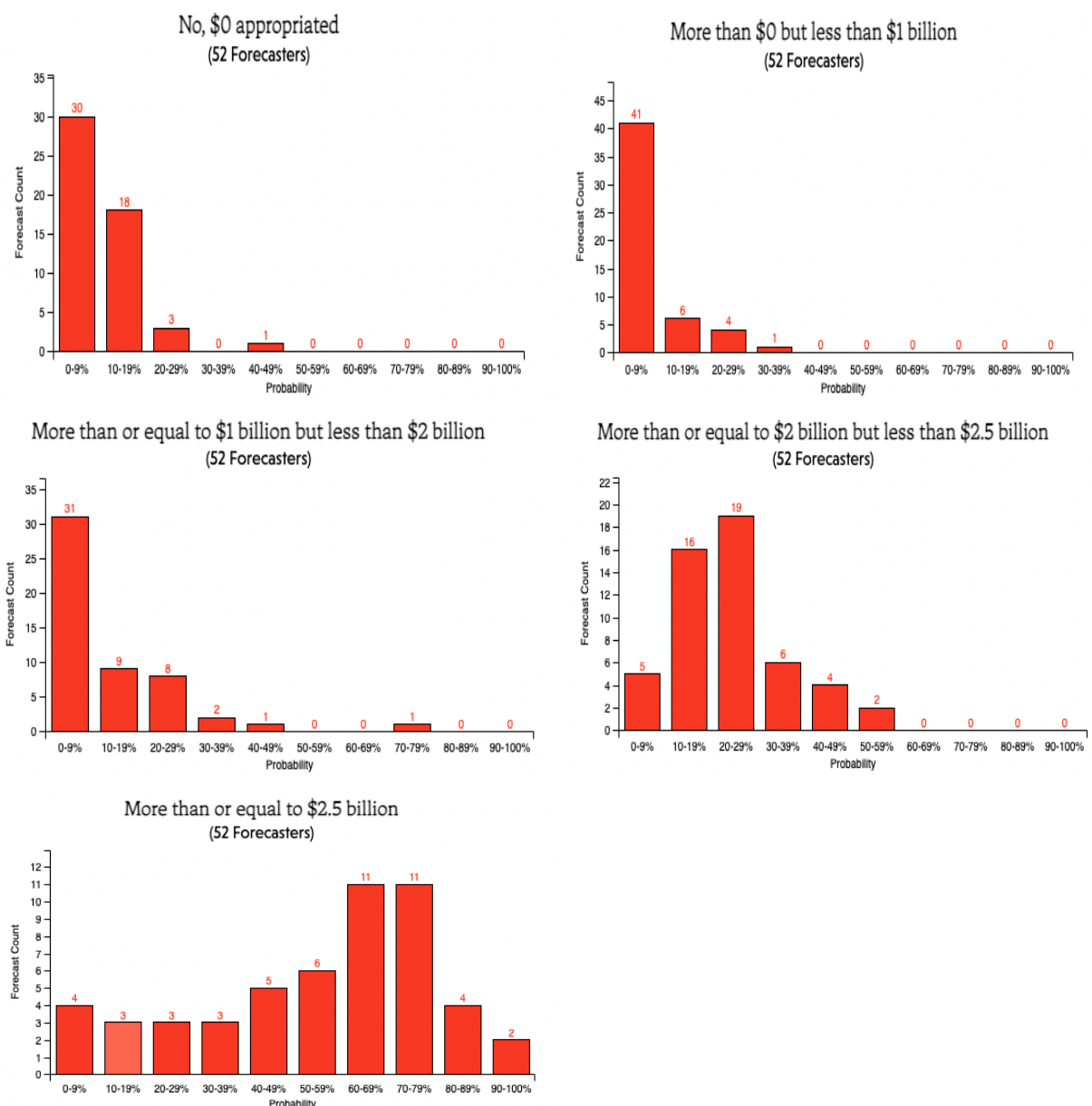
\$2.5 billion or more appropriated:	Between \$0 and \$2.5 billion appropriated:	\$0 appropriated:
<ul style="list-style-type: none">▪ There is strong existing bipartisan support for the 2.5 billion, and some forecasters expect funding to increase from the levels currently in the bill.▪ The semiconductor industry is becoming increasingly relevant strategically and geopolitically.▪ Upcoming midterm elections could encourage the government to pass this bill quickly and potentially market it as reshoring high-tech manufacturing jobs, supporting national security, and lowering reliance on imports.▪ \$2.5 billion is small enough funding to avoid getting trimmed in reconciliation discussions.	<ul style="list-style-type: none">▪ This bill is an “all or nothing” situation where either everything gets passed or nothing does.▪ The nature of budgets is such that there are so many things to consider, that in the interest of fair negotiations something usually has to be given up.	<ul style="list-style-type: none">▪ There is always a chance that reconciliation doesn’t happen and the bill doesn’t get passed.▪ A bill appropriating funding for ARPA might not be signed by September 30th, 2022, but the money may be appropriated at a later date.▪ Trying to mandate oversight of spending could hold up the reconciliation process beyond the end of the fiscal year ending in 2022.▪ Republican lawmakers might oppose any legislation that helps improve the image of Joe Biden or the Democratic party.

Will the U.S. President sign legislation which appropriates funds for the Advanced Packaging Manufacturing Program during FY'22?

Consensus Trend



Forecast Distributions (See the most up-to-date distributions [here](#).)



By 31 December 2022, will the Taiwan Semiconductor Manufacturing Company announce plans to build a semiconductor fab in Europe?

The Taiwan Semiconductor Manufacturing Company (TSMC) dominates semiconductor manufacturing.⁷ The concentration of fabs, or fabrication facilities, also known as foundries, in Taiwan has led to concern about supply chain vulnerabilities that could disrupt multiple industries.⁸ TSMC has announced plans to build fabs in the United States & Japan, and is considering whether to build one in Europe.⁹

Based on 63 forecasts by 105 forecasters:

Possible Answer	INFER % Chance
Yes	53%
No	47%

Summary of Forecaster Rationales ([See Live Forecasts and Rationales](#))

Above a 50% chance TSMC will announce plans to build a fab in Europe:	Below a 50% chance TSMC will announce plans to build a fab in Europe:
<ul style="list-style-type: none"> There is high enough demand globally for semiconductors that an announcement will be made sometime in 2022. The EU has made clear they are worried about semiconductor shortages, thus giving them an incentive to have more fabs in their territory. An announcement could be made in 2022 to begin the process, but that does not necessarily mean the beginning of anything being built this calendar year. 	<ul style="list-style-type: none"> Russia's invasion of Ukraine will likely delay any announcement, which will push any potential announced plans to build beyond 2022. TSMC is experiencing delays in its U.S. based chip plant in Arizona, including labor shortages and continued struggles with Covid-19. They will want to resolve these concerns first before announcing anything in Europe. It is in TSMC's best interest to wait and see if the EU Commission sponsored CHIPS Act gets passed, which would enhance Europe's semiconductor ecosystem, and perhaps alter TSMC's timeline in making an announcement.

