

UBS Global I/O

Global Semiconductors

TSMC's westward expansion

What does the Arizona fab mean in terms of revenue and costs?

TSMC announced its intention to build a 5nm fab in Arizona—why?

We see three key reasons: 1) the US needs an advanced fab. TSMC is not the only option but it is likely the path of least resistance. On page 11, we discuss alternatives such as Intel, Samsung and GlobalFoundries; 2) the need for talent. Now that TSMC is ahead of Intel on process tech, it needs to do more of its own advanced development, and US technical talent is a key advantage. We expect TSMC to recruit aggressively in the US; 3) Taiwan's electricity and water limitations are long-term concerns.

What are the revenue implications?

If TSMC decides to build, we would expect defence-related revenue from the US government which historically has been in the US\$60m/year range (see page 8 for details). We would also expect some market-share implications: As an example, for the Apple iPhone, if the 15% tariff was avoided by manufacturing chips in the US, we would expect Apple to be willing to pay more for the chips and still achieve overall savings.

What are the cost implications?

We estimate that a fab in the US would carry GM that is 3-5% lower than a comparable Taiwan fab. The margin is negatively impacted by labour costs and lack of economies of scale, but partially offset by slightly cheaper utilities rates. Put another way, for a 20,000/month fab, we would need to see subsidies/tax breaks in the US\$40-70m range for TSMC to offset the margin downside—which looks very achievable given that Honhai was promised US\$4.5bn for its Wisconsin facility. We also look at other moves to the US—Fuyao Glass and Honda Motor—and the subsidies received.

Stock implications: Positive for TSMC; negative for ASE—and for semicaps ...?

For TSMC, cost concerns are likely offset by government subsidies but we do see some additional share opportunities (although we disagree Intel outsources the CPU). For ASE, we believe TSMC chips made in the US are unlikely to be packaged in Taiwan—the initial impact may be small but over time this would be a negative. For semicaps, government incentives to add more US capacity are positive—at least for a period of time—as to some degree this fuels some duplicative spending. If the US government enacts further and broader export restrictions on US semi-equipment companies shipping into China, this could also serve to offset some of the lost revenue.

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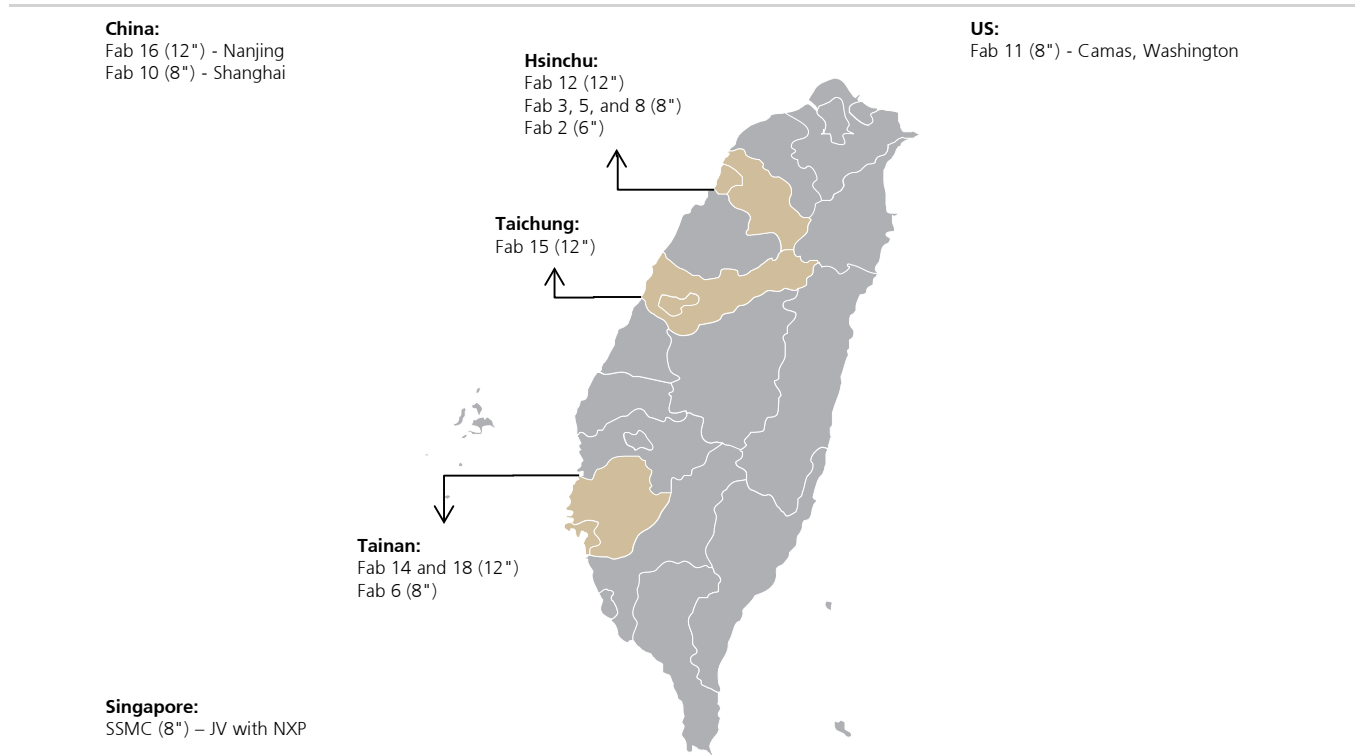


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Why would TSMC build a fab in the US?

