

A Work Project, presented as part of the requirements for the Award of a Master Degree in Finance from the
NOVA – School of Business and Economics.

Texas Instrument

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A Project carried out on the Master in Finance Program, under the supervision of:

(Francisco Martins)

DATE
12/14/2022

Abstract

In this report, I analyze the company from Sector Economic overview. Using SWOT to analyse company and figure out the potential risk. And using scenario analysis to get company's target value with **\$ 212.38**

Keywords: Semiconductor, SWOT, Scenario analysis,

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

This report is part of the Equity research report (annexed), developed by Zhenming yang and Niklas Athoff and should be read as an integral part of it.

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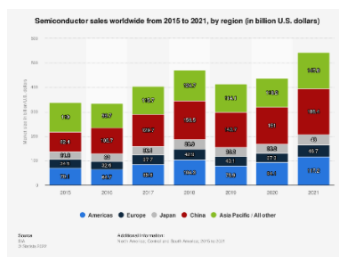
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Introduction

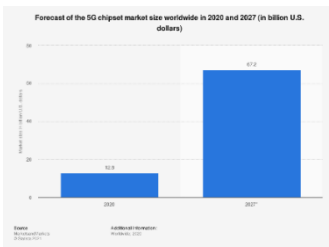
The purpose of the Joint report is to figure out the target price of TXN and give the investment recommendation on the stock. Base on our analysis. The target price for the company is \$ **212.38** with a buy recommendation. We did effort on the economic level and sector level and company level from financial side and management side. And finally, we using scenario analysis to get that target price. In my sections. I cover the Sector, Economic overview, SWOT and potential risk analysis, Valuation model and Scenario analysis. Recommendation.

My pair Niklas cover Segment analysis, Financial analysis and Sensitivity Analysis

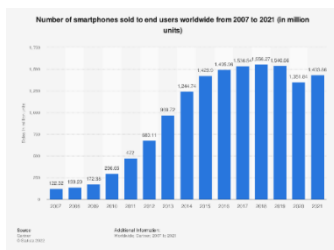
Sector overview



Before the pandemic and the trade war between China and the United States, the global semiconductor market experienced stable growth from 2015 to 2018. This expansion is being driven by rising demand for smartphone, electronic vehicle, industrial, and 5G technology, all of which require a large number of

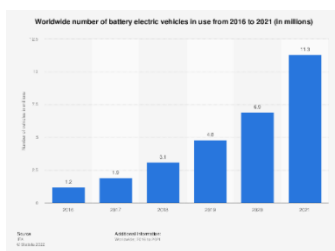


semiconductors, such as analog systems, embedded systems, and sensors, to manufacture. 5G satellite markets are expected to be worth \$67.2 billion in 2027, with the number of electric vehicles increasing from 1.2 million to 11.3 million between 2016 and 2021. Although it appears that the number of smartphones sold peaks in 2018 and then falls until 2020, this fall can be attributed to the impact of the pandemic in 2019 and the US-China trade war.

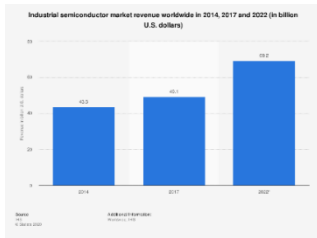


However, we can expect a recovery to begin in 2020, and based on 5G development, smartphone chipset demand will continue to rise. As for the industrial semiconductor market, it kept growing from 2014 to 2017, and the market size can be foreseen at 69.2 billion in 2022.

During the pandemic, the supply chain for semiconductors is almost cut off because of the lockdown in different countries, for example, China, the United States, and Taiwan, which are the essential countries on the supply chain. Syed Alam, Accenture's global semiconductor practice lead, explains that components for a chip could travel more than 25,000 miles before completion and can cross borders more than 70 times before a final product is delivered to the end customer.



The United States' share of the semiconductor manufacturing market has been declining over the last two decades and is expected to fall to 10% by 2023. Taiwan Semiconductor



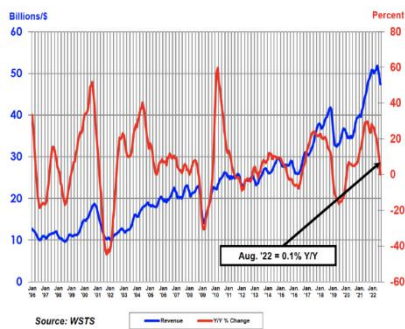
Manufacturing Co. (TEMCO), for example, became the world's largest semiconductor manufacturer by outsourcing manufacturing to U.S. semiconductor companies.

In order to bring back the manufacturing industry to the U.S. and create more jobs, President Joe Biden in August 2022 signed an executive order on the implementation of the \$52.7 billion semiconductor chip manufacturing subsidy and research law. The implementation included a tax credit for chip plants estimated to be worth \$24 billion, and the White House also said that the Commerce Department launched CHIPS.gov. The department will make funding awards for chip production.

In the Made in China 2025 Plan, the Chinese government has committed \$120 billion to shore up domestic semiconductor manufacturing, with the goal of producing 70% of all chips needed for local consumption.

Economic overview

Worldwide Semiconductor Revenues
Year-to-Year Percent Change



Texas Instruments is an international company that exports its products around the world, such as to China, Japan, Europe, and the Middle East. Although this will benefit the company because it will diversify its business risks, its exposure to the international market means that its operations are impacted by the economies and policies of different countries. For example, the exchange rate between the dollar and other currencies fluctuates. The company needs

to do some hedging to prevent losses. So, it is essential for us to analyze the economic situation in various countries and regions.

In 2021, we saw the recovery of the economy from the pandemic, and the supply chain for semiconductors also recovered. The increased demand for semiconductors can be attributed to the fact that more people must work remotely. In 2020 and 2021, we can also see a shortage of semiconductors. The smartphone market is one of the industries that got impacted. Some manufacturers had only received 70% of key components by the third quarter of 2021. Even the two largest smartphone manufacturers, Samsung and Apple, have become affected by the chip shortage (according to Verisk).

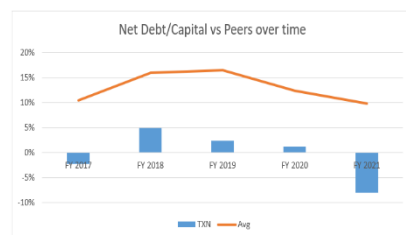
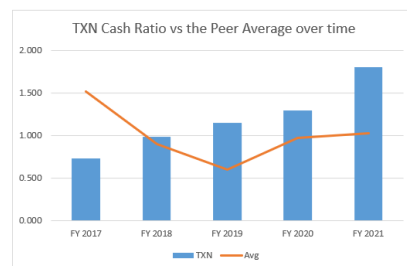
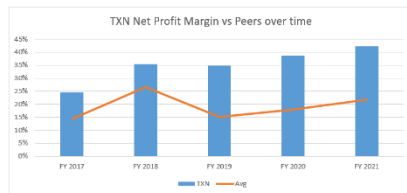


Although the shortage of semiconductors has been alleviated as a result of the pandemic's recovery, the inflation pump soon followed. The U.S. inflation rate will peak at 9.1% in June 2022. During the period from 1960 to 2021, the average inflation rate was 3.8%. The EU area inflation rate was 10.1% in August 2022. The inflation can be attributed to the war between Ukraine and Russia. During the pandemic, most countries implement expansionary fiscal and monetary policies in order to stimulate the economy and save businesses. The more money in circulation, however, drove up the price of the asset, which was mirrored in the security market. The Dow Jones Industrial Average and the S&P 500 reached historic highs in December 2021 before plummeting by 20% until October 2022. This crash was triggered by the uncertainty in

the market. For example, the supply chain is not fully recovered. China is the country that has the most comprehensive supply chain and plays an essential role in the world market. However, COVID-19's "zero" policy makes the lockdown more frequent, affecting both the manufacturing industry and the global supply chain. Furthermore, the shortage of gas and fuel caused by the war, as well as the fact that European countries reduced their energy imports from Russia to express their displeasure with the country, exacerbated the situation in Europe. Another reason is that the U.S. increased the interest rate and restricted investment and consumption to fight against inflation. In addition, the federal government intends to increase interest in the future. The Fed expected to raise its target rate to around 4.4% by the end of 2022. And they don't foresee inflation reaching their 2% target until 2025.

SWOT analysis on Texas instruments

Strength:



are possible because Texas Instruments keeps investing in R&D and acquiring and building facilities to increase its manufacturing advantages and give itself more power to control the supply chain itself. For example, the 300-millimeter wafer costs only 60% as much as the 200-millimeter wafer.

The investment in this manufacturing facility has enabled TXN to maintain the supply of its semiconductor production even during the pandemic and increase product margins, and we can see that TXN's investment in its wafer manufacturing facility has helped its net profit margin maintain a high level in the industry, fluctuating between 25% and 42%, which is higher than peers' net profit margins of 14% to 22%. TXN's ROA and ROIC are higher than the peer average too, showing its strong ability to generate profit.

It has a broad portfolio; the company focuses on analog and embedded processing and has 80,000 products in its portfolio. And \$1.6 billion is invested in R&D in 2021 to

expand the product portfolio, making the company add 500 products to its portfolio annually. This measurement will help the company maintain its leadership in the industry. For example, the production of electronic vehicles' semiconductor requirement is projected to increase from \$712 in 2022 to \$931 in 2025 per vehicle. According to the report from Gartner, TXN has a big product portfolio, meaning it has more opportunity to cover most of the demand from the vehicle manufacturers.

It has broad market channels, Beside the traditional channel to distribute the product to the client, the company also has an online channel to allow the client access to their product. For example, TI.com attracts millions of visitors every year, which allows TXN to deliver its product all around the world and make its indirect revenue increase by 10% in 2021. Over the years, TXN has invested to improve their online channel to allow clients a more convenient way to search, select, and purchase their products and has built local websites in most countries. Also, the online channel also allows TXN to enrich its database on client demand in different

countries and get a better understanding of what those clients need.

Outside of the top 100 clients, product diversity and reputation generate 40% of revenue. The revenue of the company is very diverse, not only because of its large portfolio and access to various markets and segments but also because of its reputation, which gives it a market premium.

Comparing the financial information with the peer average, TXN's liquidity situation is better than the peer average in the past 5 years. Also, we can see its cash ratio increasing gradually in the past 5 years to about 1.8, which is higher than the average of 1.025 in 2021. For the capital structure section, In comparison to the peer average Next Debt/Capital Ratio, which ranges between 10% and 16%, TXN's capital structure has been stronger than the peer average over the last five years, with the Next Debt/Capital Ratio ranging between -2% and 5%. In our opinion, we believe TXN has a robust financial situation, which displays its lower default risk to investors.

lower attrition rate in the work force: TXN's attrition rate in the work force is lower than in the industry; its turnover rate is 8.5% in 2019 and 7.5% in 2018. We can see an increase in it. while the industry turnover rate is 16.5%. This is an advantage because the company doesn't have to spend more money on training its new employers. Also, this may decrease the R&D research expense because it always takes a long time to develop a new product in the industry. If the core researchers have a high retention rate, it will boost the development progress on new products and increase the future profitability and company's valuation.

