

Investment strategy of TSMC based on industry research, financial analysis, and PE valuation

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Abstract. With the rise of 5G technology, new energy vehicles, IOT and other industries in the last two years, the demand for semiconductor chips has reached a peak, but the slow recovery of wafer fab capacity due to the global economic downturn caused by the impact of the COVID-19 has a very important impact on the current chip supply. This paper conducts a study of the business status of TSMC, the leading semiconductor product company, in three dimensions: industry outlook, financial condition and P/E valuation, and gives data-backed recommendations for future investments. The research in this paper shows that the industry has a broad outlook, good operating status, leading net profit margin in the industry, reasonable investment in technology R&D, and is now in a reasonable valuation range, worthy of continued attention and long-term value investment. This paper provides some help and insight for stockholders and institutions to study the analysis and valuation of the semiconductor product segment track.

Keywords: TSMC, Financial Statement Analysis, P/E Valuation.

1. Introduction

Under the influence of the COVID-19 and the background of macroeconomic recession, with the price increase of upstream raw materials, the gradual increase of chip production capacity, and the growing downstream demand, this paper analyzes TSMC's corporate operations based on publicly disclosed annual reports and other reports, studies the main impact of the New Crown Pneumonia Epidemic on the semiconductor manufacturing industry, and performs industry average calculations based on the current state of the industry, and selects suitable competitor companies perform P/E valuation analysis on TSMC's stock price, draw conclusions, and give investors certain recommendations on future market sentiment and industry development forecasts.

TSMC is engaged in the research, development, manufacturing, and distribution of integrated circuit (IC) related products. The company's foundry division engages in the manufacturing, sales, packaging, testing and computer-aided design of integrated circuits and other semiconductor devices, as well as mask production services. Its products and services are used in computers, communications, and consumer electronics, among others.

Yinxiang Xu (2008) uses a top-down research approach to analyze the real estate leader Vanke Co. which has very important insights into the analytical approach and article structure of this paper [1]. Lili Gao (2016) argues that the relative valuation method cannot simply apply the average or median of industry indices for valuation but needs to select the data of global listed companies in specific segments of the track for valuation modeling with high goodness-of-fit [2]. In this paper, the global leading companies in the segmentation track of semiconductor products are adopted for the calculation of industry average P/E, which has a high feasibility from the theoretical point of view.

2. Method

This paper uses industry based TSMC investment value analysis, financial statement analysis and PE valuation method to analyze the semiconductor product industry to which TSMC belongs, TSMC's operating conditions and stock valuation, with data obtained from public data such as Morningstar.com, Wind and company annual reports.

The industry based TSMC investment value analysis is mainly conducted from three aspects: Market analysis, Upstream Raw Materials and Competition; Financial statement analysis is

conducted from four dimensions: Income Statement analysis, Balance Sheet analysis, Cash Flow statement analysis and Return on Investment analysis; PE valuation method mainly selects suitable competitor companies and calculates the respective P/E and industry average to TSMC's stock price for valuation comparison, and the data are selected from the annual report data of each company in 2021 and the closing price of stock trading on 2021.12.31. The relevant formula for PE valuation is as follows.

Figure 1. Neural network structure

$$P/E \text{ Ratio} = \frac{\text{Share Price}}{\text{Earnings per Share}} \quad (1)$$

$$P/E \text{ Industry Average} = \frac{(\text{Competitor 1's P/E} + \text{Competitor 2's P/E} + \text{Competitor 3's P/E} + \dots + \text{Competitor n's P/E})}{n} \quad (2)$$

$$\text{Target Company's Valuation} = \text{Target Company's EPS} \times P/E \text{ Industry Average} \quad (3)$$

3. Industry-based TSMC Investment Value Analysis

3.1 Market Analysis

Global market size continues to grow. According to IC Insights, global semiconductor industry capital expenditures will reach a record high of \$190.4 billion in 2022, up 24% year-over-year. Semiconductor companies have significantly increased capital expenditures to expand capacity. TSMC, Samsung, and Intel have increased capital spending in 2022 to expand their dominance in the foundry sector, with the three companies together accounting for more than half of total industry spending [3].