⁷<https://www.cnbc.com/2021/03/16/2-charts-show-how-much-the-world-depends-on-taiwan-for-semiconductors.html>

⁸<https://www.nationaldefensemagazine.org/articles/2021/3/24/just-in-taiwan-viewed-as-achilles-heel-of-us-micro-electronics-supply-chain>

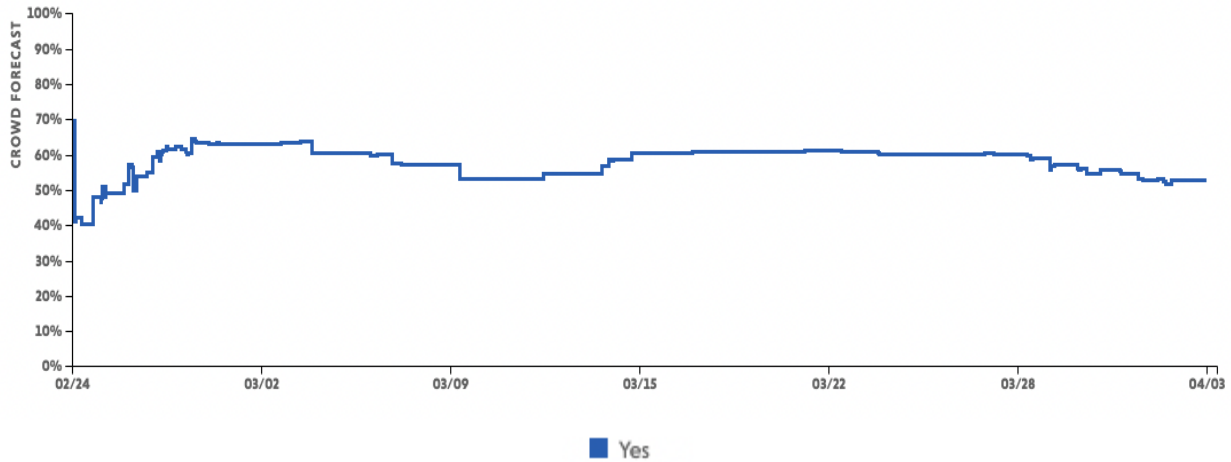
<https://www.discoursemagazine.com/politics/2021/04/16/the-future-of-taiwan-semiconductors-alone-make-the-islands-continued-freedom-crucial-to-the-u-s/>

⁹<https://www.bloomberg.com/news/articles/2021-12-11/tsmc-in-early-stage-contact-with-germany-about-potential-plant>

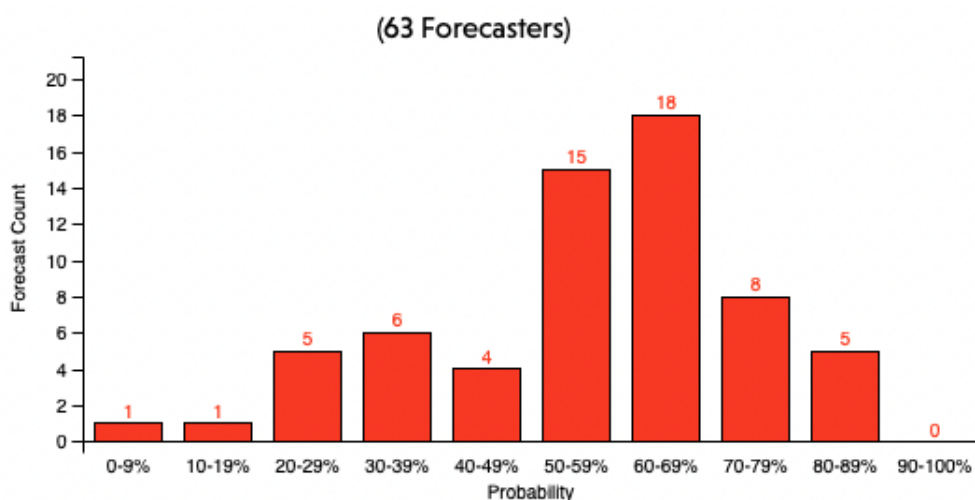
<https://www.cnbc.com/2022/02/11/eu-chips-act-europe-will-need-help-from-us-asia-to-achieve-goals.html>

By 31 December 2022, will the Taiwan Semiconductor Manufacturing Company announce plans to build a semiconductor fab in Europe?

Consensus Trend



Forecast Distributions (See the most up-to-date distributions [here](#).)



How many integrated circuit (IC) units will China produce in 2022?

Given ICs are integral to nearly all modern electronics, their production is critical for any national advanced technology strategy. In 2021, Chinese semiconductor manufacturing accelerated, with ~360 billion IC units being produced, increasing 33.3% year-on-year, compared to a 16.2% increase in 2020.¹⁰

Based on 83 forecasts by 51 forecasters:

Possible Answer	INFER % Chance
Less than 200 billion	1%
200 billion - 300 billion	4%
300 billion - 400 billion	22%
400 billion - 500 billion	64%
More than 500 billion	9%

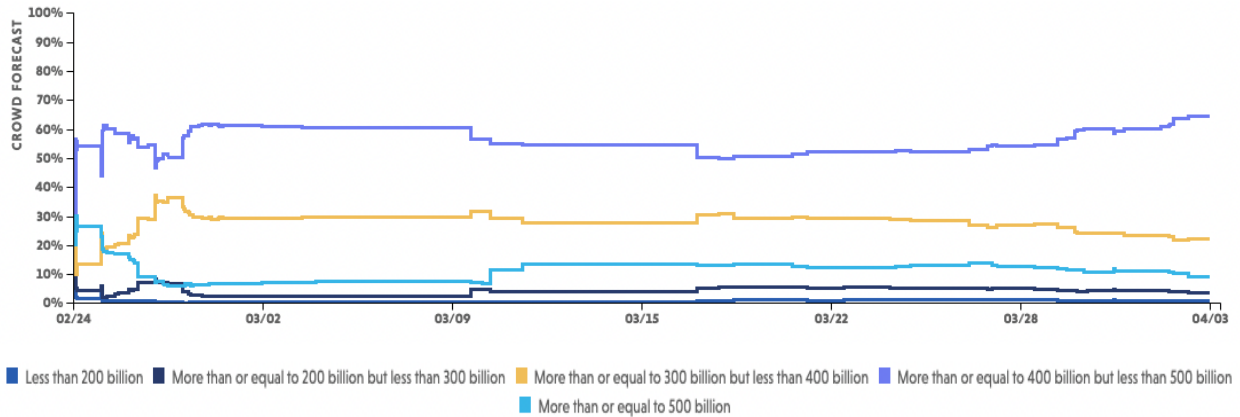
Summary of Forecaster Rationales [\(See Live Forecasts and Rationales\)](#)

Forecasters who assessed with highest probability that less than 400 billion will be produced:	Forecasters who assessed with highest probability that 400 billion or more will be produced:
<ul style="list-style-type: none">▪ Due to increased trade tensions, and advancements in technology coming from other countries including Taiwan and South Korea, there could be a decrease from the 2021 amounts.▪ The war in Ukraine could have a current and lasting negative impact on production well into 2022.	<ul style="list-style-type: none">▪ Starting with the base rate of 360 Billion produced in 2021, it is highly unlikely that figure decreases in 2022. If even a slight increase, then the 400 billion + figure will be achieved.▪ As the global economy continues to rebound post-Covid, production will almost certainly increase from 2021.