Weakness:

lower bargaining power against the suppliers with a smaller APP (average payable period). The industry average is about 70 days, while TXN's APP is 35 days. This will force TXN to invest more in working capital and decrease the efficiency of using cash. which will decrease the company's value.

Investment in Research and Development: Although TXN is a big company and its investment in R&D is above the average in the industry, it is lower than some of the fastest-growing players in the industry. TNX is more mature but has a lack of innovation compared with the industry leaders, and they prefer to serve products that have been tested by the industry.

Opportunity:

Policy Favor: The White House's decision to bring the semiconductor manufacturing industry back to the U.S. is an opportunity for companies, and more jobs will be created in the U.S. TXN will also get subsidies from the government. Before the Act, U.S. semiconductor companies purchase material from other countries and region such Taiwan (TSMC), and South Korea (Samsung). Following the Act, TXN will have easy access to lower-cost and higher-quality materials in the United States.

New technology: New technologies such as 5G, virtual reality, and electronic appliances will drive up demand for semiconductors. More market space in this industry allows TXN to use its strategy to earn more market share.

Lower shipping costs: Although shipping costs rose during the pandemic, they fell after the situation stabilized and technology was developed to make shipping fees lower in the future, which could benefit the company's profit level or TXN could gain market share by compensating customers.

Online channel: Following the pandemic, clients are more accustomed to searching, designing, and ordering via the internet. This is an excellent opportunity for the company to gather information about its customers' preferences for its products in order to support the development of new products or the implementation of new strategies.

Threats:

New Entrants: Despite the high entry barrier, new entrants with large capital can still exist in this industry. Their strategy is to focus on more specific products that differentiate with analog and embedded processing and steal market share from existing companies. New entrants from other countries, such as some Chinese companies compensated and supported by the Chinese government, pose a significant threat because China has made semiconductor development one of its national strategies.

Costs will go up: The break in the global supply chain will cause global inflation, which will drive up the price of materials. Also, the increasing price act will cause prices to go up and make the product less competitive on the market, which will hurt profits. Because the companies do business in various countries, their profits are volatile due to currency fluctuations. Also, the appreciation of the dollar in 2022 will make products less competitive from a price standpoint.

New-Technology: The rapid development of new technology forces the company to be flexible in a changing world, make the right investment decisions, and develop the right product to meet the needs of the market, which necessitates that the company's directors deeply understand the industry and forecast the market.

Policy: The unstable global environment is another threat to the company. The war between Russia and Ukraine makes the administration of U.S. President Joe Biden expect to announce new restrictions on exporting high-performance semiconductor technology in October 2022. China is the most important customer, accounting for more than half of TXN's revenue. This act will impact revenue.

Although the situation is improving and the lockdown in each country is easing, normalcy has not yet been restored. However, the lockdown in China is very frequent, which is an uncertain factor that will affect revenue.

Potential Risk

Business risk

The business risk we would mention is that we saw the company have a higher average cash conversion cycle of about 132 days, compared to the industry average of about 80 days. TXN's higher cash conversion cycle (CCC) can be attributed to its higher average holding period and lower average payable period, meaning the company has more exposure to business risk. If the economy gets into a worse situation, such as a recession, company has invested more into working capital since the higher CCC, making it more fragile in a contractionary situation that would upset the demand side and decrease sales. If revenues fall, so will the company's value.

Financial risk

Inflation rate: The US inflation rate in 2021 is 4.7%, and it is expected to reach 7% in December 2021. The inflation rate is higher than anticipated. which can cause financial damage to the value of the TXN. Despite the fact that the Fed is implementing a contractionary monetary policy, the result of this measure is uncertainty. TXN's products will be more expensive as the

CPI rises, and demand for semiconductors will fall. Furthermore, the Fed will increase the interest rate to try to control inflation, which will increase the R_f rate and increase the WACC. With the rise of WACC, the stock price of TXN will decrease. Furthermore, the impact of the pandemic is on the supply side since workers are locked up at home to quarantine and don't add real value to the GDP. In the worst case, we will see stagflation.

Core Invested Capital Driver

TI's core invested capital (IC) decreased with a 2.66% CAGR from 2017 to 2020. From 2020 to 2021 core IC grew by 17.11% resulting in a 1.01% 5Y CAGR.

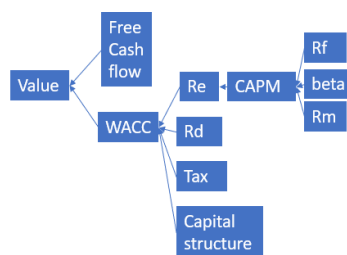
This was due to the overall increase in receivables by 20.30% despite a decrease in the ACP by almost 3 days. The main driver behind the increase in IC from 2020 to 2021 lies, however, in the significant increase in PP&E of 57.27%

A gradual decrease in intangibles and inventory holdings by 2.30% is also noticeable with the AHP substantially decreasing from 137.44 to 116.81 days. This signals a better inventory turnover and a lower execution risk for the company. Similarly, an increase in operating leases by 53.82%. and 57.35% in accounts payables contributed negatively to the core IC.

Other items such as goodwill, accrued compensation, and expenses as well as capitalized software fluctuated over the period remaining relatively unchanged.

This greater efficiency in collecting cash, converting inventory into sales, and an extended payable period, paired with its increased expenditures to fuel capacity objectives drive the increase in its core IC.

Valuation model



. In this report, we used the discounted cash flow (DCF) open model to calculate the intrinsic value of the company to decide if we needed to sell or buy the stock. In the model, we divide the revenue into segments based on geography and separate the revenue into segments based on product model. After calculating, we got the value of 223.9, and the market price is 177 in November 2022. So, we will give it a strong buy.

In our model, we use a time period of 12 years to predict the free cash flow and terminal value of the company. Because we anticipate rapid growth in the automotive and industrial markets, the first five years will be a period of rapid growth for companies. In the later 3 years, we expect stable growth for the company and assume it will mature. The reason why we make this assumption is that Texas Instruments was established in 1930, which is a long history, meaning that company is considered to be more mature with a stable market share and competitive products. However, the development of electronic vehicles, smartphones, and 5G technology in the last year has increased demand for semiconductors, creating more market space for the industry's growth.

WACC calculation:

$$WACC = \frac{E}{E + D} * R_E + \frac{D}{E + D} * R_D * (1 - T)$$

E: Equity value

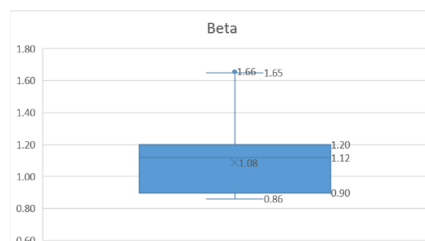
D: Net debt

Re: Return on Equity

Rd: Return on Debt

T: Tax rate

Capital structure: We assumed that the company's net debt will be **\$-182** million on average from 2017 to 2021. We did the average because the net debt of **\$ -1998** million in 2021 is abnormal. This outlier is because, as the industry begins to recover from the pandemic, the demand that had been pressed since the previous year's lockdown was released. Thus, the company generates lots of cash. Another reason is that the company's long-term debt is issued gradually and increases at a similar rate to cash, so we assumed that it would maintain a stable net debt

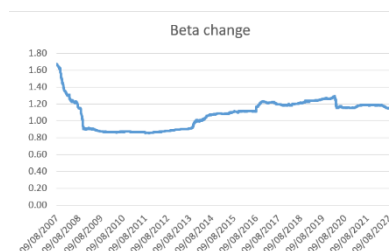


For the equity value of the company, we used the total equity in 2021 as the input. TXN is a mature company and have a long history, so we assume it will maintain the same capital structure in the future.

CAPM

Re: the required return on the equity is calculated by using the CAPM. **R_f** return we use the 10-year U.S. Treasury bond rate with 2.11%, because it is risk free backed by U.S government.

$$R_i = R_f + \beta_i * (R_m - R_f)$$



R_m is the return on market, the return data we got to calculate the R_m is from the S&P500 from 2002 to 2022. Since TXN is an American company and S&P 500 can reflect the whole U.S. market situation. Using the data, we got annual market return is 7.38%.

When it comes to beta, we get the unadjusted beta by running a regression between S&P500 and company return. The we got Beta = **1.10486**. with 95% confidence upper of **1.1389** and lower of **1.07**. The sensitivity analysis on Beta's impact on company value is display in the paper after. We also calculate the Beta by using 5 years periods data. We saw a decrease of unadjusted Beta from 1.60 to 1.16 from 2007 to 2021. which is proof that company's beta is decrease and converge to Beta=1

The mean of the beta is **1.08** and median is **1.12**. we can see that data is not normal distribution, and the mean is distorted by the outliers. So, we choose the 1.10486 to be the continue calculation

Adjusted beta

According to Blume, a Howard Butcher Professor of Finance at the University of Pennsylvania, his 1975 report shows that a company's beta has a tendency to coverage to market beta in the long run, which is the beta in the next period can be estimated by using the beta in the previous. In this report, we use the Bloomberg estimate to calculate the adjusted beta of 1.059.

Interest rate	Amount(M)	Percentage of total debt
1.85%	500	6.4%
2.25%	500	6.4%
2.63%	300	3.8%
1.38%	750	9.6%
1.13%	500	6.4%
2.90%	500	6.4%
2.25%	750	9.6%
1.75%	750	9.6%
1.90%	500	6.4%
3.88%	750	9.6%
4.15%	1500	19.2%
2.70%	500	6.4%

Based on what we got from adjusted beta, Rf, and Rm, we got the required return (**Re**) of **7.7%**.

To estimate the **cost of debt**, we check the long-term debt the company has and use that to calculate the interest rate using the weighted average method. The cost of the debt we have is **2.6%**.

For the tax rate in the company, we follow the corporate tax rate from the previous year, which was 21%, and assume that it will remain at the same rate.

In conclusion, WACC calculated based on the input we have is 7.77%.