Semiconductor companies have significantly increased capital spending to expand capacity. According to IC Insights, the global semiconductor industry will spend \$153.9 billion in 2021, up 36% year-over-year, and \$190.4 billion in 2022, up 24% year-over-year, a record high. Annual capital expenditures for the semiconductor industry have never exceeded \$115 billion until 2021.

Intel has increased capital spending in 2022 to expand its dominance in the foundry sector. TSMC expects capex to reach \$40-44 billion in 2022, up 33.2%-46.5% year-on-year, mainly for 7nm and 5nm advanced process expansion. Samsung's 2022 capex in the chip sector will be approximately \$37.9 billion, up 12.46% year-over-year. Intel's capital expenditure in 2022 is expected to reach \$25 billion [4].

TSMC, Samsung, Intel announced the expansion of advanced process capacity. TSMC intends to build new plants in Taiwan, Arizona and Kumamoto, Japan, with total capital expenditures of more than \$48 billion. Samsung will build a new plant in Texas, U.S., with an investment of \$17 billion and a process node of 7-5nm, with construction to begin in the first half of this year and production in the second half of 2024. Intel will build two advanced process plants in Ohio, the initial investment amount of more than \$ 20 billion; the next 10 years in Ohio to build the world's largest semiconductor production base, the total investment amount of \$ 100 billion.

In 2022, wafer capacity will continue to increase. According to IC Insights data, from 2016-2021, the global IC industry wafer installed base grew year by year, with a CAGR of 6.3%. IC Insights forecasts that installed wafer capacity will increase from 242.5 million wafers in 2021 to 263.6 million wafers in 2022, an 8.7% year-over-year increase.

Capacity utilization remains high. Global wafer capacity utilization will decline from 93.8% in 2021 to 93.0% in 2022, a decrease of 0.8 percentage points year-over-year [5].

3.2 Upstream raw materials

3.2.1 Semiconductor materials market scale is at record high, silicon wafer is the highest cost share of materials

The global semiconductor materials market is at a record high. Benefit from the high boom in the wafer market in 2021, semiconductor materials market volume and price, sales record high. According to SEMI statistics, the global semiconductor materials market size of \$64.3 billion in 2021, an increase of 15.9% year-on-year, a new record. Among them, the wafer manufacturing materials revenue of \$ 40.4 billion, an increase of 15.5%; wafer packaging materials revenue of \$ 23.9 billion, an increase of 16.5% [6].

Sourcing: SEMI



Figure 1. Global Semiconductor Materials Market Size and Growth Rate 2015-2021

Wafer manufacturing materials mainly include silicon wafers, photomasks, photoresists and auxiliary materials, CMP polishing materials, process chemicals, targets, electronic special gases, etc. According to SEMI statistics, in 2020, the global wafer fabrication materials market, silicon wafer market share of 37%, is the highest proportion of the wafer fabrication materials market materials.

3.2.2 Silicon wafer capacity shortage, prices continue to rise

Global silicon wafer shipments continue to grow, the growth rate is less than the wafer demand. According to SEMI data, global wafer shipments in 2021 were 14.165 billion square feet, and global wafer shipments in 2022 are expected to reach 14.958 billion square feet, an increase of 6.5%. In 2021, the wafer market will be in short supply; in 2022, the increase in wafer production capacity will not meet the demand of wafer fabs, and the wafer supply will continue to exceed demand. SUMCO, a global leader in silicon wafers, said in the first quarter of 2022, including new capacity, 12-inch wafer capacity by 2026 has been covered by long-term contracts, cannot supply customers outside of long-term contracts, 12-inch wafers in the first quarter of 2022 using the new contract prices, and in the second quarter prices will continue to rise [7].

Wafer fab inventory is increasing. In recent years, affected by epidemics, natural disasters and geopolitics, foundries are paying more and more attention to the security of the industry chain. Silicon wafers are the most used and costly material upstream of IC manufacturing, and foundries have significantly increased their silicon wafer inventories since the problem of chip supply shortage.

3.3 Competition

In 2021, the top 10 foundries in the world will achieve a total revenue of US\$102.9 billion. The global foundry market is highly concentrated, and the profitability level has increased. The top 10 foundries together account for 93.4% of the global foundry market [8].