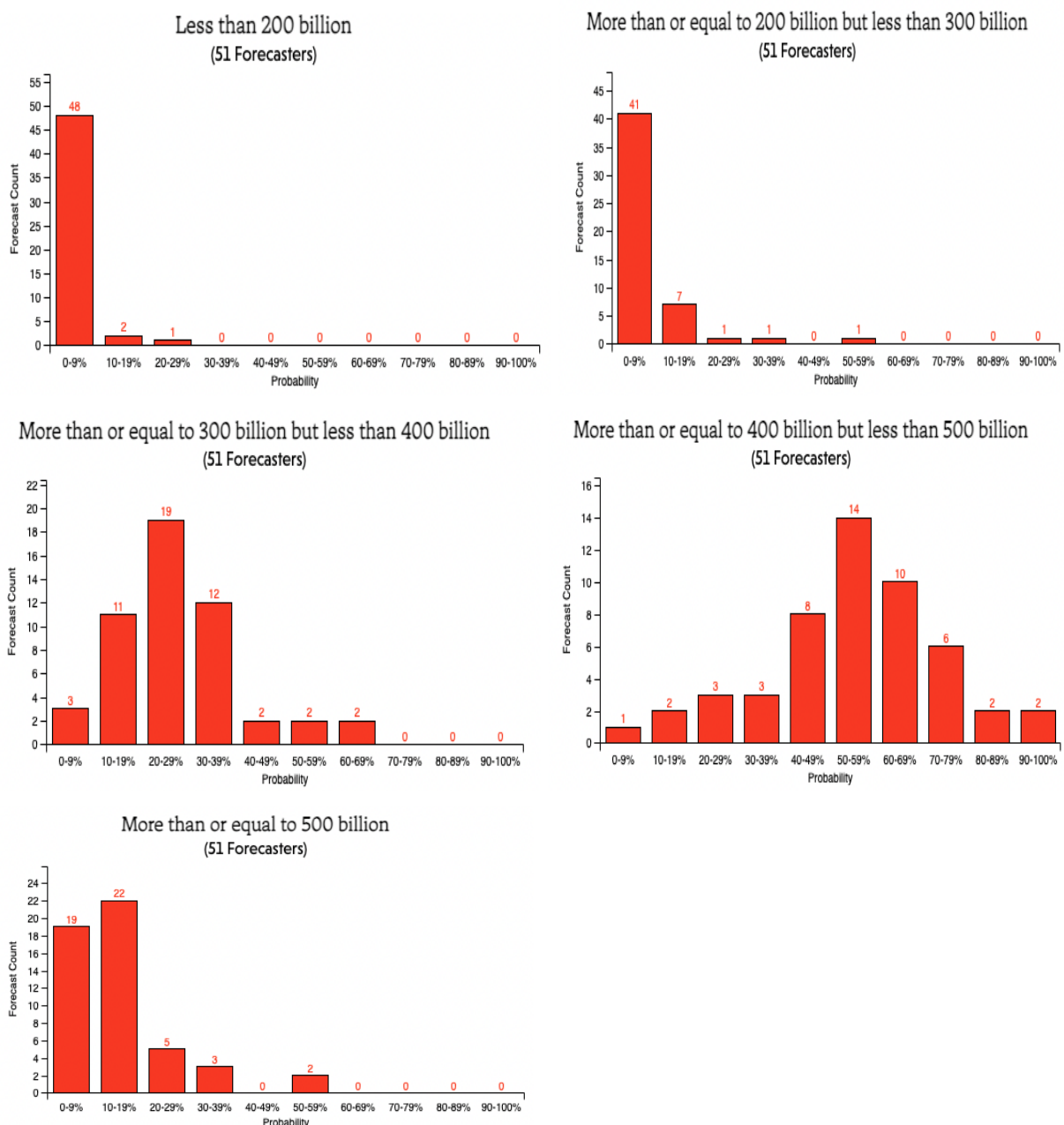
¹⁰https://www.yahoo.com/video/us-china-tech-war-chinese-093000108.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuaW5mZXltcHVlLnNvbS8&guce_referrer_sig=AQAAIDP98r-z7-e7LuhQPimjiU2MFp2RpwUhyyvHprmViBh2lAfYTNvVIObl1fe4lNnxlcQsA_kOkCT2exEwL4i1fFdw97Qc6dvOvgdagU_uTlhcxrHMDwLQAHEBMDKBNiLxbH5dC14S3hldyghyT8vZ4CNmeEu2Wc22DA0iESQIm

How many integrated circuit (IC) units will China produce in 2022?

Consensus Trend



Forecast Distributions (See the most up-to-date distributions [here](#).)



How will the percentage of SMIC revenue from 28 nm chips or smaller change over the next three years?

Based on 272 forecasts by 69 forecasters:

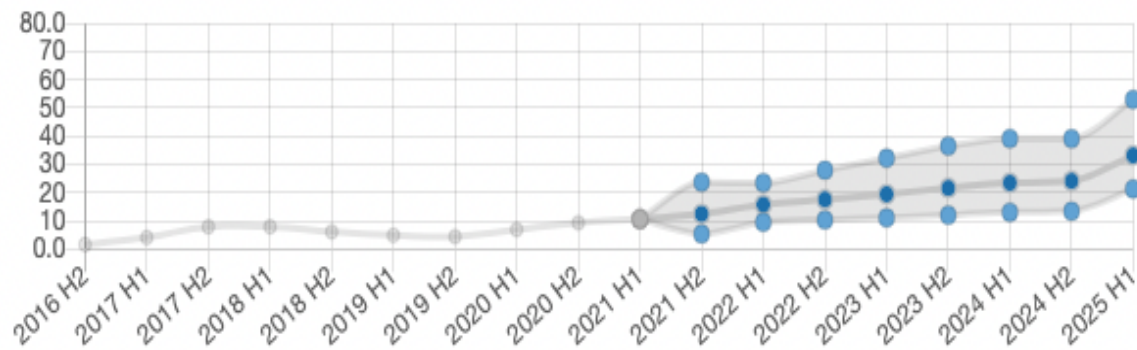
Time Period	Forecasted Percentage of Revenue from 28nm chips or smaller
2022 H1	16% of revenue
2022 H2	18% of revenue
2023 H1	19% of revenue
2023 H2	22% of revenue
2024 H1	23% of revenue
2024 H2	24% of revenue
2025 H1	33% of revenue

Summary of Forecaster Rationales [\(See Live Forecasts and Rationales\)](#)

Forecasters who assessed SMIC’s revenue share from 28nm chips or smaller increasing:	Forecasters who assessed SMIC’s revenue share from 28nm chips or smaller stagnating or decreasing:
<ul style="list-style-type: none">▪ Forecasters referenced SMIC’s ability to overcome difficulties in producing 14 and 28 nm chips.▪ SMIC may enter the 7 nm chip market in 2023 which would further increase revenue for chips under 28nm.▪ Forecasters cited SMIC’s plans to increase investment, expand production capacity, and build three new plants in Beijing, Shanghai, and Shenzhen.▪ Demand for smaller chips will increase more rapidly due to advances in AI, 5G, and other technologies placing higher demands on the underlying microelectronic hardware.	<ul style="list-style-type: none">▪ Cyclical market trends may lead to stagnation in revenue share of <28nm chips in 2023.▪ SMIC’s potential inability to access highly-specialized Extreme Ultraviolet Lithography machines could impact their ability to produce <28nm chips at scale.▪ SMIC’s Tianjin fab is expanding, yet doesn’t produce 28 nm chips.▪ Similarly, SMIC’s Beijing fab which primarily produces 40 nm chips is also expanding and currently makes up a large percentage of SMIC’s revenue.