Bloomberg Estimate

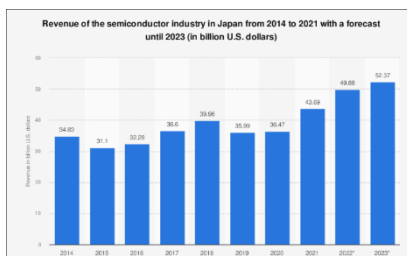
Adjusted Beta = Regression Beta (0.67) + 1.00 (0.33)

year	Real U.S. GDP Growth rate
2010	2.70%
2011	1.50%
2012	2.30%
2013	1.80%
2014	2.30%
2015	2.70%
2016	1.70%
2017	2.30%
2018	2.90%
2019	2.30%
2020	-3.40%
2021	5.70%

GOWTH RATE

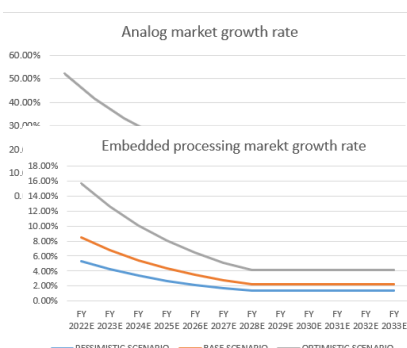
We calculate the terminal growth rate with 2.38% by using average of nominal GDP growth rate from 2015 to 2019 since the data in 2020 and 2021 is impact from the pandemic. So we didn't take them into the consideration.

Scenario analysis



Gartner forecasts worldwide semiconductor revenue growth to slow to 7% in 2022 (reference 5) and be -2.5% in 2023.

The reason for a sharp decrease in growth rate from 26.3% in 2021 to -2.5% in 2023 is that we can see a bad forecast for the effect of inflation and rising interest rates, which will slow down demand.



After carefully considering the comprehensiveness of our analysis, We decide to analyze not only the base scenario but also the optimistic scenario and the pessimistic scenario. And we use the probability weight of price in different scenarios to generate the final price

Our analysis is first based on the product segment and then

considers the geography segments. We break the revenue and cost of revenue into different drivers and assume various parameters in different scenarios to get the final value of the company and try to figure out each driver's impact on the final value

For our forecast, we expect the company's market share will change and the market size of the industry will keep growing since the demand for electronic appliances and electronic vehicles is still growing. The semiconductor industry still has potential for growth until 2028.

Because the company generates revenue from three segments: analog, embedded processing, and other business activities. For the calculation of the revenue from each segment, we used the formula below.

$$\text{Revenue} = \text{Industry market size} * \text{Company market share}$$

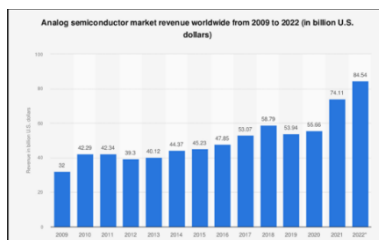
And we sum up the segment revenue to the final revenue in each year.

Base scenario

Price 214.63

The base scenario has a high probability, so we believe its probability is **70%**. The company is currently growing at a normal rate.

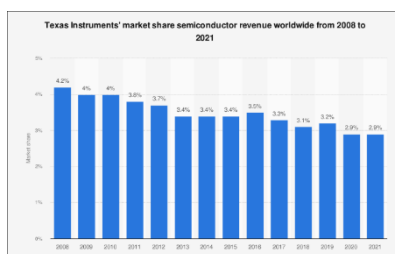
The semiconductors' growth rate is boosted because the \$52.7 billion will go toward the construction and expansion of the semiconductor market. The market growth rate of the electric car market is assumed to be (GAGR) 23.1% based on Reference 3 from 2022 to 2030.



The growth rate of the car analog requirement will increase by 26% in 2023 compared with 2021. So we assumed that the analog requirement will increase by about 17% in 2022, and the growth rate will diminish by 20% per year until 2028, then maintain at 4.46% after the industry matures because of the ongoing electrification trend. Also for the embedded

processing system, we assume a 5.3% growth rate and diminish it by 20% annually until 2028, then maintain it at 1.39% after.

For the market share in the analog industry, we assume the company maintains its market share at about 19% in the analog market and 14% in embedded processing.



TXN will construct RFAB2 (Richardson, Texas) and its 300-millimeter wafer fabrication facility, which plan to begin production in the second half of 2022;

It also purchases a 300-millimeter wafer fabrication facility in Lehi, Utah, to support analog and embedded processing manufacturing, which is expected to begin production in early

2023; and another two 300-millimeter wafer fabrication facilities in Sherman, Texas, are planned to be built in the beginning of 2022. This North Texas site has the potential for up to four fabrication facilities to meet demand over time because semiconductor growth in electronics, particularly in electronic appliances, automotive markets, and smartphones, is expected to continue well into the future. TXN's construction and purchasing of the facility make us believe that TXN can maintain its dominant position in the market at 19% in the analog market and 14% in embedded processing.

for the assumption on other business activities, since we don't have the market data for this

segment. This segment is not significant since, according to the report, TXN pays more attention to and invests more in the embedded processing and analog segments, and we also can see a continually decreasing trend from 2017 to 2020.

As a result, we estimate that its revenue will fall by 10% and remain unchanged after 2028. since a small competitor will steal this segment. As we can see from the report

Cost of goods sold

In 2021, the cost of goods sold as a percentage of revenue reached its lowest point, at 33%.The reason for this situation is that the pandemic has influenced the global supply chain and caused a shortage of semiconductor supplies. As a result, the price increased and the margin increased, so we believe that this situation is temporary. However, TXN's investment in 300-millimeter wafer fabrication facilities, which will increase the margin of the product because of its scale, So we assume the cost of revenue is 34%.

We also got the evaluation of the ROE and ROIC and found that the ROE will peak in 2026 at 69.26% and decrease after, and the ROIC will peak in 2023 at 52.1% and decrease after. The reason for this is that the company's growth in the analog and embedded processing markets is slowing.

And we can get a 21% return in this scenario.

Optimistic scenario

Price: 278.47

The optimistic scenario is that we assume companies get a relative advantage in the industry and the growth of the market is more optimistic; also, the company's construction and purchase of the new wafer manufacturing facility help them produce high-quality products and reduce the cost of good sales. And we make aggressive assumptions in this scenario.

Since the maturity of the electronic car industry, we assume an analog market growth rate of 20% in 2022 and a 20% per year decline until 2028 at 6.55%, while embedded processing grows at 7.2% and declines 20% per year until 2028 at 1.89%.Also, the market share is assumed to increase since the investment in the wafer manufacturing facility will help reduce costs, help the company achieve cost leadership in the industry, and help it gain more market share on both analog and embedded processing. We assume market share increases by 1% per year until 2027. Furthermore, the company's investment in facilities helps them to decrease the cost of goods sold, and we assume it is 34% at 2022 and decreases to 29% at 2027.

ROE peaks at 82.59% in 2027 and decreases afterward, while ROIC achieves 55.8% in 2027 and decreases afterward. The reason for the decrease is the deleverage of the company from the Dupont analysis, which is a good sign for reducing financial risk. Also, the invested capital is decreasing since the company will be more mature after 2027.

In this scenario, we get a return of 57%. We assume this probability is 20%

Pessimistic scenario

Price:139.88

Companies gradually lose their competitive advantage in the industry in a pessimistic scenario. The extremely rapid growth of the semiconductor market and the entry of more competitors will have a negative effect on the TXN market share, according to Statista. We can assume a gradual decrease from 2006 to 2021. The company's management team cannot catch up with the opportunity in the rapid growth of the semiconductor market. New competitors appear and

steal TXN's market share. Also, the growth of the analog and embedded processing markets is lower than expected because of the supply chain's slow recovery from the pandemic. The investment in wafer fabrication didn't reduce the cost as anticipated because the demand for the semiconductor is not strong and the company cannot produce enough product to achieve economies of scale.

We assume that the market growth rates for analog and embedded processing will be 14% and 3.2%, respectively, in 2022. Both growth rates will fall by 20% per year until 2027 and then remain stable. As for the market share on the analog, It will decrease by 5% per year until 2027, when it will be 13.94%. The cost of goods sold is at 34% and increase to 39% until 2027 and maintain after.

In this scenario ROE is decreased in the forecast, and ROIC peak at 47.8% in 2023 and decrease after. This result is because the increase of the cost of goods sold decrease the margin ratio and invested capital is increase faster and erode the profitability of the company.

In this scenario we get a return of -21% And we assume the probability of this scenario is 10%

RECOMMENDATION

Texas Instruments is one of the biggest mature players in the semiconductor industry, which catches lots of investors' eyes. The rapid growth rate of the electric vehicle market is expected to be 23.1% from 2022 to 2030. This rapid growth can be attributed to government policy; for example, the Chinese government compensates its citizens to purchase electric vehicles. Also, people's eco-friendly awareness is rising, and they prefer using electric vehicles. Thus, this market can be seen as a big revenue driver for the semiconductor industry and TXN.

The rapid growth rate of the demand market creates more space in the industry, enabling players to increase their market share without sacrificing margin. TXN has a relatively large market share (13.1%) and a long history, meaning it has a robust group of lock-in clients. Furthermore, its recent acquisition of wafer fabrication facilities will aid in economies of scale and increase the product's competitiveness.

However, the impact of the pandemic on the global supply chain has damaged almost all industries, and we can see a sharp price decrease from peak prices in this whole industry. Advanced micro devices decreased by 57%, Intel Corp. decreased by 58%, Applied Materials decreased by 38%, and NXP semiconductors decreased by 28%. We can see a smaller decrease for TXN at 15%. This makes us believe that investors are still confident in TXN.

After considering various scenarios (pessimistic, base, and optimistic scenarios with probabilities of 10%, 70%, and 20%), we obtain a target price of 212.38 in 2023, and if we invest today, we will obtain a 20% return in 1 year. As a consequence, our final recommendation is to buy.

“TEXAS INSTRUMENT ”

“SEMICONDUCTOR”

STUDENT: “ZHENMING YANG”

“NIKLAS ALTHOFF”

COMPANY REPORT

10 OCT 2022

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Semiconductors transform the world

Speed the data processing and change our lives

We are recommending buying share of Texas Instrument based on our estimated price target of \$ 212.38 in 2023.

- This will yield 20% return to investors.
- Texas instruments play as an important role in the industry with market share of 13.1%.
- Semiconductor market is expected a rapid growth in the future driven by the electrical vehicle market with 23.1%(GAGR) from 2022 to 2030.
- Positive correlation with S&P500.

Company description

Founded 1930 in Delaware, Texas Instruments (TI) is a leading semiconductor company in the world designing, producing, and selling semiconductors in over 30 countries worldwide. Headquartered in Dallas Texas, the company is selling its products to electronics designers and manufacturers worldwide and reported a total of \$18.344 billion revenues in 2021. TI is reporting its revenues in five operating regions namely the United States, Asia, Europe Middle East and Africa (EMEA), Japan and the Rest of the World.