TSMC has historically concentrated on building its fabs in Taiwan, with three focus areas: Hsinchu, Tainan, and Taichung. The company has built elsewhere in the past, include an 8" fab in Camas, Washington (called WaferTech) that was started as a JV, an 8" fab in Shanghai, China, and more recently a 12" fab (16nm) in Nanjing, China.

Figure 1: Global locations of TSMC's fabs



Source: Company data

TSMC has said that historically its fabs outside of Taiwan tend to be less profitable relative to its fabs in Taiwan, but why? We think there are several reasons:

- In Taiwan, TSMC builds fabs in clusters, or what the company calls "GigaFabs". Doing so brings economies of scale: Fab 12A, B, C, D, and E can share facilities such as delivery systems for electricity, filtered water, gas and chemicals. The fabs can use one software licence, one set of support staff, etc. Outside Taiwan, each fab requires its own set of facilities.
- In Taiwan, TSMC has an established workforce, which includes fab operators, but also engineers that support development in case there are any issues.
- In Taiwan, the ecosystem is mature. Large suppliers are just minutes away, which makes service/support easy. In Nanjing, TSMC has the only fab there—as far as we know—and in Camas, Washington, TSMC is also the only semiconductor fab (although Intel in Hillsboro is less than an hour away).

What has changed? Given that historically TSMC has kept most of its facilities in Taiwan, why is it veering from that strategy? We believe there are three reasons:

Geopolitical pressure on civilian and military applications

The US government recently issued restrictions on TSMC's ability to [ship to Huawei](#). This is likely to severely limit Huawei's ability to procure application-specific integrated circuits (ASICs) for its 5G equipment, and to a lesser extent chips for its smartphones. The US has realised that Huawei is very dependent on TSMC for leading-edge foundry production, but it is likely also coming to the realisation that US fabless companies are just as dependent on TSMC as their Chinese competitors. In the case of conflicts or geopolitical tensions between China and Taiwan, this could cause significant issues for the US tech industry. Additionally, the US government has historically made military-related chips at the IBM fab in Fishkill, New York. The fab was sold to GlobalFoundries (GF) in 2015, and GF subsequently sold the fab to On Semiconductor (On Semi) in 2019. Given On Semi's product portfolio, we find it unlikely that it will continue to develop advanced technologies there. The US military needs manufacturing in the US and that need is more pressing since the fab's sale to On Semi.

The need to recruit US talent

Thirty years ago, when Intel passed IBM in semiconductor process technology, it also hired away many of IBM's key engineers. In 2019, TSMC finally exceeded Intel [in process technology](#). Even if Intel retakes its crown in the next few years, as it has stated it will do, it does not have the two-year lead it once had. As such, we would expect TSMC to hire more aggressively as it needs to do more trailblazing, and having a US base for advanced technologies is helpful when hiring.

Is there talent available? Based on published data, Intel has laid off over 12,000 employees since 2016. We cannot estimate what percentage was R&D staff, but we do believe hiring in the US should be achievable for TSMC.

Figure 2: Intel's recent major lay-offs

Date	Summary	Remark
Apr-16	Intel cuts up to 12,000 people from its staff globally, or about 11% of its workforce. Intel says most of the employees affected by the layoffs will be notified in the next 60 days, while some of the cuts may happen through mid-2017.	
Mar-19	Intel lays off hundreds of IT workers at sites across the company, according to multiple sources inside the company.	Most substantial cutbacks since 2016; mainly tech administrators
Feb-20	Intel lays off 128 workers at four locations at its Santa Clara headquarters. The cuts follow the chipmaker's confirmation last month that it would cut roles as it shifts resources. The lay-offs were due to take place by 31 March, according to the filings with the EDD.	<1% of workforce