How will the percentage of SMIC revenue from 28 nm chips or smaller change over the next three years?

Consensus With 90% Forecast Intervals



Of the following companies, which will start volume production on a 3nm chip or smaller before 17 September 2023?

Although the industry is accustomed to TSMC releasing new product every two years.¹¹ TSMC’s volume production of the 3nm chip is not expected to begin until the second half of 2022.¹² Samsung has plans to roll out their 2nm design in 2025, but volume production of the 3nm chip was delayed from 2021 to 2022.¹³ Intel’s roadmap calls for them to overtake their competition by releasing a 1.8nm chip by 2024.¹⁴

Based on 43 forecasts by 35 forecasters:

Possible Answer	INFER % Chance
Intel	30%
Samsung	50%
TSMC (Taiwan Semiconductor Manufacturing Company)	65%

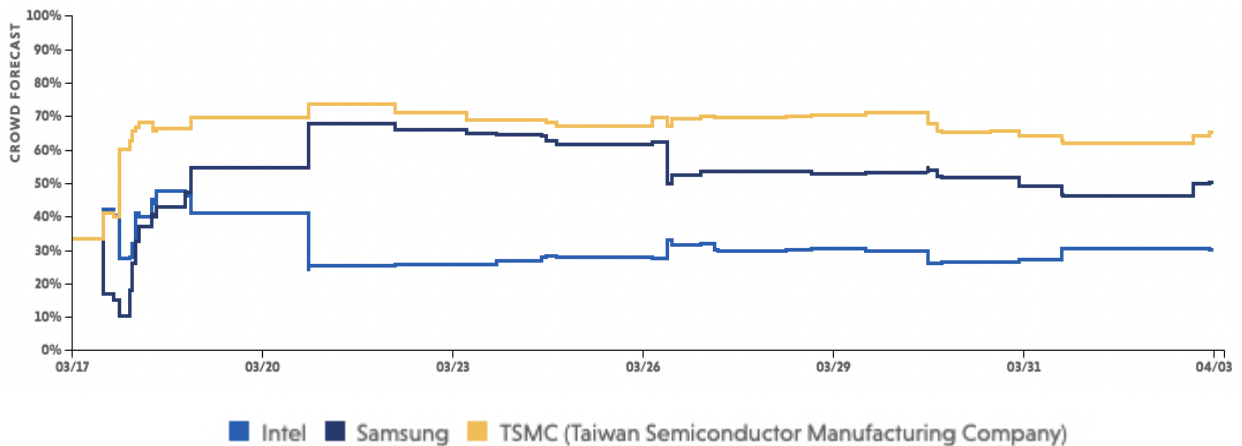
Summary of Forecaster Rationales [\(See Live Forecasts and Rationales\)](#)

Rationale for Intel:	Rationale for Samsung:	Rationale for TSMC:
<ul style="list-style-type: none">▪ Intel continues to invest in new conductor technologies and new fabric in Germany which will increase the chances of production.▪ Intel may struggle to meet production by this date, specifically due to the complexities of designing the production process and how they have already seemingly fallen behind on technology.▪ Intel has proven over time they they are capable of adapting quickly to emerging markets, more so than Samsung and TSMC.	<ul style="list-style-type: none">▪ Samsung is scheduled to start producing its customers’ first 3nm-based chip designs in the first half of 2022, while its second generation of 3nm is expected in 2023. I don’t see why they won’t have it started by 2023.▪ They are still planning on rolling out volume production in 2022, which gives me a lot of wiggle room even if there are delays.	<ul style="list-style-type: none">▪ They are currently planning (even after 8 months of delays) to begin volume production in Q4 2022, meaning they have an additional 9 months past the scheduled start of production to resolve positively here.▪ TSMC has access to the most LUV technology and will take advantage of it.▪ TSMC has access to the most LUV technology and will take advantage of it. TSMC has already kicked off pilot production of chips built using N3 at its Fab 18 in southern Taiwan and will move the process to volume production by Q4 2022.

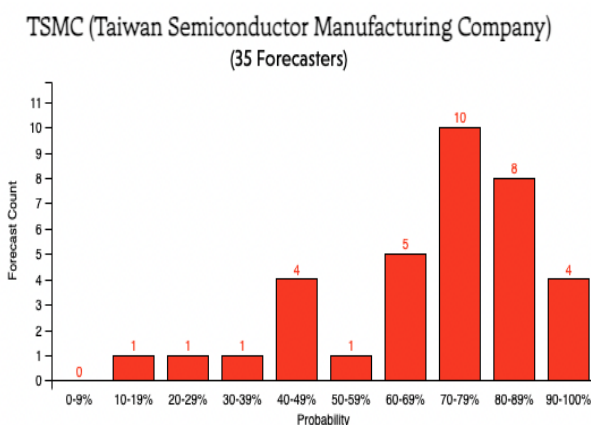
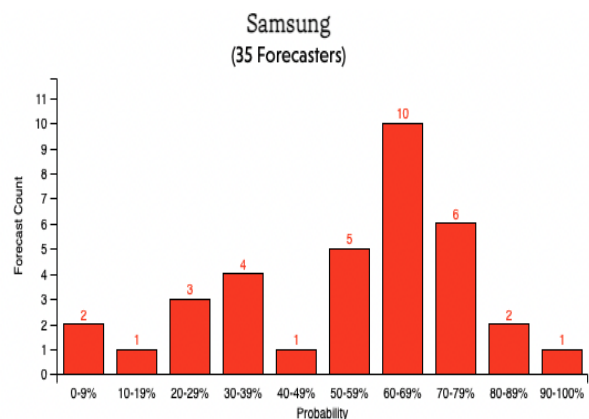
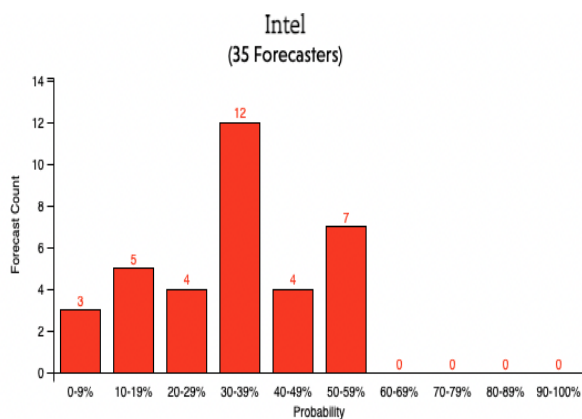
¹¹ <https://www.anandtech.com/show/17013/tsmc-update-3nm-in-q1-2023-3nm-enhanced-in-2024-2nm-in-2025>
¹² https://www.tsmc.com/english/dedicatedFoundry/technology/logic/l_3nm
¹³ <https://www.electronicdesign.com/technologies/embedded-revolution/article/21178098/electronic-design-samsun-g-foundry-delays-3nm-node-to-2022-2nm-due-by-2025>
¹⁴ <https://analyticsindiamag.com/the-race-to-reduce-nanometers-in-chips/>

Of the following companies, which will start volume production on a 3nm chip or smaller before 17 September 2023?