Table 1. Top Five Global Foundry Revenue in 2021

Top Five Global Foundry Revenue in 2021				
Ranking	Company	Headquarter	Operating income (USD Mil)	Market share (%)
1	TSMC	Taiwan, China	56,832	51.6
2	SamSung	Korea	18,796	17.1
3	UMC	Taiwan, China	7,626	6.9
4	Global Foundries	America	6,585	6
5	SMIC	Mainland, China	5,443	4.9

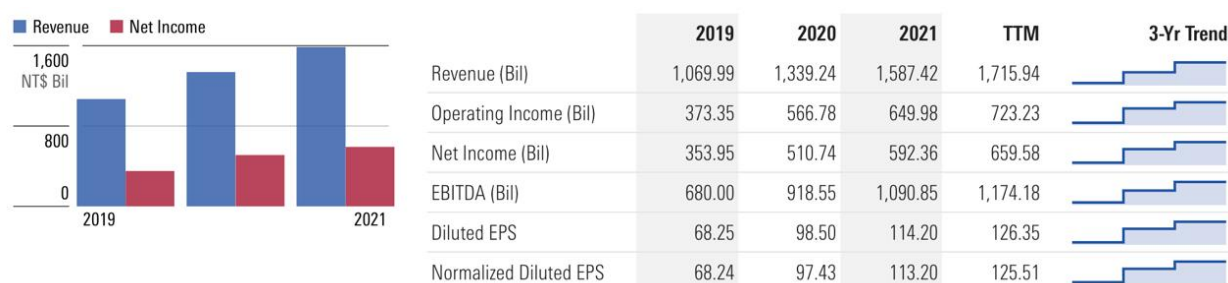
Sourcing: Company Website

TSMC dominates the market. In 2021, TSMC's revenue will be US\$56.8 billion, capturing 51.6% of the global market share. In terms of revenue growth, TSMC's revenue grew year-over-year thanks to line expansion and market demand for specialty processes remaining high; in terms of net profit, TSMC ranked first with net profit of US\$21.39 billion in 2021; in terms of gross margin, TSMC had the highest gross margin among the top 10 foundries in 2021. Thanks to the development of advanced process areas, TSMC's gross margin reached 51.6% [9].

4. Analysis of financial indicators

4.1 Income Statement Analysis

According to the public data from Morningstar.com, TSMC's gross operating income has increased steadily in the past three years, and the TTM gross operating income reached NT\$ 1,715.94 billion. Among them, the gross profit in 2021 is NT\$ 819.54 billion, up 15.24% year-on-year; operating income is NT\$ 649.98 billion, YOY is 14.68%; net income is NT\$ 592.36 billion, YOY is 15.98%. Sourcing: Morningstar



Fiscal year ends in Dec 31 | TWD in Bil except per share data

Figure 2. the Summary of TSMC's Income Statement

Looking at the total revenue for the past five years, the total revenue of nearly NT\$1 trillion in 2017 will reach NT\$1.5 trillion in 2021, achieving a steady year-on-year growth trend. New Taiwan dollars.

The operating profit for the last five years shows that the operating profit for the first three years has been decreasing year by year, but the decrease is smaller, basically maintaining the operating profit at NT\$380 billion. Starting from 2020, operating profit increased significantly in four quarters, including a 50% year-over-year increase in 2020 and a slight decrease in 2021, but overall operating profit still increased significantly to NT\$650.31 billion.

According to wind data, net profit was basically stable at NT\$350 billion in 2017-2019, followed by a significant increase in net profit in 20 years and the fourth quarter of 21 years, partly due to the impact of the epidemic leading to a shortage of chip production capacity, oversupply, and a greater degree of price increases. The 20% decline in net profit in 2021 compared to the same period last year was due to a gradual recovery in production capacity and higher raw material prices resulting in lower net profit. In the first quarter of this year, affected by the rebound of the epidemic and the global

economic downturn, production capacity has increased resulting in higher shipments, with a new round of price increase strategy makes the net profit in the first quarter and year-on-year growth significantly higher. Net profit is expected to exceed NT\$600 billion this year.