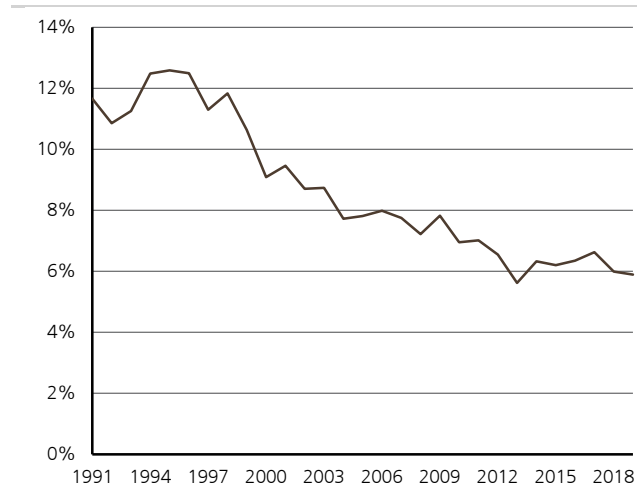
Source: Company data

Taiwan's resource limitations

Our conversations with Taiwanese tech manufacturers suggest they are increasingly concerned about utilities in Taiwan. We estimate that Taiwan imports 98% of the energy that is consumed domestically, and energy from renewable sources accounted for only 6% of 2019's electricity production. Additionally, as shown in Figure 3 and Figure 4, Taiwan's electricity surplus has been shrinking consistently—demand from the tech industry has doubled as a percentage of total consumption over the past 20 years. While we do not know the exact size of TSMC's portion of Taiwan's electronics manufacturing, we note the company's growth has been significantly higher than overall electricity consumption growth, plus advanced chip manufacturing uses extreme ultraviolet (EUV) equipment,

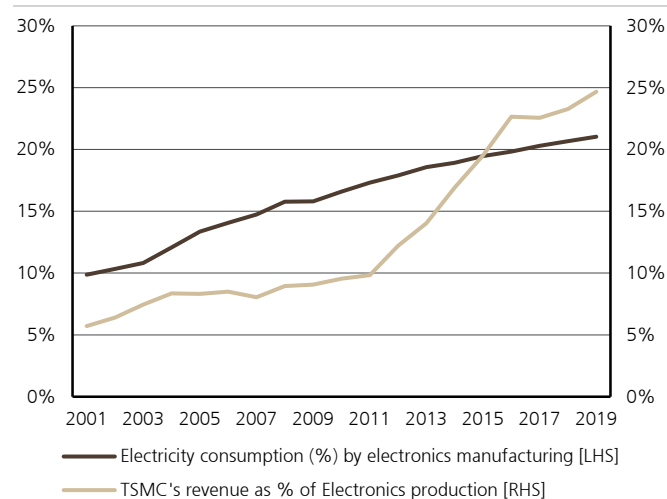
which consumes more electrical power than deep ultraviolet (DUV). Our view is that TSMC likely holds a meaningful portion of the increase by electronics manufacturers. Last, we note that the Taiwanese government has plans to phase out nuclear power by 2025.

Figure 3: Electricity surplus (generation minus consumption) as % of net electricity consumption in Taiwan



Source: Ministry of Economic Affairs (Taiwan)

Figure 4: Consumption by electronics manufacturers in Taiwan as % of total electricity consumption vs TSMC's revenue as % of Taiwan electronics production value



Source: Company data, Ministry of Economic Affairs (Taiwan)

What does this mean for TSMC?

Cost structure:

As TSMC prepares to build a leading-edge fab in the US, there could be changes to labour costs, various costs related to economies of scale, utilities, land, tax and CAPEX. Our assumption is the US government will work with TSMC to offset differences in land, utilities, taxes and, to a lesser extent, capital spending, and thus our focus here is on labour, dis-economies of scale and CAPEX. We also summarise the differences in utilities and taxes.

Figure 5: TSMC's COGS breakdown

	2018	2019
COGS (NT\$ m)	533,488	577,283
D&A	266,878	259,601
- Depreciation	264,805	256,531
- Amortisation	2,073	3,070
Labour	63,598	64,702
Materials	96,028	115,457
Utilities and others	106,984	137,524
As % of COGS		
D&A	50%	45%
Labour	12%	11%
Materials*	18%	20%
Utilities and others	20%	24%

Source: Company data, UBS estimates

Labour:

Figure 6 compares the minimum wages in Taiwan versus Arizona, USA. We note that the US minimum wage is 2.4x more than Taiwan's. TSMC's engineers and fab operators are some of the best paid in Taiwan, and our own informal poll suggests the salary gap is more in the 30-40% range. Since labour was 11-12% of TSMC's COGS in 2018/19, the labour rate doubling could impact GM by around 3-4%.

Figure 6: Minimum-wage comparisons

	Taiwan	US (Arizona)
Minimum wage		
Monthly	NT\$23,800	
Hourly	NT\$158 (approx. US\$5)	US\$12

Source: Executive Yuan (Taiwan), Industrial Commission of Arizona

CAPEX:

Even though TSMC has said that it will invest US\$12bn in the Arizona facility between 2021-29, we believe actual upside to TSMC's CAPEX is likely fairly small:

- US\$12bn is a total spend, not just CAPEX.
- TSMC has stated it plans to start with 5nm technology and 20,000 wafers/month capacity. We estimate a 20k/month fab built with new equipment likely costs around US\$4bn and TSMC could very well start with used equipment as, by 2024, its 5nm fab in Taiwan will be four years old.
- TSMC typically builds to demand. Unless the US fab materially changes TSMC's demand outlook, any upside to Arizona CAPEX is likely balanced by downside to Taiwan and other markets.