Consensus Trend



Forecast Distributions (See the most up-to-date distributions [here](#).)



Which company will be the largest semiconductor company by sales revenue in 2022?

Despite an ongoing semiconductor shortage, worldwide semiconductor revenue rose to over \$500 billion for the first time in 2021.¹⁵ In this context, Intel, the U.S.’s largest semiconductor company, saw sales stall at \$75.55 billion, while Samsung’s sales surged to \$83.085 billion, generating more semiconductor sales revenue than Intel for the first time since 2018.¹⁶

Based on 65 forecasts by 52 forecasters:

Possible Answer	INFER % Chance
Intel	32%
Samsung	59%
TSMC (Taiwan Semiconductor Manufacturing Company)	8%
Other	1%

Summary of Forecaster Rationales [\(See Live Forecasts and Rationales\)](#)

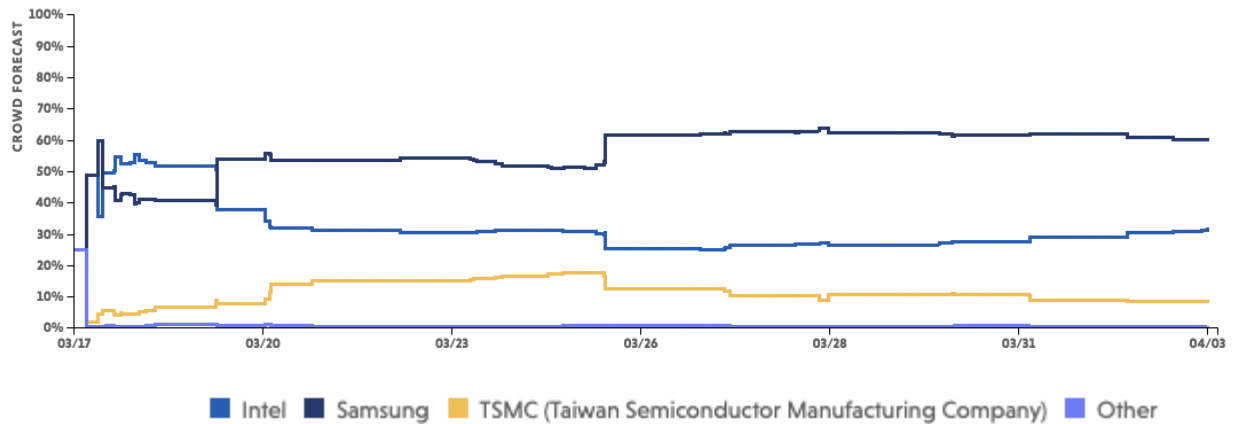
Intel:	Samsung:	TSMC:
<ul style="list-style-type: none">▪ Intel is a massive semiconductor company that captures a wider variety of applications and has a great upside.▪ Intel will retake first place boosted by its planned \$36 billion expansion of its European operations, including two fabs in Germany.▪ Intel and Samsung will be neck and neck, but based on historical data and trends, I have to think that Samsung’s recent surge in sales is an outlier and Intel will regain the top spot.	<ul style="list-style-type: none">▪ Samsung’s rise in revenue in 2021 was not an outlier, and the popularity of the NAND and DRAM markets, which Samsung has the lead in, will keep them on top for 2022.▪ Intel made some missteps in its data center line of business that provides a clear line for Samsung to eat up even more market share chunks.▪ The arguments for Samsung include rapid growth that is likely sustainable, a more diverse product base, and they appear to be the much more geopolitically company.	<ul style="list-style-type: none">▪ They are tied for most advanced semiconductors (5nm, 3nm), and are also mostly focused on semiconductors, which could give them a strategic advantage.▪ Opening a new plant in the US, which could benefit them greatly.

¹⁵ <https://www.windowscentral.com/samsung-intel-2021-semiconductor-revenue>

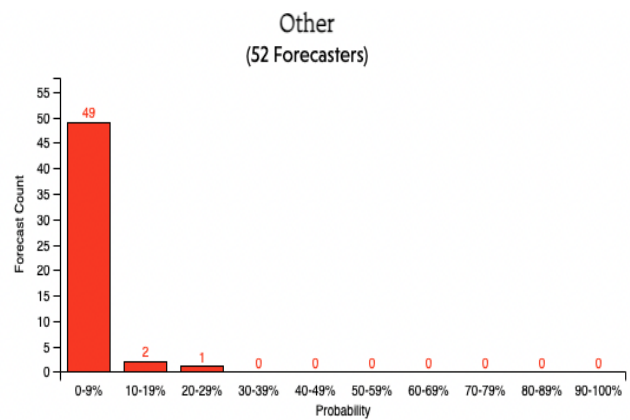
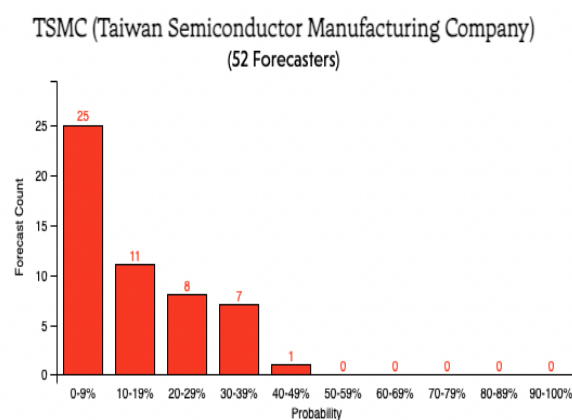
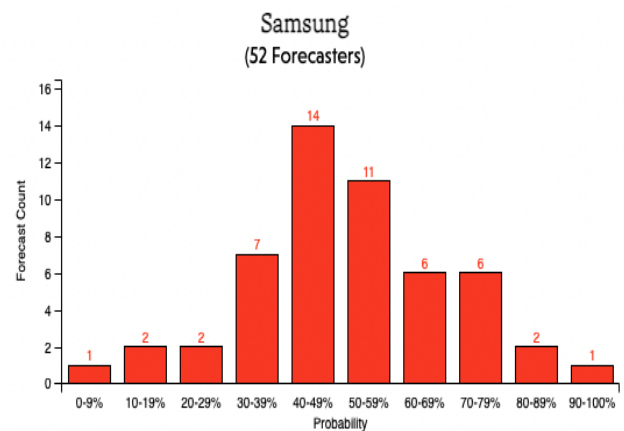
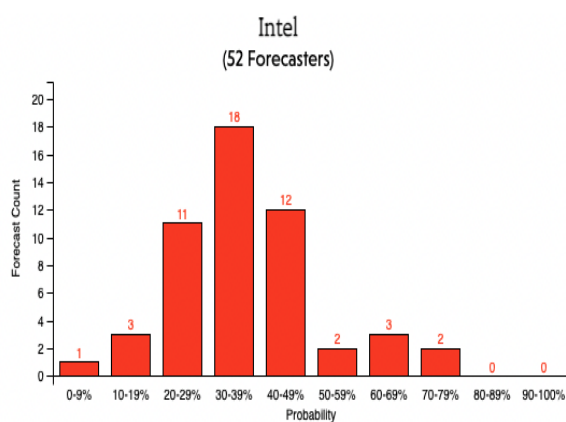
¹⁶<https://www.icinsights.com/news/bulletins/17-Semiconductor-Companies-Forecast-To-Have-100-Billion-In-Sales-This-Year/>