4.2 Balance Sheet Analysis

From the data disclosed by Morningstar.com, it can be concluded that TSMC's total assets have increased year by year in the past three years, reaching nearly NT\$4,000 billion in the first quarter of this year; liabilities are also increasing further, with total liabilities of NT\$1,537.62 billion in 2021, an increase of 70.15% compared to the same period last year; owner's equity of NT\$2,151.68 billion, an increase of 17.21% year on year; cash and cash equivalents Cash reached NT\$1,204.91 billion, an increase of 50.21% year-over-year. The debt-to-asset ratio was also gradually increasing, approaching 20%.

Sourcing: Morningstar



Fiscal year ends in Dec 31 | TWD in Bil except per share data

Figure 3. the Summary of TSMC's Balance Sheet

From Wind's statistical chart of TSMC's capital structure changes can be seen: as of the first quarter of this year, total assets have increased year by year in the past five years, and total liabilities have significantly decreased in 2018, resulting in a decrease in gearing ratio to 20.52% in 2018; owner's equity has slightly decreased in 2019, but with the increase in total assets and total liabilities, gearing ratio returned to about 30%; 2021 The high gearing ratio from 2021 to 2022Q1 is maintained at around 42%, indicating that the financial risk is relatively high in the past two years, which may bring about a break in the capital chain caused by insufficient cash flow and failure to pay off debts in time, thus leading to the bankruptcy of the enterprise. But from the cash flow is more stable and has a certain growth rate, so TSMC's financial risk deserves continued attention.

Sourcing: Wind

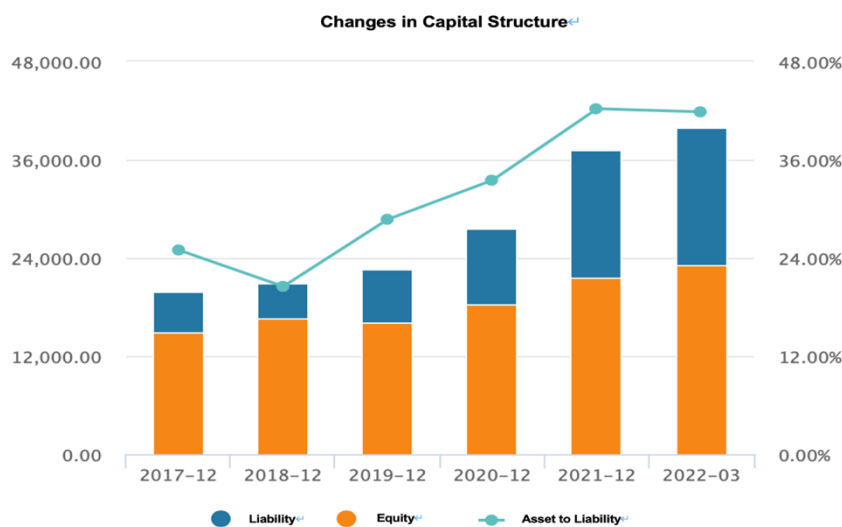
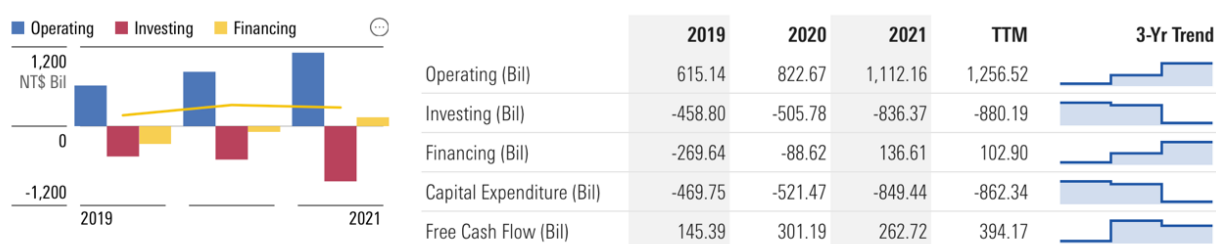


Figure 4. Changes in Capital Structure

4.3 Cash flow statement analysis

According to TSMC's annual and quarterly reports, the company's cash flow from operating activities increased year by year during 2019-2021, and the scale of investment also gradually expanded, among which the cash flow from investing activities in 2021 increased by 65.36% compared with the same period last year, and the TTM reached NT\$880.19 billion investment cash flow; cash flow from financing activities reached NT\$136.11 billion in 2021, the first time in the past three years. This indicates that TSMC is in a period of rapid development, when its products are rapidly capturing the market and sales are showing a rapid upward trend, which is reflected in the return of large amounts of monetary funds from operating activities. Capital expenditures have been increasing year by year, with a year-over-year increase of 62.89% to NT\$849.44 billion in 2021. There is some fluctuation in free cash flow, with FCF doubling from 2019 to 2020, declining slightly to NT\$262.72 billion in 2021, and then rising to nearly NT\$400 billion in FCF in the first quarter of this year. In the short term, the company does not have a cash flow shortage problem.