- Building in Arizona does require additional land and facilities, but assuming the land is at least partially granted by the government, the cost of building and facilities should be less than US\$1bn.

Net-net, we see no material changes to TSMC's cost structure on the CAPEX side.

Economies of scale:

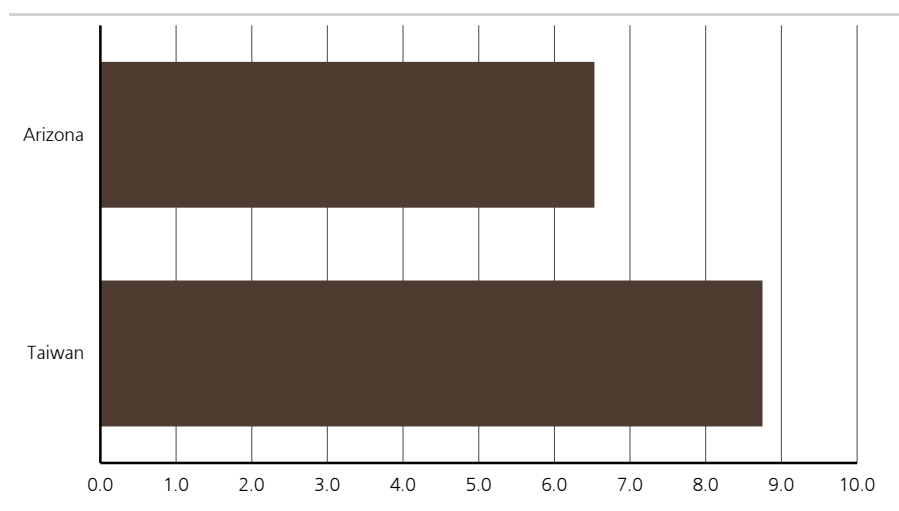
What cost advantages TSMC gets from clustering its fabs in Taiwan is hard to estimate. Part of it might be shared utilities, software licences, etc, but our guess is a good portion is the flexibility of moving customer products from fab to fab, the mobility of employees between fabs, and the accelerated learning as phase 2, phase 3, etc—factors that are subjective—could vary with each location and therefore remain hard to quantify.

Added together, our best guess is GM impact is in the 2-3% range.

Utilities:

Figure 7 compares the electricity costs for Taiwan versus the US; we note that Arizona is in fact over 25% cheaper than Taiwan.

Figure 7: Comparison of basic electricity rates (US¢/kWh)



Source: Electricitylocal, Taiwan Power

We estimate utilities are 10% of TSMC's COGS and thus this could be an incremental positive of around 2-3% as TSMC moves to Arizona.

Taxes:

The federal corporate tax rate in the US is a flat 21%, though TSMC could qualify for two tax credits in Arizona: 1) qualified facility tax credit, and 2) R&D tax credit.

Qualified facility tax credit offers a refundable income tax credit equal to the lesser of:

- 10% of the qualifying capital investment, or
- US\$20,000 per net new job at the facility, or
- US\$30,000,000 per taxpayer per year.

This offers up to US\$70mn per calendar year in tax credits currently.

R&D tax credit: The 2011-through-2022 R&D tax credit is equal to 24% of the first US\$2.5m in qualifying expenses, plus 15% of the qualifying expenses in excess of US\$2.5m. For 2023 and thereafter, tax credit rates will be 20% of the first US\$2.5m in qualifying expenses plus 11% of the qualifying expenses in excess of US\$2.5m.

Altogether, our guess is the initial fab in Arizona may carry GM that is 3-5% lower than TSMC's Taiwan fabs. The margin is negatively impacted by labour costs and lack of economies of scale, but partially offset by slightly cheaper utilities rates. Net-net, for a 20,000/month fab, we estimate that TSMC needs subsidies and tax breaks of US\$40-70m for it to offset the added costs.

Additional revenue and market share

While building the fab comes with additional costs, we also believe TSMC would see some new revenue opportunities. TSMC's initial commitment for capacity is fairly small at 20,000/month, and at US\$4,000 a wafer in 2024, that would equate to revenue of US\$960m a year versus total 2020E TSMC revenue of US\$41.5bn.

We note that the US Trusted Foundry Program has amounted to roughly US\$60m a year in foundry revenues to GlobalFoundries, mostly for chips used for fighter planes, satellite systems and weapon systems. That could move to TSMC given the lack of upgrades in the GlobalFoundries (and now On Semi) fabs.