Recommendation: BUY

Price Target FY23: 212.38 \$

Price (as of 27-Jan-23) 177 \$

Bloomberg: NASDAQGS: TXN

52-week range (€) 144.46-194.22

Market Cap (€m) 154,296.3

Outstanding Shares (m) 910

Source: CIQ



Source: CIQ

(Values in € millions)	2021	2022E	2023F
Revenues	18,344	20,718	22,971
EBITDA	9,919	11,231	9,888
Net Profit	7,971	8625	7259
EPS	8.38	9.26	7.93
P/E	21.44	17.87	21.44

Source: Annual Report: Analyst estimate

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Company Overview

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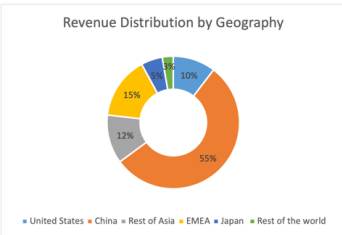


Figure 1

forecast and analysis simplicity (Figure 1).

Purpose proposition

Having started as a company transforming vacuum tubes into transistors and integrated circuits, TI is rooted to this day in the idea of contributing towards creating a better world by making electronics more affordable through semiconductors. Providing innovative technology to its customers and helping to transform its end-user industry, the industrial and automotive market, results in a growing industry, market, and customer base. This trend is fostered by the fact that its technology becomes more reliable, affordable, and sustainable over time.

- Long-term value for owners as the main objective

TI's main objective is to make progress and create long-term value for shareholders, indicated and measured by the free cash flow per share growth. In hopes of maximizing its overall goal, TI adopted a three-point strategy.

Firstly, TI's operations and success are based on four competitive advantages differentiating the company from its competitors. Besides a strong foundation in manufacturing and technology, and a broad portfolio of Analog and Embedded Processing products, the reach of its marketing channels is crucial. In its annual report, TI states that its primary focus lies on the diversification and quality of its products, markets, and customer positions.

Secondly, to fulfill its purpose TI follows a disciplined allocation of capital. To achieve organic growth TI invested in R&D, sales, and marketing as well as working capital for inventory. A focus lies on capital expenditures, which are the most important driver of long-term free cash flow per share.

Lastly, TI tries to maximize efficiency, defined as investing in the most profitable areas creating impact as well as optimizing cost-cutting. TI tries to implement the idea of efficiency and ongoing improvement in every area of its business, to grow its revenue, and increase the long-term value for its shareholders.

Product Segmentation

Semiconductors, also known as "chips", are electronic components that serve as building blocks inside modern electronic systems and equipment, combining multiple transistors to form a complete electronic circuit. TI has a diversified portfolio of over 80.000 products, which are integral to almost every type of electronic equipment fulfilling different tasks. These can vary from converting and amplifying signals to interfacing with other devices, over managing, and distributing power up to improving signal resolutions. Based on several factors such as similar

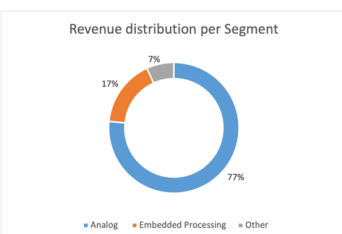


Figure 2

design, development requirements, product characteristics, manufacturing, and distribution channels, TI combines and reports its products in three different segments.

- Analog

With \$14.05 billion (Figure 2) in revenues, Analog is the most important segment representing 76.59% of the company's total revenues in 2021 (Figure 3). This segment is further divided into two product lines, Power and Signal Chain.

The Power Line combines products that allow customers to control power in different electronic systems for different voltage levels. Solutions for Battery-management, power switches, and lightning products count towards products in this sub-segment.

The Signal Chain features products that sense, condition and measure real-world signals, allowing for user data transformation, conversion, and analysis. (TI Annual Report 2021) Besides amplifiers, products such as interface devices and for example clocks can be found in this sub-segment.

- Embedded Processing

This segment generated \$3.05 billion in revenues over 2021 (Figure 3), therefore accounting for 16.62% of TI performance (Figure 2). The second biggest segment contains products designed to handle specific tasks vital for many types of electronic equipment used in the industrial and automotive markets. These products are characterised by great adaptability and can be easily and adjusted customized for customer demands.

Typical products are microcontrollers which control specific tasks for electronic equipment. The products range varies from low-cost products, found in simple applications as electric toothbrush's up to complex devices like motor controls.

- Other

Products, that do not meet the threshold to be an individually reportable segment and can't be grouped within the other segments as are bundle under "Other". It is the smallest of the three segments accounting for 6.79% (Figure 2) of TI with \$1.25 billion in revenues generated throughout 2021 (Figure 3). Besides products used to project high-definition images, acquisition and restructuring charge items and corporate level items such as environmental costs are reported in this segment.

Customers, Markets, and Industry Characteristics

In 2021 TI generated its revenues from sales to a wide range of over 100,000 customers worldwide. An advantage that results is that TI isn't relying only on large clients. In the past more 40% of the total revenues were generated from relationships with smaller clients outside the largest 100 customers.

- Sales Markets for TI's products

TI shows a well-diversified positioning in terms of the markets and industries it is distributing. As can be seen in Figure 3. TI sold its products in the six markets throughout 2021. The industrial market which includes smaller sectors such as Factory automation and control or Medicals was the largest sales market accounting for 41%. While the Personal electronic market, with sub-sectors such as Mobile phones, PCs or TVs was the second biggest

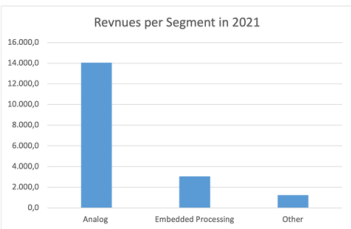


Figure 3

Analog is the largest business segment followed by Embedded Processing and Other



Figure 4

market, the Automotive market accounted for 21% being the third largest market. The remaining markets accounted for 14% (Figure 4) of TI's revenues separated by sales markets.

- Industry Characteristics

Based on TI's historical figures its revenues undergo seasonal variations peaking in the second and third quarters. Moreover, the semiconductor industry is characterized by periods of supply and demand mismatches. The main reason is the time and capital-intensive building process of manufacturing facilities. Lastly, the industry shows a high level of competition for broad and niche products.

Manufacturing

Producing semiconductors is a highly specialized investment-heavy process, as they are produced on a thin silicon wafer through a sequence of photolithographic and chemical processes. Significant competitive advantages result from TI's investment in manufacturing technologies and facilities. TI owns several manufacturing facilities in North America, Europe, and Japan. This allows the company to produce and test most of its products through in-house manufacturing and test facilities resulting in cost and supply chain advantages.

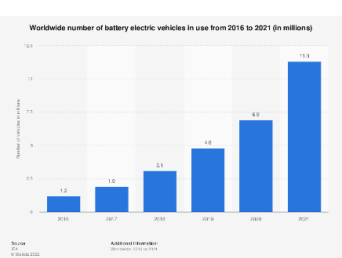
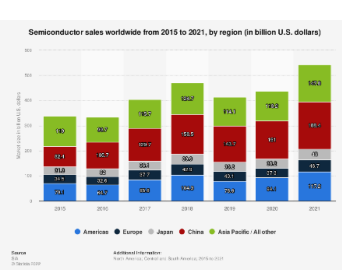
One of TI's most substantial cost advantages comes from its investments to produce on 300-millimeter wafers. This technology reduces the costs of an unpackaged chip by 40% compared to a chip being built on a 200-millimeter wafer. Additional investments include constructing and purchasing a 300-millimeter wafer fabric and planning additional capacities.

Sales and Distribution

TI uses direct sales channels as well as external distributors to sell its products. While the latter is less used the direct channels including TI's website, broad sales, and applications accounted for more than two-thirds of its revenue in 2021. The importance of online purchasing possibilities become more relevant as revenues through this direct channel grew to 10%. TI invested in new and improved capacity in terms of customer support, e-commerce enhancements, and order fulfillment services. Thereby TI is increasing customer satisfaction and offering new selling opportunities. This should result in a closer relationship with customers strengthening the market channel advantage and give greater insights into demand.

Sector overview

Before the pandemic and the trade war between China and the United States, the global semiconductor market experienced stable growth from 2015 to 2018. This expansion is being driven by rising demand for smartphone, electronic vehicle, industrial, and 5G technology, all of which require a large number of semiconductors, such as analog systems, embedded systems, and sensors, to manufacture. 5G satellite markets are expected to be worth \$67.2 billion in 2027, with the number of electric vehicles increasing from 1.2 million to 11.3 million between 2016 and 2021. Although it appears that the number of smartphones sold peaks in 2018 and then falls until 2020, this fall can be attributed to the impact of the pandemic in 2019 and the US-China trade war. However, we can expect a recovery to begin in 2020, and based on 5G development, smartphone chipset demand will continue to rise. As for the industrial semiconductor market, it kept growing from 2014 to 2017, and the market size can be foreseen



at 69.2 billion in 2022.

During the pandemic, the supply chain for semiconductors is almost cut off because of the lockdown in different countries, for example, China, the United States, and Taiwan, which are the essential countries on the supply chain. Syed Alam, Accenture's global semiconductor practice lead, explains that components for a chip could travel more than 25,000 miles before completion and can cross borders more than 70 times before a final product is delivered to the end customer

Since the share of semiconductor manufacturing market share of U.S. was keep decreasing in past 20 years and are expected to decrease to 10% in 2023. For example, Taiwan Semiconductor Manufacturing Co (TSMC) became the largest semiconductor manufacturer in the world because the manufacture outsourcing from the U.S semiconductor companies.

In order to bring back the manufacture industry to U.S and create more occupation, President Joe Biden in August, 2022 signed an executive order on implementation of the \$52.7 billion semiconductor chips manufacturing subsidy and research law, the implementation include a tax credit for chip plants estimated to be worth \$24 billion, and White House also said that Commerce Department launched CHIPS.gov. The department will make funding awards for chips production.

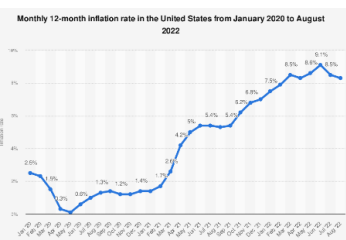
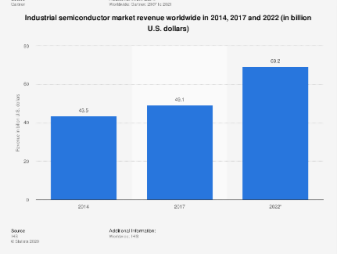
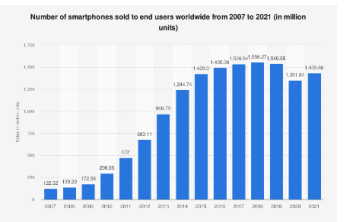
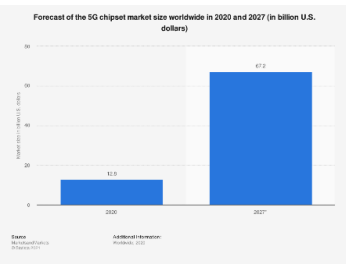
In the Made in China 2025 Plan, the Chinese government has committed \$120 billion to shore up domestic semiconductor manufacturing with the goal of producing 70% of all chips need for local consumption.