Fiscal year ends in Dec 31 | TWD in Bil except per share data

Figure 5. the Summary of TSMC's Cash Flow Statement

Sourcing: Morningstar

4.4 Return on Investment analysis

From the wind database ROE of return on net assets can be derived from 2017 to 2019 ROE is basically around 22%, while the return on net assets in 2020 reached 27.84%, 21 and 20 years is very close, indicating that investment in TSMC has a high return, and due to the increase in debt in the last two years led to an increase in ROE.

In terms of return on assets, TSMC's ROA stays unchanged at 17.79% for the two years 2017-2018, drops slightly to 16.26% in 2019, then rises again to 20.33% in 20 years, and drops back to the level of 2017 and 2018 in 2021, which shows that its ROA fluctuates and changes but is generally

stable at around 18%, indicating a good utilization of corporate assets. It indicates that the enterprise has achieved good results in terms of increasing revenue and saving capital usage [10].

A comprehensive comparison of ROE and ROA to analyze TSMC's return on investment, both indicators have a certain degree of volatility, but through the data of the past five years, ROE basically maintained at about 25% up and down, ROA basically maintained at about 18%, with high profitability worthy of long-term attention and investment.

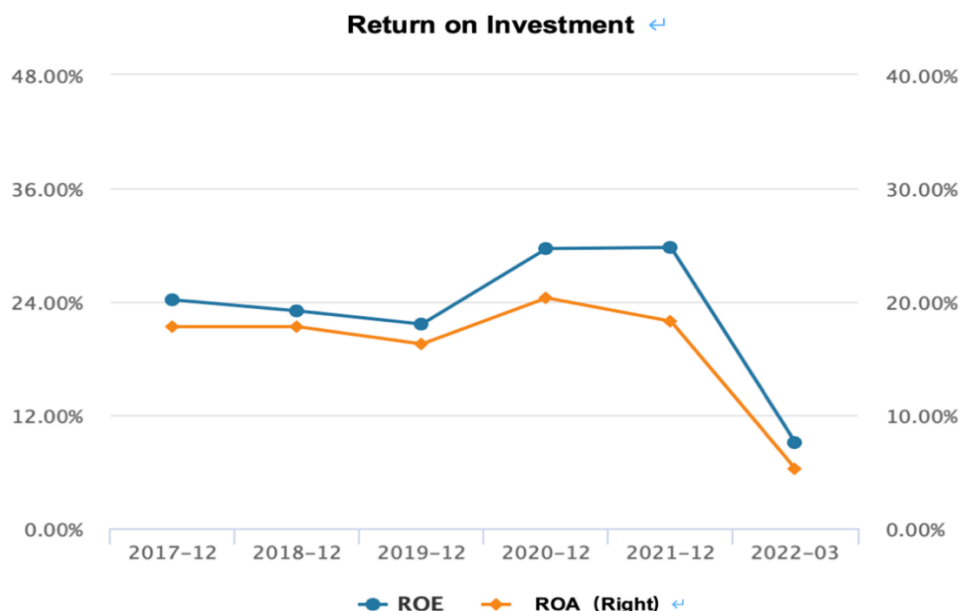


Figure 6. Return on Investment

Sourcing: Wind

5. P/E Valuation analysis

Earnings per share analysis from the last five years of public data shows that EPS for 2017-2019 remains in the range of \$13-14, with growth of \$19.7 starting in 2020, up more than 40% year-over-year, and EPS growth of \$22.84 in 2021 but with lower year-over-year growth. The first quarter of this year's results were very bright leading to a single quarter of EPS growth of nearly 80% year-over-year, followed by three quarters of earnings per share is also expected to grow [11].