- What is the Trusted Foundry Program? It is also called the Trusted Suppliers Program. It is a Department of Defense (DoD) program designed to secure the manufacturing infrastructure for IT vendors providing hardware to the military. It was originally implemented as an arrangement with IBM before being broadened in 2007 to ensure the entire supply chain could be trusted.
- In 2004, IBM's microelectronics segment won a contract to become the sole provider of leading-edge foundry services for the DoD.
- In 2007, the programme was broadened to include companies that cover the entire supply chain, such as integrated circuit (IC) design houses, photomask vendors, specialty foundries and packaging houses. Unlike the IBM deal, however, the other trusted suppliers don't have a yearly contract with guaranteed business.
- IBM provided foundry capacity under the Trusted Foundry program until 2015, when it sold its chip unit to GlobalFoundries. The Trusted Foundry contract was transferred from IBM to GlobalFoundries.

More recently, the CHIPS for America Act (Creating Helpful Incentives to Produce Semiconductors) is new bipartisan legislation that, according to our recent expert calls, appears likely to achieve congressional approval. This will establish a range of incentives to establish US-based manufacturing and could ultimately amount to around US\$40bn of incentives provided by the US government. The bill will also help to support leading-edge research for advanced semiconductor manufacturing in the US. These incentives appear likely to stimulate a new investment wave in US-based chipmaking capacity.

We also believe some US customers may choose to use TSMC's US fab given easier logistics and higher US content—eg, if Apple could avoid paying the 15% tariff on phones made in China, the saving per phone could be in the US\$50-75 range. We estimate that the A13 processor at TSMC currently costs US\$22, and thus Apple could be willing to pay for a US-made chip if it could reduce tariffs. This would not necessarily be additional business for TSMC if it were only Apple transferring production from Taiwan to the US, but it may help the company win shares with customers such as AMD, Qualcomm and Nvidia.

Case studies: Foxconn, Fuyao Glass and Honda

We look at instances of other major manufacturing companies that made the move from 'overseas' to the US.

Foxconn Technology Group

Foxconn Technology Group (Foxconn) is a Taiwanese multinational electronics contract manufacturer. It announced in July 2017 that it would build a US\$10bn TV LCD manufacturing plant in Wisconsin and would initially employ 3,000 workers (set to increase to 13,000 by as early as 2022).

- The Scott Walker administration in Wisconsin approved an agreement that Foxconn was set to receive subsidies of US\$3-4.8bn (paid in increments if Foxconn met certain targets).
- The firm was exempted from Wisconsin's environmental rules regarding wetlands and streams. In 2018, the Walker administration shifted up to US\$90m in local road funding to road works related to the Foxconn factory.
- At the end of 2018, Foxconn did not qualify for US\$10m in subsidies as it created only 156 of the 260 jobs required under the agreement.
- In January 2019, Foxconn said it was reconsidering its initial plans to manufacture LCD screens at the Wisconsin plant, due to high US labour costs, and that it would hire mostly engineering, rather than manufacturing, staff.

Fuyao Glass Industry Group

Fuyao Glass Industry Group (Fuyao) is a manufacturing company in China engaged in the production of float, automobile and construction glass, with customers including large international car manufacturers. In 2014, it acquired the former General Motors facility in Moraine, Ohio and operations began in late 2015.

- The Ohio Tax Credit Authority voted unanimously to grant Fuyao a 15-year tax credit worth up to nearly US\$10m for its first North American manufacturing plant.
- The 75% state tax credit is worth up to US\$9.69m if Fuyao Glass America Inc. lives up to its promises: hiring 800 employees, generating an annual payroll of US\$32.5m by the end-2019 and staying at the Moraine facility for at least 18 years.
- The state tax credits are in addition to a US\$700,000 grant from Montgomery County for infrastructure improvements and a US\$1m, five-year forgivable loan from the city of Moraine.

Honda Motor Company

Honda Marysville Auto Plant is a Honda manufacturing facility located near the intersection of US 33 and State Route 739. It is one of the most integrated and flexible auto plants in North America. The assembly opened in 1982.

- Honda received US\$27m in direct economic development incentives from the state of Ohio over 1977-88. Another US\$64m was spent improving and widening US 33.

- Honda's economic impact study states that for every US\$1 Ohio spent on incentives, the state has received nearly US\$40 in revenue benefits from Honda.

Alternatives to TSMC: Intel & Samsung Foundry

We note that besides TSMC, Samsung currently has a fab in Austin, Texas, Intel has offered foundry services in the past, and GlobalFoundries has owned fabs in New York and Texas. Given that GF has announced that it will no longer develop advanced logic processes, our view is the most likely alternatives would be Intel and Samsung.

Intel: The location of the new TSMC fab is close to a large existing Intel manufacturing site and we have previously theorised that, given a host of factors, Intel could move to outsource more production over time. These factors include some migration in some architecture elements that would disaggregate functionality into different pieces of silicon rather than a single monolithic strategy. This is similar to what AMD has done with its "chiplet" architecture. In theory, this could enable Intel to potentially partner with TSMC for a US fab and serve as an 'anchor' customer. Alternatively, the two chipmakers could partner and take on additional customers, though that seems less likely. Intel has historically had much higher COGS per wafer than TSMC, partially due to its architecture and partially due to its design flow and tight manufacturing tolerances. The chiplet move would to some degree change this dynamic, though we still expect any insourcing foundry efforts by Intel to remain limited by its design windows and higher wafer costs. For this reason, we see it as more of an outsourcer versus insourcer.