Economic overview

Texas is an international company that exports its products around the world, such as to China, Japan, Europe, and the Middle East. Although this will benefit the company because it will diversify its business risks, its exposure to the international market means that its operations are impacted by the economies and policies of different countries. For example, the exchange rate between the dollar and other currencies fluctuates. The company needs to do some hedging to prevent losses. So, it is essential for us to analyze the economic situation in various countries and regions.

In 2021, we saw the recovery of the economy from the pandemic, and the supply chain for semiconductors also recovered. The increased demand for semiconductors can be attributed to the fact that more people must work remotely. In 2020 and 2021, we can also see a shortage of semiconductors. The smartphone market is one of the industries that got impacted. Some manufacturers had only received 70% of key components by the third quarter of 2021. Even the two largest smartphone manufacturers, Samsung and Apple, have become affected by the chip shortage (according to Verisk).

Although the shortage of semiconductors has been alleviated as a result of the pandemic's recovery, the inflation pump soon followed. The U.S. inflation rate will peak at 9.1% in June 2022. During the period from 1960 to 2021, the average inflation rate was 3.8%. The EU area inflation rate was 10.1% in August 2022. The inflation can be attributed to the war between Ukraine and Russia. During the pandemic, most countries implement expansionary fiscal and monetary policies in order to stimulate the economy and save businesses. The more money in circulation, however, drove up the price of the asset, which was mirrored in the security market.



- List of Peer Companies**
- Analog Devices
 - Intel Corp
 - Broadcom Inc
 - Advanced Micro Devices Inc
 - Applied Materials Inc
 - NXP Semiconductors NV

The Dow Jones Industrial Average and the S&P 500 reached historic highs in December 2021 before plummeting by 20% until October 2022. This crash was triggered by the uncertainty in the market. For example, the supply chain is not fully recovered. China is the country that has the most comprehensive supply chain and plays an essential role in the world market. However, COVID-19's "zero" policy makes the lockdown more frequent, affecting both the manufacturing industry and the global supply chain. Furthermore, the shortage of gas and fuel caused by the war, as well as the fact that European countries reduced their energy imports from Russia to express their displeasure with the country, exacerbated the situation in Europe. Another reason is that the U.S. increased the interest rate and restricted investment and consumption to fight against inflation. In addition, the federal government intends to increase interest in the future. The Fed expected to raise its target rate to around 4.4% by the end of 2022. And they don't foresee inflation reaching their 2% target until 2025.

Financial Analysis

In this section, we are going to examine TI's financials over time and in comparison, to its industry peers. We are going to look at liquidity ratios, the company's cash flow management, sales, and cost drivers. Additionally, we are going to assess the company's performance with the help of a margin and profitability analysis. The aim is to gain a deeper understanding of the company itself and in relation to its peer and industry context. We picked 6 peers (Table 1) based on financial similarity in terms of market capitalization and financial metrics after making sure that these companies operate within the same industry and geography. Further, we calculated all financial metrics and the averages, in a similar way as we did for TI to ensure comparability.

TXN Liquidity Ratios					
	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Ratio	3,868	3,273	4,127	4,284	5,327
Change		-15,39%	26,09%	3,81%	24,34%
Peer	3,001	2,377	3,184	3,466	4,583
Change		-20,81%	33,97%	8,85%	32,24%
Peer	0,733	0,985	1,148	1,300	1,803
Change		34,37%	16,49%	13,25%	38,67%



Figure 5



Figure 6

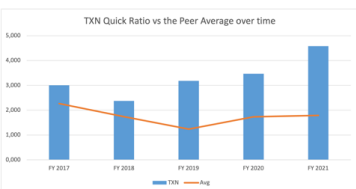


Figure 7

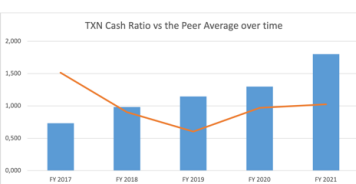


Figure 8

Liquidity Analysis

TI's current ratios of 5.3% (see Table 2) specifies the company's ability to cover its short-term obligations using all its short-term assets. While TI's current ratio grew by a cumulative annual growth rate (CAGR) of 6.61% (Figure 5), the metrics decreased annually by 4.41% over the last 5 years on average, looking at its peers. As Figure 6 indicates TI consistently

outperformed its peers on average in terms of trend and absolute values having a current ratio more than twice as high as its peers on average in 2021.

The company's quick ratio of 4.5 (see Table 2) strengthens the hypothesis of TI's superior liquidity position, indicating that it isn't relying on high levels of inventory. While the company's ability to meet its short terms obligation, using its current assets without selling the inventory, grew by an 8.8% CAGR (Figure 5), between 2017 and 2021, the average quick ratio of its peers decreased by 4% annually. TI, additionally, outperformed its peers in absolute values (Figure 7) underpinning its superior liquidity positioning in the market.

While TI's cash ratio was significantly below the peer average in 2017, this trend was reversed over the last five years. In 2021 TI's cash ratio exceeded the peer average by more than 75% (Figure 8). As this metric increased by 19,71% annually over the last 5 years, TI is now able to almost meet its short-term obligations twice only using cash and cash equivalents (Figure

Overall, these results suggest that TI shows a satisfactory and healthy liquidity position considering both development and peer performance. Concluding TI should have a lower risk of experiencing financial distress in the short term than its peers.

Cash Flow Management

In 2021 it took TI 33.85 days on average to collect its accounts receivables and convert them into cash, indicated by the average collection period (ACP). Over the last five years, this ratio remained relatively constant growing by 1.6% annually (Figure 9 TBD). In comparison, TI's peers need on average almost 20 days more to do so. Throughout the period of consideration, TI was significantly more efficient in collecting cash than the average of its peers, as indicated by Figure 10.

TI's average holding period (AHP) yields contradicting results in terms of cash flow management efficiency. While TI's inventory remained on average 116.81 days within the

company before being sold in 2021, TI's peers are more efficient holding inventory only for 105.82 days on average. As Figure 11 shows, TI was less efficient for the last 5 years, decreasing the gap with its peers constantly. This is in line with TI's 5-year CAGR of -2.65% implying more efficient inventory turnover. In 2021 TI was able to decrease the AHP by 15.01%, marking the most successful year over the past 5 years under analysis (Figure 9).

The average payable period (APP) arguably represents TI's cash flow ratio with the biggest improvement potential and lowest efficiency. In 2021 TI had to pay its bills on average 35 days earlier than its peers, prohibiting the use of this money for exploiting investment opportunities. As seen in Figure 12, TI was consistently outperformed by its peers supporting this premise.

As for the other ratios TI was able to increase its efficiency in 2021 increasing the APP by 36.89% (Figure 9).

The cash conversion cycle CCC, the combination of the beforementioned metrics underpins the trends stated by the AHP and APP. Despite the increase over the first 4 years, TI was able to decrease the CCC by 23.08% in 2021 (Figure 9). Nevertheless, over the last 5 TI was significantly less efficient than its peers, and in 2021 its CCC was 27 days higher than the peer average (Figure 13).

Overall, these figures suggest mixed results. On the one hand, TI is significantly less efficient looking at the current and past CCC, indicating the inventory turnover and average payable period as main improvement targets. The development and increased efficiency in 2021 on the other hand point towards a more positive picture.

Capital Structure

The most important metrics we looked at when analysing TI's capital structure evolution and comparing it to peers were Debt to Equity, Net Debt to Equity, Gearing, Solvency, Financial Autonomy, Total debt to EBIT, and Net Debt to EBIT ratios.

Capital Structure Ratios

TI's total debt-to-equity ratio increased gradually from 2017 to 2020. However, from 2020 to

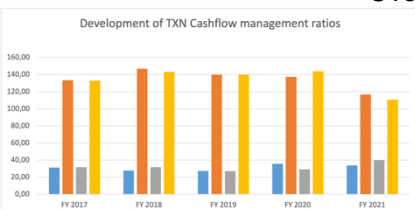


Figure 9

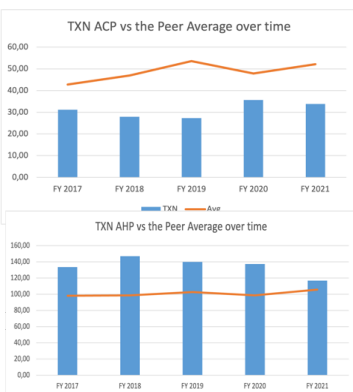


Figure 11

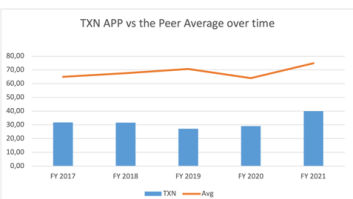


Figure 12

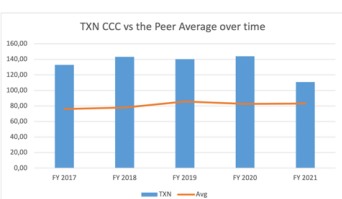


Figure 13

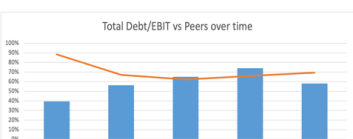


Figure 14

2021 it decreased by 21.54%. This is due to equity increasing by 45.13% whereas net debt increased by only 13.87% over this period.

Compared to its peers TI has a below-average total debt-to-equity ratio potentially signalling that the company could use more leverage in case it possesses the financial stability and creditworthiness to further support an increase in leverage as we will further investigate. (Figure 14)

When we take net debt instead of total debt to equity into consideration, we see that TI's Net debt to equity is negative. This is due to the cash & cash equivalents (including short-term investments) which have been increasing substantially, 117.92% from 2017 to 2021 surpassing the debt level in 2021.

In comparison to its peers, this ratio is significantly lower (Figure 15). This could potentially signal that the company may be holding too much cash which, on one hand, strengthens its cash position and creates a cushion against potential liquidity pressures. On the other hand, this could entail that the company is choosing not to invest a lot of its cash which could be potentially damaging to the company's growth and its investors.

TI's gearing ratio supports these findings, as it is based on net debt and invested capital. TI's gearing ratio was significantly lower than the average ratio of its peers and is currently negative, yielding a difference of 17.42 percentage points (Figure 16).