Which company will be the largest semiconductor company by sales revenue in 2022?

Consensus Trend



Forecast Distributions (See the most up-to-date distributions [here](#).)



In 2022, will the Shanghai Micro Electronics Equipment Co. list a new lithography machine as an available product on its website?

Photolithography is a critical weakness of China’s semiconductor industry.¹⁷ Shanghai Micro Electronics Equipment Co (SMEE), the leading Chinese manufacturer, currently offers lithography equipment to support chips with 90nm nodes.¹⁸ In September, SMEE announced that it had delivered a new product employing 3d chip packaging, but they did not announce its resolution and the new packaging product is not currently available on its website 2021.¹⁹

Based on 44 forecasts by 49 forecasters:

Possible Answer	INFER % Chance
Yes	16%
No	84%

Summary of Forecaster Rationales ([See Live Forecasts and Rationales](#))

Forecasters who gave it a 25% + chance:	Forecasters who gave it below a 25% chance:
<ul style="list-style-type: none"> ▪ There seems to be a political will to make China independent in the semiconductor business, and they will be making this a priority. ▪ Having a home-grown lithography machine for China is something that seems to be important to them, and while they will get there eventually, the timing of when becomes the great question. ▪ With Beijing’s display of technological might and scientific independence, SMEE should publish shortly, once it has recovered from the consequences of the U.S. Commerce Department’s export watch list. 	<ul style="list-style-type: none"> ▪ SMEE may face issues when it comes to importing parts after being listed as a “military end user” by the U.S government. ▪ There seems to be a roughly 5 year cycle for new models in this space, so taking that into account, it is unlikely to happen within this calendar year. ▪ Concerns about persistent inflation, supply chain disruptions from new COVID variants, and the Ukraine conflict are all factors that have weighed on the risk appetites for investors, which will likely decrease the possibility for SMEE releasing new product.

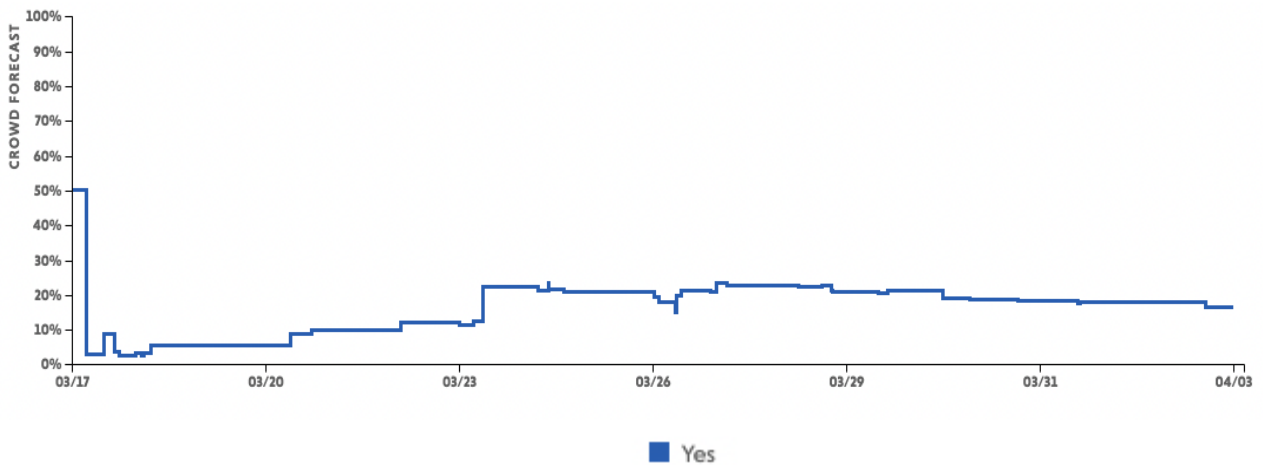
¹⁷ <https://www.ccsinsight.com/blog/chinese-chipmakers-look-inward-for-equipment-suppliers/>

¹⁸ http://www.smee.com.cn/eis.pub?service=homepageService&method=indexinfo&onclicknodeno=1_4_4_1

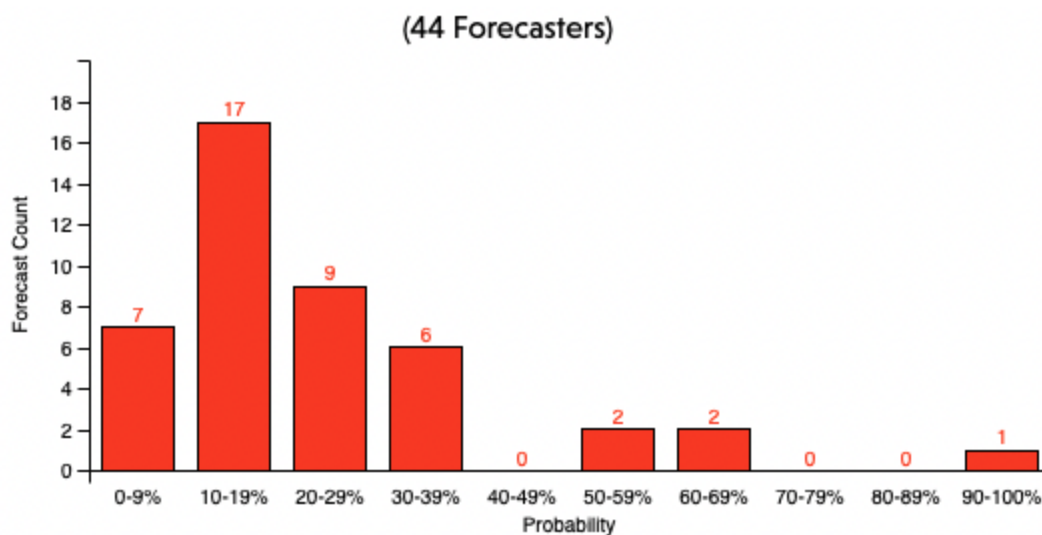
¹⁹ <https://news.cgtn.com/news/2022-02-07/China-delivers-its-1st-advanced-2-5D-3D-chip-packaging-stepper-17swMyw1NHq/index.html>

In 2022, will the Shanghai Micro Electronics Equipment Co. list a new lithography machine as an available product on its website?