Our US semiconductor research team currently does not expect Intel to offer additional foundry services.

Samsung: Samsung already has a manufacturing site in Austin used by Samsung Foundry (Logic). We believe it recently secured some adjacent greenfield in case they would have to build an additional fab. We believe that if it was to do so, it would also be for Samsung Foundry (Logic). For memory, we do believe that cost considerations could be too penalising (Austin, incidentally, was originally a memory fab).

We do not believe that Samsung has taken any decision yet. But we do believe it would give due consideration to a project considering potential incentives, proximity to clients, access to the US talent pool, risk management (all Logic capacity currently is in South Korea), and potential political capital. We would however expect the Korea government to continue to impose an "N-1" rule, as enacted by law, whereby a Korean chipmaker cannot mass produce at the most leading-edge process technology at the same time or ahead of doing so in Korea.

Supply-chain implications

Semicap equipment: Government incentives to add more US capacity are seen as positive for semi equipment—at least for a period of time—as to some degree this fuels some duplicative spending, especially considering China’s substantial manufacturing efforts. Specifically for the TSMC fab, though, any money spent in the US would likely come at the expense of CAPEX spent elsewhere—either by TSMC itself or by a potential partner such as Intel—so it is hard to argue a significant positive for semiconductor production equipment (SPE) companies. If the US government were to enact further and broader export restrictions on US semi equipment companies shipping into China, this US effort could also serve to offset some of the lost revenue.

Outsourced semiconductor assembly and test (OSAT): Geography matters for assembly and testing. For wafers manufactured in the US, we think the odds are low that they would then be tested and packaged in Asia only to be shipped back to a US customer. TSMC’s announced 20,000/month fab is small in the overall scheme, so the impact to Asian OSAT is not significant. We also note that ASE has a test facility in Silicon Valley and the company could choose to expand. That said, we feel less confident OSAT would get the same subsidies/tax breaks as foundries if it were to expand into the US. Net-net, we view it as a slight negative to Asian OSAT companies.

Valuation Method and Risk Statement

ASE: Our price target is based on a P/BV valuation, relative to previous historical valuation ranges for ASE and SPIL.

Intel: Due to ramping depreciation, we focus on EV/FCF but use PE as a sanity-check.

Samsung: We value Samsung Electronics based on a target PE multiple.

TSMC: We derive our price target based on a PE multiple.

Tech investing involves risk. It is difficult for the investment community, ourselves included, to project tech companies financial results' as their operating models are highly volatile and unpredictable, and they compete in a highly dynamic market place. In addition to their low predictability, valuing tech stocks can be challenging because neither traditional nor non-traditional valuation measures have provided much insight into how tech stocks trade.

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Short-Term Rating	Definition	Coverage ³	IB Services ⁴
Buy	Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%
Sell	Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%

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Company Disclosures

Company Name	Reuters	12-month rating	Short-term rating	Price	Price date
ASE Industrial ¹⁶	3711.TW	Neutral	N/A	NT\$67.60	30 Jun 2020
Intel Corp. ^{4, 6a, 6b, 6c, 7, 16}	INTC.O	Buy	N/A	US\$59.83	30 Jun 2020
Samsung Electronics	005930.KS	Buy	N/A	Won52,800	30 Jun 2020
Taiwan Semiconductor Manufacturing ¹⁶	2330.TW	Buy	N/A	NT\$313.00	30 Jun 2020