On the hand, this indicates significantly less risk of default since the debt can be fully covered by TI's cash without even considering the invested capital. On the other hand, there might be evidence to suggest that the ratio indicates, that TI's capital structure is not efficient. One could argue that the company should consider using significantly more debt to finance additional projects and investments to increase its profitably. Considering the significantly lower net debt, the company could do this without risking losing its low default risk.

- Solvency and Financial Autonomy Ratio

TI's solvency ratio of 1.18 in 2021 indicates that the firm can meet its obligations using its equity. Even though this metric is slightly above the average of its competitors this is not concerning as a solvency ratio higher than 1 is considered good. While TI's solvency ratio was superior to its competitor this trend changed over the last year as indicated by figure 17.

Nevertheless, TI was able to reverse its personal negative trend, as its solvency ratio grew by 30% in 2021.

The financial autonomy ratio is an additional ratio supporting the solvency ratio by measuring the extent to which firms are dependent on debt holders. TI's ratio of 0.54 in 2021 indicates a sustainable independence as the accepted thresholds tend to vary around 0.25. Although TI's ratio decreased while the peer average increased over the last 5 years, TI is still showing a slightly higher financial autonomy ratio (Figure 18). This indicates that TI is more than competitive compared to its peers.

The overall results indicated by these ratios are that TI has a high solvency, considering both

the overall accepted thresholds and the peer averages. In conclusion, it can be said that TI has a sustainable capital structure to finance its activity without being exposed to too many medium and long-term risks.

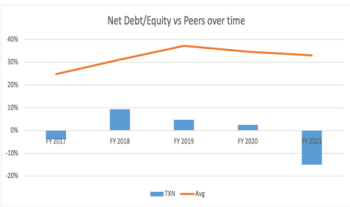


Figure 15

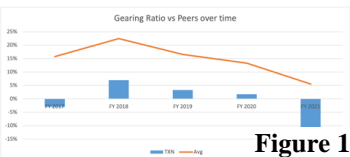


Figure 16

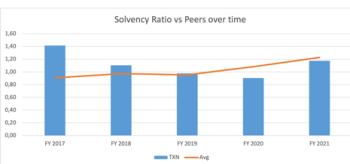


Figure 17

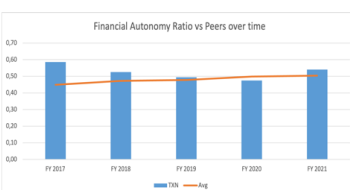


Figure 18

- Credit Ratios

Credit ratios can be used to assess the debt capacity of companies as financial institutions often use them to assess companies' default probabilities. Both TI's total debt and net debt to EBIT ratio are significantly below the peer average (Figures 19&20). Both ratios decreased over the last year, indicating a decreased default probability of the company's outstanding debt as it is covered by the company's EBIT. Furthermore, these ratios suggest that it should not be problematic for TI to receive additional debt financing at a competitive rate. In addition to

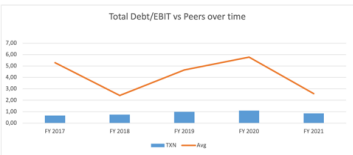


Figure 19

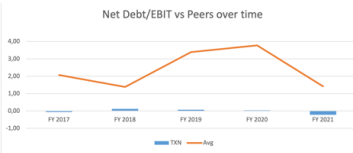


Figure 20

the capital structure analysis conducted above this indicates that it could be optimal for TI to increase its leverage to finance additional projects and strengthen its market positioning.

The fact that TI has improvement potential in its capital structure, which could yield higher returns in the future without adding too much risk compared to its competitors, might be an important incentive for future investors.

Sales Drivers

As already mentioned in the introduction TI is reporting its revenues for three product segments and 6 geographies. After comparing the company's revenue with its peers, we are going to take a more detailed look into the segment and geographies.



Figure 21

Figure 21 shows TI's revenue growth over the last 5 years. After mixed results for the years before TI was able to grow its revenues by 26.85%. TI's revenue growth rate was, however, inferior compared to its competitors. TI's revenue growth was significantly lower between 2018 and 2020 as indicated by Figure 22. Further evidence for this can be found in the 3- and 5-year CAGRs. Both are 4 respectively 6 percentage points lower than the peer average.

- Analog

In 2021 Analog was the most important segment accounting for 76.59% of TI's revenue. Since 2017 the importance of this segment constantly increased as its contribution to the total revenues increased by 15% since then (Figure 23). In 2021 revenues from this segment increased by 29.06% and were the main driver of the overall revenue growth.

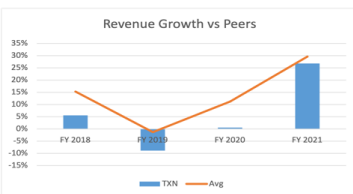


Figure 22

- Embedded Processing

Embedded Processing represents the second biggest segment of TI's operations, accounting for 16.62% in 2021. In contrast to Analog, this segment lost in terms of importance over the years as the figure 23 indicates. Revenues from Embedded Processing's increased in 2021 by 18.26% contributing to the overall revenue growth and strengthening the position of the company.

- Other

Revenues from the smallest segment increased in 2021 by 23.88%. The percentage this segment accounted for in terms of total revenues decreased over time by 31.59%. In 2021 this segment only accounted for 7.15%.

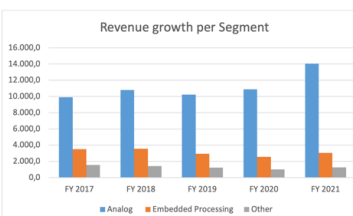


Figure 23

Overall, all three segments could report increased revenues in 2021, attributable to the improved performance of the company. Looking at the last 5 years a clear trend is visible, which indicates that the Analog segment became more important at the expense of the remaining segments.

- Geographies

TI reports its revenues in six different geographical regions, as figure 24 shows. While based in the US, Asia and particularly China play the most important roles in TI's success, accounting for 72%, respectively 55% of the total revenues. While all six regions reported revenue growth rates higher than 10% the three Asian regions outperformed the remaining regions significantly with growth rates higher than 40%.

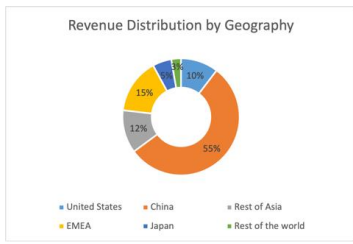


Figure 24

While especially EMEA but also regions like Japan and the US lost in significance, measured as the percentage of total revenues they account for, China could consistently grow its importance (Figure 25). Over the last 5 years, China's revenue stake increased by 23.57%. TI's success in China can be explained by an increased demand for technology products such as smartphones and tablets or electric vehicles. This increase in demand is driven by both the further growth and development of China's middle class, as well as favorable policies.

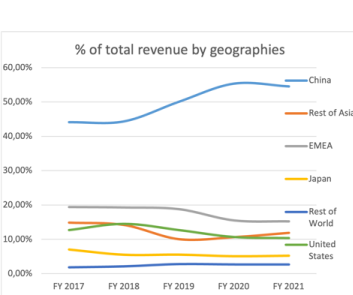


Figure 25

Cost Drivers

TI core operational costs arise from three sources, namely cost of revenue, Research and Development (R&D), and Selling, General and Administrative (SG&A) expenses (Figure 26).

COGS, driven by the manufacturing, marketing, and shipping costs represents the largest share of TI's cost and increased by 11.6% over the last 5 years. With its investments in technology and manufacturing facilities for 300-millimeter wafer production, TI was able to realize cost improvements. Over the same period, COGS increased at a significantly lower rate than revenues.

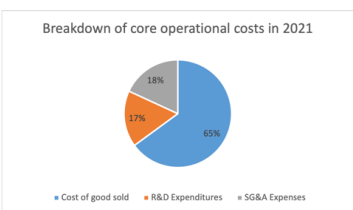


Figure 26

SG&A and R&D expenses accounted for 18% respectively 17% of the total costs in 2021. Over the last five years, the total amount of these costs fluctuated slightly around their current level. R&D expenses play an important role in the business model, creating and maintaining TI's competitive advantage and positioning within the market. R&D investments are used to develop new products, expand the portfolio, and increase manufacturing efficiency. Over the last years, these investments yielded 500 new products annually.

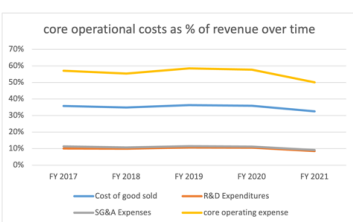


Figure 27

Besides this, TI records additional costs such as interest expenses or restructuring charges among others. None of these expenses belongs to TI's core operations nor account for more than 2% of the total cost.

Cost as a percentage of revenues and the core operational margin provide insight into how efficiently TI uses its costs. As figure 27 suggests the first metrics remained relatively stable for the three main costs, before decreasing by about 13% in 2021. The core operational margin figures are in line with this, supporting the premise of increased cost efficiency in 2021 (Figure



Figure 28

28). This might be a result of R&D and capital expenditures of the past years which is expected to yield further improvements in the future further strengthening TI's position in the market.

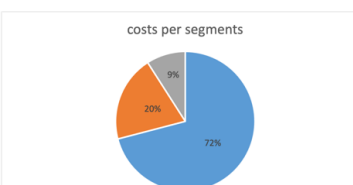


Figure 29

Analog is the strongest and most cost-intensive segment followed by Embedded Processing and Other (Figure 29). The same order holds true looking at the cost efficiency per segment. Based on the gross margin and cost as a percentage of revenues Analog significantly

outperforms the remaining segments. The segment-specific metrics follow the same trend as the overall company metrics, indicating efficiency enhancement throughout all parts of the company.

Core Invested Capital Driver

TI's core invested capital (IC) decreased with a 2.66% CAGR from 2017 to 2020. From 2020 to 2021 core IC grew by 17.11% resulting in a 1.01% 5Y CAGR.

This was due to the overall increase in receivables by 20.30% despite a decrease in the ACP by almost 3 days. The main driver behind the increase in IC from 2020 to 2021 lies, however, in the significant increase in PP&E of 57.27%

A gradual decrease in intangibles and inventory holdings by 2.30% is also noticeable with the AHP substantially decreasing from 137.44 to 116.81 days. This signals a better inventory turnover and a lower execution risk for the company. Similarly, an increase in operating leases by 53.82%. and 57.35% in accounts payables contributed negatively to the core IC.

Other items such as goodwill, accrued compensation, and expenses as well as capitalized software fluctuated over the period remaining relatively unchanged.

This greater efficiency in collecting cash, converting inventory into sales, and an extended payable period, paired with its increased expenditures to fuel capacity objectives drive the increase in its core IC.

Margin Analysis

In this section, we will be analysing the overall profitability and efficiency of TI's operations by looking at the gross profit, EBITDA, EBIT, and net income margins.