Consensus Trend



Forecast Distributions (See the most up-to-date distributions [here.](#))



Newly published questions to appear in future reports:

On 31 March 2022 we published 3 new microelectronics forecast questions. Due to the short time they have been available for forecasters to make predictions, the data is non-reportable as of now.

Links to each are available below:

- [What percentage of ASML's lithography sales will be to the United States in 2022?](#)
- [How many Chinese Universities will be listed in QS World University Rankings' top 100 universities for computer science in 2023?](#)
- [What will the price per ton of aluminum be on 1 June 2022?](#)

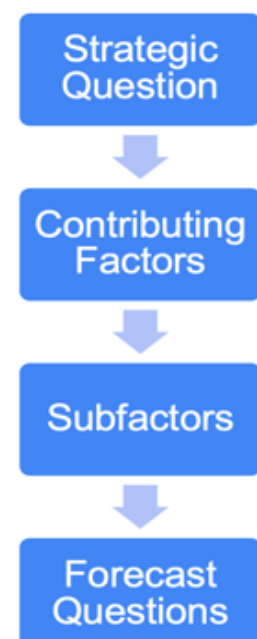
Appendix A - Methodology for Identifying Forecast Questions

INFER operates as a continuous, 4-step life-cycle between U.S. Government policymakers and a global community of forecasters who bring a diverse, informed perspective to their assessment of the future.

1. As initial input, policymakers work with INFER to identify *priority areas* (e.g. “AI competitiveness”) and *strategic questions* within those priority areas (e.g. “Will the U.S. regain its lead in microelectronics?”) where guidance, regulation, or clarification is needed to inform policy and strategy.
2. INFER defines what *contributing factors* about the future will need to be understood to best inform the answer to the strategic question (e.g. “What will the future of domestic microelectronics manufacturing capabilities be?”). We call the process of identifying these pivotal factors “strategic question decomposition.”
3. Using those factors we identified in the decomposition, we define signals or sign-posts that we can use to assess the outcome of that factor. From those signals, we author the *forecast questions* that appear on our public crowdsourced forecasting platform at inferpublic.com (e.g. “Will the U.S. Congress pass tax credits to incentivize semiconductor manufacturing and design in 2022?”).
4. Based on the forecasts the crowd generates, INFER creates curated reports and automated dashboards to share with policymakers. Unlike a one-time survey, individuals are encouraged to update their forecasts over time so INFER can always create near real-time assessments of what will happen in the future.

Here’s a model of that strategic question decomposition process and terms we use to describe it:

- **Strategic questions** represent the broad categories we want to learn more about. Breaking down a strategic question is the main focus of a decomposition.
- **Contributing factors** are the primary drivers of the strategic question. They directly influence the outcome in one direction or another.
- **Sub-factors** are the individual elements that make up and influence a contributing factor. Depending on the size and scope of the strategic question, it may be possible to identify signals directly from the contributing factors without the need for sub-factors.
- **Signals** are specific metrics or events that tell us how a factor or sub-factor is trending, and that ultimately turn into **Forecast questions** we publish on INFER.



Once forecast questions have collected forecasts, we can use the decomposition model to synthesize and analyze data from individual forecasts and glean information about how a strategic question might trend. We call this **recomposition**—the process and product of combining forecasts together to provide insight into the strategic question. This final recomposition can take many forms, e.g., a dashboard, a summary report, or an index.

Decomposing our strategic question about microelectronics

Forecast questions are selected to provide coverage over this conceptual space, with an emphasis on questions that allow us to assess multiple factors or subfactors at once. In addition, U.S. strength in this arena cannot be assessed without an assessment of Taiwan, China, and other industry players. Taiwan is the current industry leader and China is a geopolitical competitor who is aggressively pursuing dominance in this area. Catching Taiwan and remaining ahead of China is key to achieving the U.S.’s strategic goal of reclaiming and retaining a two generation lead in microelectronics. As such, the set of forecast questions are designed to cover advances and setbacks in all three countries, across all three contributing factors.

Below is the table we are populating with forecast questions to assess our broader strategic question about regaining and retaining a two-generation lead in microelectronic technology. Some have already been published on the platform, others will be published in the coming weeks and will appear in subsequent reports.

Contributing Factor	Subfactor	Forecast Question
Government Investment	Strategy	How many Chinese Universities will be listed in QS World University Rankings’ top 100 universities for computer science in 2023?
	Tax Credits	Will the U.S. Congress pass a tax credit for semi-conductor manufacturing or design before 1 January 2023?*
	Research Funding	Will the U.S. President sign legislation which appropriates funds for the Advanced Packaging Manufacturing Program in Fiscal Year 2022?*
	Infrastructure Funding	TBD
Manufacturing	Sales Targets	How will the percentage of SMIC revenue from 28 nm chips or smaller change over the next three years?*
		Which company will be the largest semiconductor company by sales revenue in 2022?*
	Production Targets	How many integrated circuit (IC) units will China produce in 2022?*
	Development Targets	Of the following companies, which will start volume production on a 3nm chip or smaller before 17 September 2023?*
		In 2022, will the Shanghai Micro Electronics Equipment Co. list a new lithography machine as an available product on its website?*
	Sourcing	What will the price per ton of aluminum be on 1 June 2022? What percentage of ASML’s lithography sales will be to the United States in 2022?
R&D	Fabrication Facilities	By 31 December 2022, will the Taiwan Semiconductor Manufacturing Company announce plans to build a semiconductor fab in Europe?*
	Advanced Packaging	TBD
	Extreme Ultraviolet Lithography	TBD
	3D Chip Stacking	TBD

	Photonics	TBD
	Carbon Nanotubes	TBD
	Gallium nitride transistors	TBD
	Domain specific hardware architectures	TBD
	Electronic Design Automation	TBD
	Cryogenic Computing	TBD

*Forecast Reports included in this report.

Appendix B - Current Forecaster Pool Profile

Attributes of the forecasters who have responded to the forecast questions included in this report.

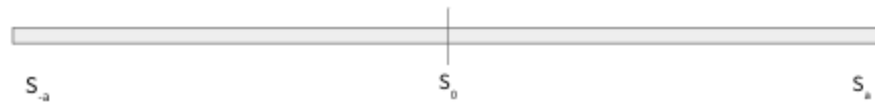
Gender	
Male	64%
Female	31%
Nonbinary, or prefer not to say	5%
Age	
18-24	24%
25-36	45%
37-60	27%
60 and older	3%
Country	
United States	54%
Canada, UK, European Union, AUS	25%
South East Asia	7%
Central and South America	13%
Other	1%
Education	
Graduate education (completed or have some)	65%
Undergraduate education (completed or have some)	35%
Degree Fields - choose all that apply	
Science, Engineering, or Technology	34%
Political Science, International Relations, International Business	34%
Foreign Service, Security, or Government	20%
Public Policy	19%
Public Administration, Business Administration	8%
Other	21%
Experience in Relevant Topics 1-Not at all familiar to 5-Very Familiar	Rated 4-5
AI or machine learning	43%
U.S. policy on AI	22%
China policy on AI	16%
Advanced computing (supercomputers, quantum)	18%
Biotechnology	19%
Climate science	27%
Energy	27%
Forecasting and critical judgment	59%
Reasoning, decision making, and rationality	74%
Cognitive psychology	42%

Appendix C - Methodology for Slider Position

For each strategic question, three scenarios are defined:

- S_a : Scenario A
- S_{-a} : Scenario -A represents the opposite of Scenario A
- S_0 : Scenario 0 represents perpetuation of the status quo.