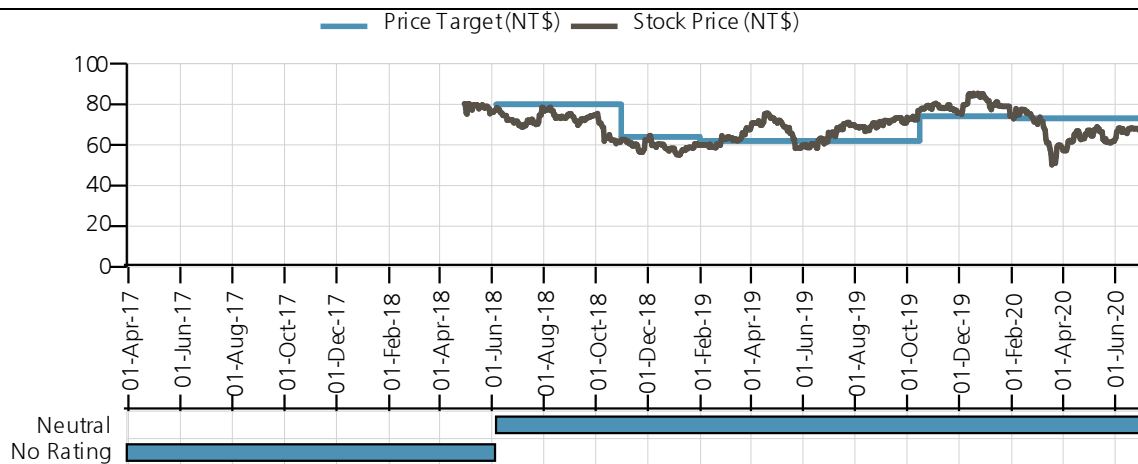
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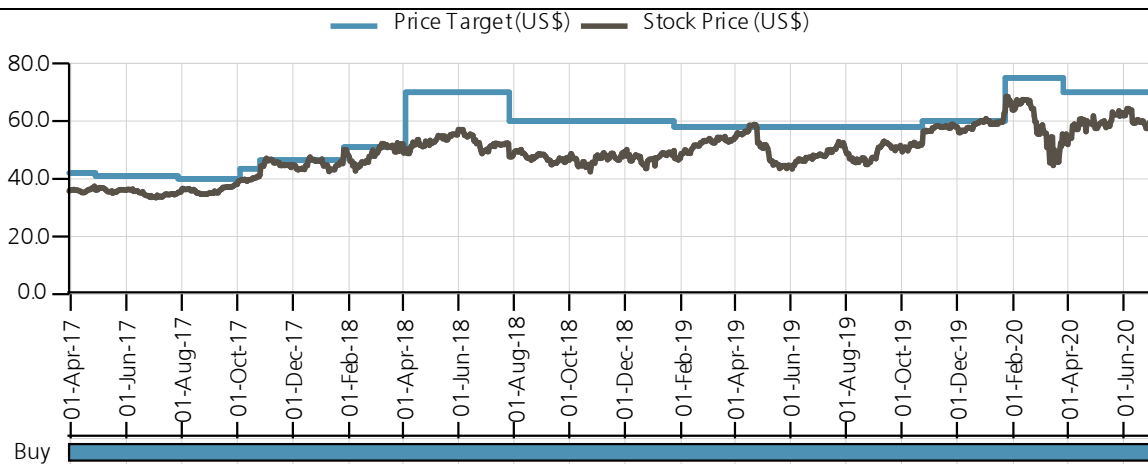
ASE Industrial (NT\$)



Date	Stock Price (NT\$)	Price Target (NT\$)	Rating
2017-03-30	NaN	-	No Rating
2018-06-06	77.6	80.0	Neutral
2018-10-31	62.4	64.0	Neutral
2019-01-31	60.0	62.0	Neutral
2019-10-16	77.0	74.0	Neutral
2020-02-07	74.8	73.0	Neutral

Source: UBS; as of 30 Jun 2020

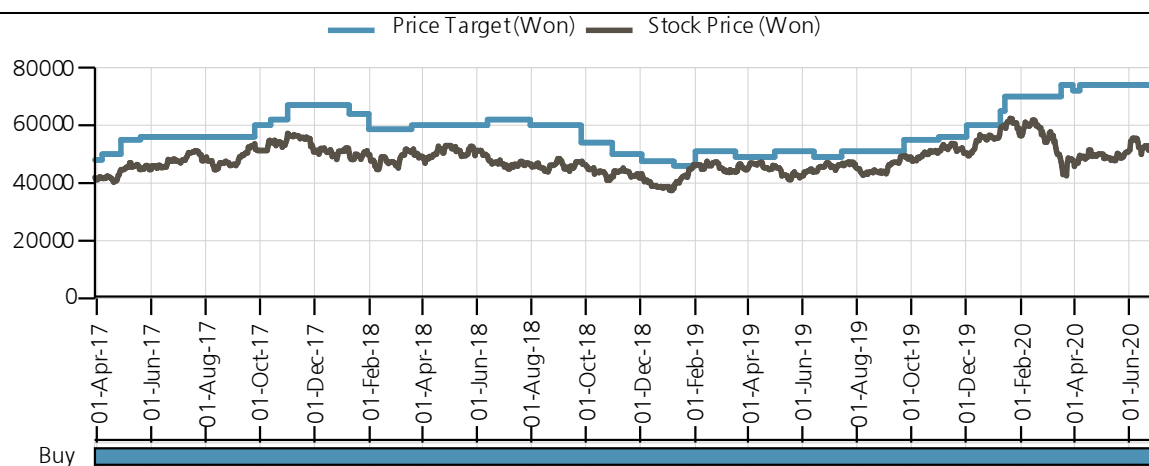
Intel Corp. (US\$)