▪ Gross Profit Margin

TI's gross profit margin increased by 5% over the last years, mainly driven by increased efficiency in 2021 (Figure 30). This resulted from higher revenues, as demand for products from the Analog segment increased. From a geographical perspective, China and the Rest of Asia were the main drivers. At the same time, TI was able to achieve slower growth in COGS, due to higher production efficiency based on the previous R&D and capital expenditures.



Figure 30

In comparison to its peers, TI's is not only continuously outperforming the average over the last 5 years but was consistently superior compared to every peer company on its own. The difference in absolute terms diminished slightly, as the average gross profit margin of its peers grew by 10% over the same time.

▪ EBITDA Margin

Since changes in SG&A and R&D expenses were minor and M&A expenses somewhat decreased, TI reported an EBITDA almost 40% higher than in 2020. This resulted in an increase in TI's EBITDA margin of 17%, mainly driven by the factors influencing the gross profit margin (Figure 30). TI's EBITDA margin exceeds the peer average throughout the consideration

period. While TI's margin increased by 17% from 2017 to 2021, the peer average increased by 18%. Despite TI's leading position, the company was still able to improve its efficiency at the same pace as its competitors.

Title 3

EBIT Margin

TI's EBIT margin increased by 21% in the last year after remaining stable the years before. The stronger increase of this metric when compared to the EBITDA margin, stems from the reduction in depreciation and amortization (D&A) followed by a lower PP&E. Decreases in capital expenditures (CAPEX) between 2017 and 2020 amplified the differences between EBITDA and EBIT.

The EBIT margin and TI's peers showed the same development trend however the increase of the average metric was 34% over the last years. Nevertheless, TI continuously outperformed its peers, and its 2021 EBIT margin was 24 percentage points higher (Figure 32).

The financial year 2021, however, saw an increase of 279% in TI's CAPEX, due to the investment in new production facilities. Consequently, we expect to see an increase in D&A in

the upcoming years. This might result in a reduction in TI's EBIT margin, pushing it more toward the average of its competitors.

Net Income Margin

In 2021 TI was able to generate 42% net income out of every dollar revenue as indicated by the net income margin. This represents an increase of 72% compared to 2017, where TI only generated \$0.25 out of every dollar (Figure 33). TI's competitors were on average able to generate \$0.22 net income out of every dollar revenue in 2021. Consequently, TI showed a

superior net income margin over the whole five years. While the peer company experienced a strong reduction in the net income margin, TI was able to maintain and further increase its net income margin.

Return Ratio Analysis

This section analyses the overall profitability of TI's operation and tries to help understand its positioning in the market. This analysis is taking a different point of view, complementing the margin analysis, from a return perspective. We will look at the company's Asset Turnover, followed by the Return on Asset (ROA), Invested Capital (ROIC), and Equity (ROE). For the ROIC of the peer companies, we are using a proxy. This was calculated by dividing the companies operating income after tax by an invested capital proxy. The invested capital driver

proxy is the sum of the company's net debt and its equity.

Title 3

Asset Turnover

TI's asset turnover increased by 18.11% in 2021, the first increase in this profitability metric as it continuously decreased from 2018 onwards (Figure 34). TI's asset turnover indicates that in 2021 each unit of TI's invested asset is yielding 94.80% in revenues. The peer companies were on average able to generate only 62,76% of revenues from the same amount invested. Figure 35 indicates that TI's performance in generating sales from assets was superior

throughout the last 4 years. Overall TI's management seems to be more efficiently allocating their resources, exploiting their assets, and generating sales.

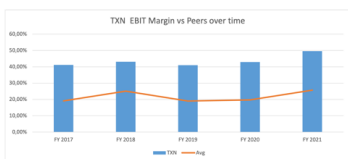


Figure 32

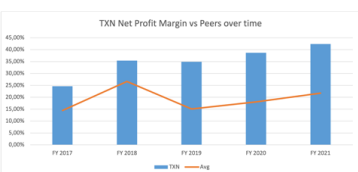


Figure 33

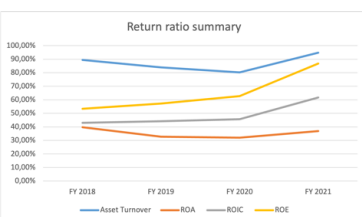


Figure 34

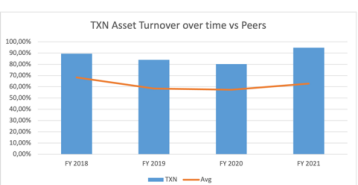


Figure 35

TI's core asset turnover of 187.64 % indicates that the company is highly efficient in terms of generating sales from its core assets. The ratio is higher than the overall asset turnover which indicates that, if the company would solely rely on its core business, it would be even more efficient than it is currently. This figure indicates, however, that the company is also highly unprofitable using its non-core and financial assets to generate sales, decreasing the overall level. TI was able to increase this ratio by 21.65% over the last 4 years. Looking at the invested capital drivers individually shows that PP&E and goodwill are the main drivers with asset turnovers exceeding 20%.

Title 3

▪ Return on Assets (ROA)

After TI's ROA decreased for three consecutive years the company was able to achieve a growth of 15.01% in 2021 (Figure 34). TI was able to generate 36% EBIT for every unit of asset invested, as indicated by the ROA. The company was unable to reach the efficiency level from 2018. However, taking the last twelve-month trailing figure (LTM) into consideration TI's ROA would pass the threshold and reach 40.42%.

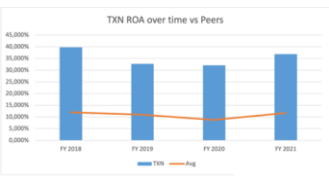


Figure 36

As figure (36) indicates, TI was able to significantly outperform its competitors, as its ROA fluctuated around 11% on average, over time. TI's return on core assets of 69.69% indicates that the company's superior performance is mainly driven by the efficiency of its core business. TI was able to increase this figure by 22.25% since 2018. While TI is generating a small amount of EBIT with its financial assets, its non-core assets are not profitable as the company is losing money with them. TI significantly improved the efficiency of its non-current assets, by increasing the quantity and quality of its investment and decreasing its non-current liabilities.

Title 3

▪ Return on Invested Capital (ROIC)

TIs ROIC continuously increased throughout the four years by over 43.16%, with the largest increase of 35.06% occurring in 2021, as indicated by figure 34. This increase was mainly driven by TI's improved core result, resulting from the increased demand throughout all segments, as discussed above. The increase in non-core IC, driven by higher investments and lower non-current liabilities damped the effect. TI showed a superior ROIC throughout the past and its ROIC was three times higher than the peer average in 2021 (Figure 37).

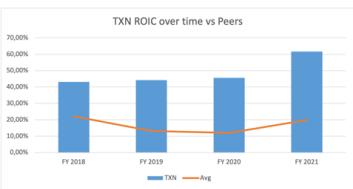


Figure 37

Taking a closer look at the ROIC per activity the results indicate a significant discrepancy in the profitability of core and non-core activities. While TI's core business has a ROIC of 81.93%, its investments in non-core activities yield a return of only 3.17%. The overall ROIC stems primarily from TI's core business, accounting for 74.25%, whereas the remainder is generated from non-core activities.

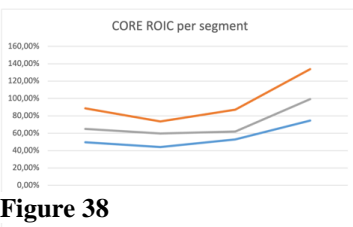


Figure 38

The breakdown of the core ROIC shows that all of TI's three segments yield high returns on their IC. As figure 38 suggests Analog is the segment with the lowest ROIC, while Embedded Processing yields the highest ROIC per segment. While 77.85% of the total invested capital is used in Analog, this breakdown suggests that it would be ideal to further think about this relation. For instance, it might be profitable for the company to shift some of the invested capital into Embedded Processing and Other, as these two segments yield a significantly higher ROIC, indicating greater investment and return possibilities.

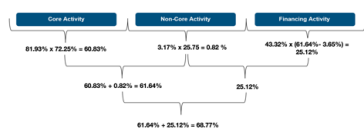
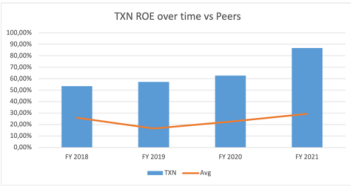


Figure 39

- Return on Equity

For the last 4 years, TI reported an ROE higher than its ROIC (Figure 34). This indicates that TI's financing contributions were continuously creating value for its shareholders. In 2021 TI's ROE was 86.77%. This did not only represent the highest ROE of the past but also shows that TI's financing decisions were highly effective in the last year. Figure 39 shows the detailed ROE breakdown in 2021. TI's ROE exceeded the average of its competitors significantly over time (Figure 40). These results indicate that TI's management showed greater efficiency in fulfilling its purpose proposition of generating value for its shareholders.

Figure 40



SWOT analysis on Texas instruments

Strength:

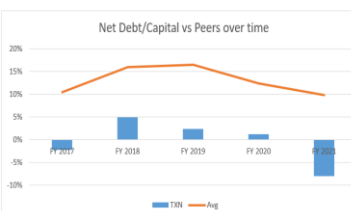
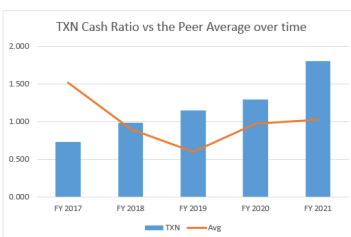
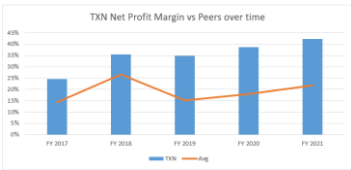
Strong foundations in manufacturing and technology are possible because Texas Instruments keeps investing in R&D and acquiring and building facilities to increase its manufacturing advantages and give itself more power to control the supply chain itself. For example, the 300-millimeter wafer costs only 60% as much as the 200-millimeter wafer. The investment in this manufacturing facility has enabled TI to maintain the supply of its semiconductor production even during the pandemic and increase product margins, and we can see that TI's investment in its wafer manufacturing facility has helped its net profit margin maintain a high level in the industry, fluctuating between 25% and 42%, which is higher than peers' net profit margins of 14% to 22%. TI's ROA and ROIC are higher than the peer average too, showing its strong ability to generate profit.

It has a broad portfolio; the company focuses on analog and embedded processing and has 80,000 products in its portfolio. And \$1.6 billion is invested in R&D in 2021 to expand the product portfolio, making the company add 500 products to its portfolio annually. This measurement will help the company maintain its leadership in the industry. For example, the production of electronic vehicles' semiconductor requirement is projected to increase from \$712 in 2022 to \$931 in 2025 per vehicle. According to the report from Gartner, TI has a big product portfolio, meaning it has more opportunity to cover most of the demand from the vehicle manufacturers.