The relative valuation PE and PB indicators calculated by wind, from 2017 to 2020 relative valuation are stable growth, except in 2018, in 2020 PE valuation reached close to 50x, PB close to 10x. 2021 relative valuation has fallen, PE fell to 35x, PB fell to 5x, in the process of high valuation retracement, continue to focus on TSMC's We will continue to pay attention to TSMC's relative valuation and wait until it is in the undervalued range before making a large buy operation.

Since the time series has a large impact on the accuracy of valuation modeling, the data disclosed in each company's 2021 annual report and the closing price on December 31, 2021, are selected as modeling data for comparison in this paper. To accurately quantify the valuation of the industry average, more appropriate competitor companies need to be selected for comparison. Statistics can be derived from the semiconductor products subcategory in the wind database, and considering that TSMC is listed in Taiwan, China, and the U.S., respectively, Chinese and U.S. companies with close composition of the company's main business and higher market capitalization and net profit are selected for comparison. In this paper, the top six U.S. stocks in semiconductor products have been selected as the top three A-shares as the competitors for valuation modeling. From the data we can see that the leading companies in semiconductor products are basically valued between 20-40x.

However, earnings per share vary widely, so it is impossible to judge the accuracy of the valuation results.

After obtaining the corresponding data in the wind database and the company's official website, the prevailing exchange rates were used for currency system alignment to better compare the competitor profiles. TSMC as the first US stock has a high net profit margin as well as operating income, but its own valuation at the end of 2021 is only about 30x, and EPS is only \$0.82, which will lead to the result of its PE valuation losing accuracy due to the low EPS, no matter how high the average valuation of the industry is.

After excluding TSMC's data, we calculated the industry average PE of 41.84x through the above formula, as shown in Table.2. which is higher than TSMC's own valuation multiple, indicating that there is still room for the company's expected value to rise. For example, NVDA's current price is \$294.11, while its intrinsic value is valued at \$354.36, which means it is slightly undervalued; while AMD's valuation is \$115.57, its current price is \$143.90, which is slightly overvalued. The final industry average P/E multiplied by TSMC's EPS is \$34.31, which is significantly lower than the current price, but considering its industry outlook and financial data, the valuation method does not reflect TSMC's overvaluation or undervaluation well and needs to be combined with other valuation methods for further judgment.

Table 2. TSM's PE Valuation

TSM's PE Valuation										
Stock Code	TSM.N	NVDA.O	AVGO.O	INTC.O	AMD.O	TXN.O	601012.SH	600438.SH	688981.SH	Industry Average
Stock Price (USD)	120.31	294.11	665.41	51.50	143.90	188.47	12.84	6.69	2.40	
P/E (2021 10-K)	30.53	90.63	44.36	10.00	44.28	24.19	43.23	51.49	26.51	41.84
EPS (USD)	0.82	3.91	15.70	4.89	2.61	8.38	0.25	0.27	0.22	
Operating income (USD Bil)	171.39	82.88	158.09	183.53	58.87	49.05	27.70	36.76	17.64	
Net Income Attributable (USD Bil)	70.75	16.18	49.13	81.13	7.86	22.01	3.97	7.73	42.20	
PE Valuation (USD)	25.03	354.36	696.45	48.90	115.57	202.71	10.88	13.95	5.83	

Sourcing: Wind, Morningstar, Company Website

6. Conclusion

This paper examines TSMC's industry background, financial data, and PE valuation analysis, combined with data disclosed on third-party platforms and references, to conclude that TSMC's wide moat comes from its cost advantages and intangible assets, which are achieved through its leadership in process technology or nodes. TSMC's long-term leadership in process technology advancement comes from its ability to prioritize the right node innovation areas while maintaining fiscal discipline correctly and consistently.

This virtuous cycle of intangibles from extensive R&D and cost advantages from better PPAs feeds each other and prevents smaller peers from catching up. In fact, TSMC has been leading node advances and maintaining over 50% market share since the early 21st century, and its gross and operating margins have been at least twice those of its closest peers for many years [12]. Therefore, the research in this paper suggests the company is worthy of long-term attention and a value investment, but is now in a reasonable valuation range, so a large buy or sell is not recommended, but a small position can be built in tranches.

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