Date	Stock Price (US\$)	Price Target (US\$)	Rating
2017-03-30	35.75	42.0	Buy
2017-04-28	36.15	41.0	Buy
2017-07-28	35.31	40.0	Buy
2017-10-04	39.34	43.5	Buy
2017-10-26	41.35	46.5	Buy
2018-01-26	50.08	51.0	Buy
2018-04-04	49.99	70.0	Buy
2018-07-27	47.68	60.0	Buy
2019-01-24	49.76	58.0	Buy
2019-10-24	52.23	60.0	Buy
2020-01-23	63.32	75.0	Buy
2020-03-27	52.37	70.0	Buy

Source: UBS; as of 30 Jun 2020

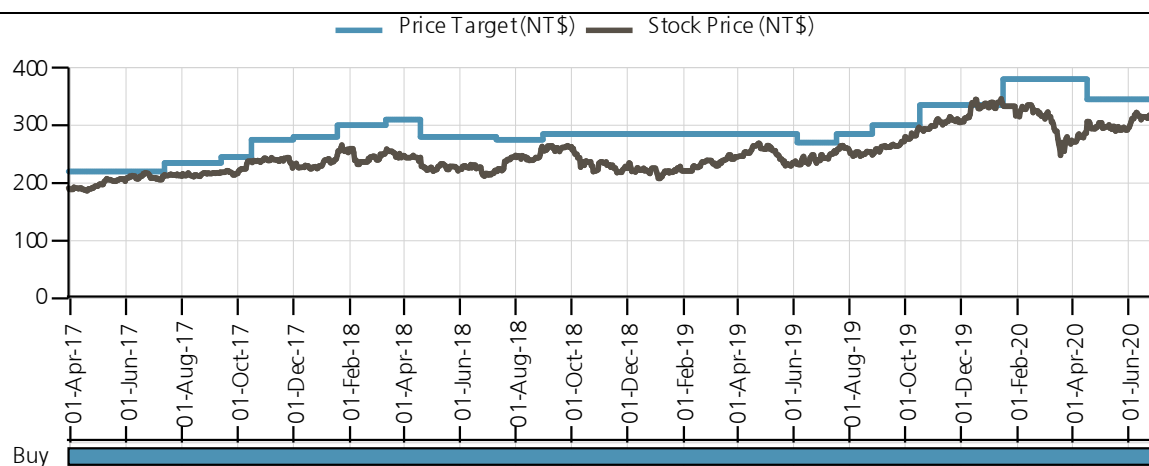
Samsung Electronics (Won)



Date	Stock Price (Won)	Price Target (Won)	Rating
2017-03-30	41980.0	48000.0	Buy
2017-04-07	41600.0	50000.0	Buy
2017-04-28	44620.0	55000.0	Buy
2017-05-20	44720.0	56000.0	Buy
2017-09-25	53620.0	60000.0	Buy
2017-10-13	54000.0	62000.0	Buy
2017-11-01	57220.0	67000.0	Buy
2018-01-09	50400.0	64000.0	Buy
2018-01-31	49900.0	58600.0	Buy
2018-03-20	51200.0	60000.0	Buy
2018-06-13	49400.0	62000.0	Buy
2018-07-31	46250.0	60000.0	Buy
2018-09-26	47400.0	54000.0	Buy
2018-10-31	42400.0	50000.0	Buy
2018-12-03	43250.0	47500.0	Buy
2019-01-08	38100.0	46000.0	Buy
2019-02-01	46350.0	51000.0	Buy
2019-03-18	43700.0	49000.0	Buy
2019-05-01	45850.0	51000.0	Buy
2019-06-14	44000.0	49000.0	Buy
2019-07-15	46450.0	51000.0	Buy
2019-09-23	49300.0	55000.0	Buy
2019-11-01	51200.0	56000.0	Buy
2019-12-02	50400.0	60000.0	Buy
2020-01-09	58600.0	65000.0	Buy
2020-01-14	60000.0	70000.0	Buy
2020-03-17	47300.0	74000.0	Buy
2020-03-30	47850.0	72000.0	Buy
2020-04-07	49600.0	74000.0	Buy

Source: UBS; as of 30 Jun 2020

Taiwan Semiconductor Manufacturing (NT\$)



Date	Stock Price (NT\$)	Price Target (NT\$)	Rating
2017-03-30	191.5	220.0	Buy
2017-07-13	214.5	235.0	Buy
2017-09-13	218.0	245.0	Buy
2017-10-16	238.0	275.0	Buy
2017-12-01	231.0	280.0	Buy
2018-01-18	248.5	300.0	Buy
2018-03-12	254.0	310.0	Buy
2018-04-19	244.5	280.0	Buy
2018-07-11	220.0	275.0	Buy
2018-08-31	256.0	285.0	Buy
2019-06-05	235.0	270.0	Buy
2019-07-18	254.0	285.0	Buy
2019-08-26	248.5	300.0	Buy
2019-10-17	293.5	335.0	Buy
2020-01-16	334.5	380.0	Buy
2020-04-17	306.5	345.0	Buy

Source: UBS; as of 30 Jun 2020

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