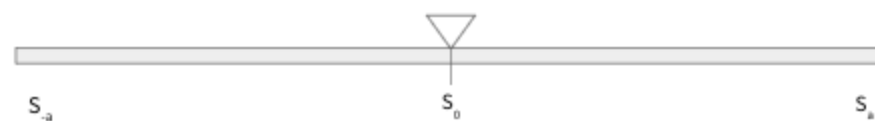
These three scenarios are represented on a horizontal axis, called the slider. This axis runs from -1 to 1, with 0 at the midpoint. The midpoint is labeled S_0 , the endpoint at -1 is labeled S_{-a} , and the endpoint at 1 is labeled S_a .



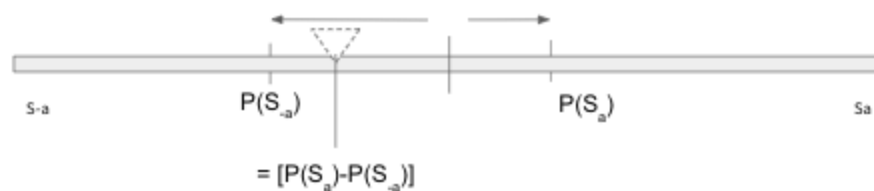
A set of forecasting questions is identified, and their answers are each associated with one of the scenarios S_a , S_{-a} , or S_0 . We define the probability of a scenario S_x as the average of the probabilities of the set of outcomes associated with S_x . More formally, for a set of outcomes, O_{xi} , $i=1, \dots, n$

$$P(S_x) = \frac{\sum_{i=1}^n P(O_{xi})}{n}$$

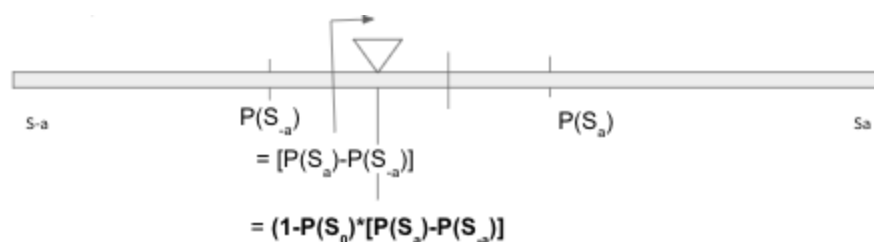
The ticker's position on the slider begins at the status quo, S_0 .



The probabilities of S_a and S_{-a} move the ticker toward their respective end points, resulting in a net movement probability of $P(S_a) - P(S_{-a})$.



The probability of the status quo scenario, S_0 , then moves the ticker back toward the status quo by multiplying the net movement probability by the probability that we depart from the status quo, $(1 - P(S_0))$.



The final position of the ticker is thus represented by the following equation:

$$= (1 - P(S_0)) \times [P(S_a) - P(S_{-a})]$$

For the purposes of this report the scenarios are defined as follows:

- S_a: The U.S. regains a two generation lead in microchip technologies.
- S_{-a}: The U.S. falls further behind in microchip technologies.
- S₀: Status quo

The answers of the forecast questions included in this metric are assigned to the following scenarios.

Question	Answers	Associated Scenario
Will the U.S. Congress pass a tax credit for semiconductor manufacturing or design before 1 January 2023?*	Yes ²⁰	U.S. Regains Leadership
	No	Status quo
Will the U.S. President sign legislation which appropriates funds for the Advanced Packaging Manufacturing Program during FY'22?	Yes ²¹	U.S. Regains Leadership
	No	Status Quo
By 31 December 2022, will the Taiwan Semiconductor Manufacturing Company announce plans to build a semiconductor fab in Europe?	Yes	U.S. Regains Leadership
	No	Status Quo
How many integrated circuit (IC) units will China produce in 2022?	300 billion or less than 300 billion ²²	U.S. Regains Leadership
	More than 300 billion, but less than 400 billion	Status Quo
	400 billion or more ²³	U.S. Falls Behind
How will the percentage of SMIC revenue from 28 nm chips or smaller	Less than 15% in H2 2022	Status Quo

²⁰ Combined answers of “Yes, for both manufacturing and design,” “Yes, for only manufacturing,” and “Yes, for only design.”

²¹ Combined answers of “More than \$0 but less than \$1 billion,” “More than or equal to \$1 billion but less than \$2 billion,” “More than or equal to \$2 billion but less than \$2.5 billion,” and “More than or equal to \$2.5 billion”

²² Combined answers of “Less than \$200 billion” and “\$200 to \$300 billion”

²³ Combined answers of “Between \$400 billion and \$500 billion” and “More than \$500 billion”

change over the next three years? ²⁴	15% or more in H2 2022	US falls behind
Of the following companies, which will start volume production on a 3nm chip or smaller before 17 September 2023?	Intel	U.S. Regains Leadership
	Not Intel ²⁵	U.S. Falls Behind
Which company will be the largest semiconductor company by sales revenue in 2022?	Intel	U.S. Regains Leadership
	Samsung	Status Quo
	TSMC or Other ²⁶	U.S. Falls Behind
In 2022, will the Shanghai Micro Electronics Equipment Co. list a new lithography machine as an available product on its website?	Yes	U.S. Falls Behind
	No	Status Quo
How many Chinese Universities will be listed in QS World University Rankings' top 100 universities for computer science in 2023? ²⁷	Less than or equal to 5	US regains leadership
	6-7, inclusive	Status Quo
	8 or more	US falls behind
What percentage of ASML's lithography sales will be to the United States in 2022? ²⁸	Less than 5%	US falls behind
	5%-10% inclusive	Status Quo
	More than 10% ²⁹	US regains leadership

²⁴ This is a multi-time period question and includes predictions about SMIC revenue for 2022-2025. Slider calculations are based on predictions for H2 of 2022. Revenue in H1 of 2021 was 10.6%, up 3.7% from H1 of 2020. Based on this trend, we defined the status quo as SMIC generating less than 15% of its revenue from 28nm or smaller chips in 2022.

²⁵ 100%-P[Intel]

²⁶ Combined answers of, “TSMC (Taiwan Semiconductor Manufacturing Company)” and “Other”

²⁷ This question was released on 3/31/2022 so does not yet have sufficient data to be included in the slider calculations. It will be included in future reports.

²⁸ This question was released on 3/31/2022 so does not yet have sufficient data to be included in the slider calculations. It will be included in future reports.

²⁹ Combined answers for “Between 10-15%, inclusive” and “More than 15%”