It has broad market channels, Beside the traditional channel to distribute the product to the client, the company also has an online channel to allow the client access to their product. For example, TI.com attracts millions of visitors every year, which allows TI to deliver its product all around the world and make its indirect revenue increase by 10% in 2021. Over the years, TI has invested to improve their online channel to allow clients a more convenient way to search, select, and purchase their products and has built local websites in most countries. Also, the online channel also allows TI to enrich its database on client demand in different countries and get a better understanding of what those clients need.

Outside of the top 100 clients, product diversity and reputation generate 40% of revenue. The revenue of the company is very diverse, not only because of its large portfolio and access to various markets and segments but also because of its reputation, which gives it a market premium.

Comparing the financial information with the peer average, TI's liquidity situation is better than the peer average in the past 5 years. Also, we can see its cash ratio increasing gradually in



the past 5 years to about 1.8, which is higher than the average of 1.025 in 2021. For the capital structure section, In comparison to the peer average Next Debt/Capital Ratio, which ranges between 10% and 16%, TI's capital structure has been stronger than the peer average over the last five years, with the Next Debt/Capital Ratio ranging between -2% and 5%. In our opinion, we believe TI has a robust financial situation, which displays its lower default risk to investors.

lower attrition rate in the work force: TI's attrition rate in the work force is lower than in the industry; its turnover rate is 8.5% in 2019 and 7.5% in 2018. We can see an increase in it. while the industry turnover rate is 16.5%. This is an advantage because the company doesn't have to spend more money on training its new employees. Also, this may decrease the R&D research expense because it always takes a long time to develop a new product in the industry. If the core researchers have a high retention rate, it will boost the development progress on new products and increase the future profitability and company's valuation.

Weakness:

lower bargaining power against the suppliers with a smaller APP (average payable period). The industry average is about 70 days, while TI's APP is 35 days. This will force TI to invest more in working capital and decrease the efficiency of using cash. which will decrease the company's value.

Investment in Research and Development: Although TI is a big company and its investment in R&D is above the average in the industry, it is lower than some of the fastest-growing players in the industry. TNX is more mature but has a lack of innovation compared with the industry leaders, and they prefer to serve products that have been tested by the industry

Opportunity:

Policy Favor: The White House's decision to bring the semiconductor manufacturing industry back to the U.S. is an opportunity for companies, and more jobs will be created in the U.S. TI will also get subsidies from the government. Before the Act, U.S. semiconductor companies purchase material from other countries and region such Taiwan (TSMC), and South Korea (Samsung). Following the Act, TI will have easy access to lower-cost and higher-quality materials in the United States.

New technology: New technologies such as 5G, virtual reality, and electronic appliances will drive up demand for semiconductors. More market space in this industry allows TI to use its strategy to earn more market share.

Lower shipping costs: Although shipping costs rose during the pandemic, they fell after the situation stabilized and technology was developed to make shipping fees lower in the future, which could benefit the company's profit level or TI could gain market share by compensating customers.

Online channel: Following the pandemic, clients are more accustomed to searching, designing, and ordering via the internet. This is an excellent opportunity for the company to gather information about its customers' preferences for its products in order to support the development of new products or the implementation of new strategies

Threats:

New Entrants: Despite the high entry barrier, new entrants with large capital can still exist in this industry. Their strategy is to focus on more specific products that differentiate with analog and

embedded processing and steal market share from existing companies. New entrants from other countries, such as some Chinese companies compensated and supported by the Chinese government, pose a significant threat because China has made semiconductor development one of its national strategies.

Costs will go up: The break in the global supply chain will cause global inflation, which will drive up the price of materials. Also, the increasing price act will cause prices to go up and make the product less competitive on the market, which will hurt profits. Because the companies do business in various countries, their profits are volatile due to currency fluctuations. Also, the appreciation of the dollar in 2022 will make products less competitive from a price standpoint.

New-Technology: The rapid development of new technology forces the company to be flexible in a changing world, make the right investment decisions, and develop the right product to meet the needs of the market, which necessitates that the company's directors deeply understand the industry and forecast the market.

Policy: The unstable global environment is another threat to the company. The war between Russia and Ukraine makes the administration of U.S. President Joe Biden expect to announce new restrictions on exporting high-performance semiconductor technology in October 2022. China is the most important customer, accounting for more than half of TI's revenue. This act will impact revenue.

Covid: Although the situation is improving and the lockdown in each country is easing, normalcy has not yet been restored. However, the lockdown in China is very frequent, which is an uncertain factor that will affect revenue.

Potential Risk

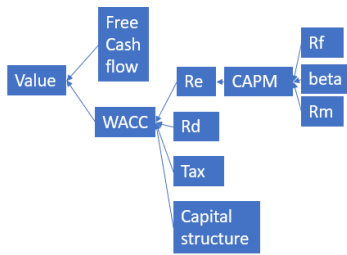
Business risk

The business risk we would mention is that we saw the company have a higher average cash conversion cycle of about 132 days, compared to the industry average of about 80 days. TI's higher cash conversion cycle (CCC) can be attributed to its higher average holding period and lower average payable period, meaning the company has more exposure to business risk. If the economy gets into a worse situation, such as a recession, company has invested more into working capital since the higher CCC, making it more fragile in a contractionary situation that would upset the demand side and decrease sales. If revenues fall, so will the company's value.

Financial risk

Inflation rate: The US inflation rate in 2021 is 4.7%, and it is expected to reach 7% in December 2021. The inflation rate is higher than anticipated. which can cause financial damage to the value of the TI. Despite the fact that the Fed is implementing a contractionary monetary policy, the result of this measure is uncertainty. TI's products will be more expensive as the CPI rises, and demand for semiconductors will fall. Furthermore, the Fed will increase the interest rate to try to control inflation, which will increase the Rf rate and increase the WACC. With the rise of WACC, the stock price of TI will decrease. Furthermore, the impact of the pandemic is on the supply side since workers are locked up at home to quarantine and don't add real value to the GDP. In the worst case, we will see stagflation.

Valuation model



In this report, we used the discounted cash flow (DCF) model to calculate the intrinsic value of the company to decide if we needed to sell or buy the stock. In the model, we divide the revenue into segments based on geography and separate the revenue into segments based on product model. After calculating, we got the value of 223.9, and the market price is 177 in November 2022. So, we will give it a strong buy.

In our model, we use a time period of 12 years to predict the free cash flow and terminal value of the company. Because we anticipate rapid growth in the automotive and industrial markets, the first five years will be a period of rapid growth for companies. In the later 3 years, we expect stable growth for the company and assume it will mature. The reason why we make this assumption is that Texas Instruments was established in 1930, which is a long history, meaning that company is considered to be more mature with a stable market share and competitive products. However, the development of electronic vehicles, smartphones, and 5G technology in the last year has increased demand for semiconductors, creating more market space for the industry's growth.

WACC calculation:

$$WACC = \frac{E}{E + D} * R_E + \frac{D}{E + D} * R_D * (1 - T)$$

E: Equity value

D: Net debt

Re: Return on Equity

Rd: Return on Debt

T: Tax rate

Capital structure: We assumed that the company's net debt will be \$-182 million on average from 2017 to 2021. We did the average because the net debt of -1998 million in 2021 is abnormal. This outlier is because, as the industry begins to recover from the pandemic, the demand that had been pressed since the previous year's lockdown was released. Thus, the company generates lots of cash. Another reason is that the company's long-term debt is issued gradually and increases at a similar rate to cash, so we assumed that it would maintain a stable net debt

For the equity value of the company, we used the total equity in 2021 as the input. TI is a mature company and have a long history, so we assume it will maintain the same capital structure in the future.

CAPM

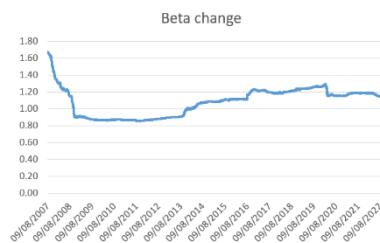
Re: the required return on the equity is calculated by using the CAPM. R_f return we use the 10-year U.S. Treasury bond rate with 2.11%, because it is risk free backed by U.S government.

R_m is the return on market, the return data we got to calculate the R_m is from the S&P500 from 2002 to 2022. Since TI is an American company and S&P 500 can reflect the whole U.S. market situation. Using the data, we got annual market return is 7.38%.

$$R_i = R_f + \beta_i * (R_m - R_f)$$

When it comes to beta, we get the unadjusted beta by running a regression between S&P500 and company return. The we got Beta = 1.10486. with 95% confidence upper of 1.1389 and lower of 1.107. The sensitivity analysis on Beta's impact on company value is display in the paper after. We also calculate the Beta by using 5 years periods data. We saw a decrease of unadjusted Beta from 1.60 to 1.16 from 2007 to 2021. which is proof that company's beta is decrease and converge to Beta=1

The mean of the beta is 1.08 and median is 1.12. we can see that data is not normal



distribution, and the mean is distorted by the outliers. So, we choose the 1.10486 to be the continue calculation.

Adjusted beta

According to Blume, a Howard Butcher Professor of Finance at the University of Pennsylvania, his 1975 report shows that a company's beta has a tendency to coverage to market beta in the long run, which is 1. And the beta in the next period can be

estimated by using the beta in the previous. In this report, we use the Bloomberg estimate to calculate the adjusted beta of 1.059.

Based on what we got from adjusted beta, R_f , and R_m , we got the required return (R_e) of 7.7%.

To estimate the **cost of debt**, we check the long-term debt the company has and use that to calculate the interest rate using the weighted average method. The cost of the debt we have is 2.6%.

Interest rate	Amount(M)	Percentage of total debt
1.85%	500	6.4%
2.25%	500	6.4%
2.63%	300	3.8%
1.38%	750	9.6%
1.13%	500	6.4%
2.90%	500	6.4%
2.25%	750	9.6%
1.75%	750	9.6%
1.90%	500	6.4%
3.88%	750	9.6%
4.15%	1500	19.2%
2.70%	500	6.4%

For the tax rate in the company, we follow the corporate tax rate from the previous year, which was 21%, and assume that it will remain at the same rate.

In conclusion, WACC calculated based on the input we have is 7.77%.

Bloomberg Estimate

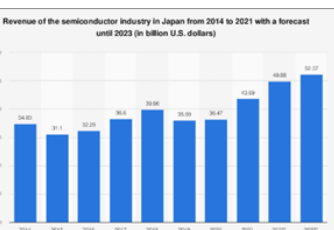
$$\text{Adjusted Beta} = \text{Regression Beta} (0.67) + 1.00 (0.33)$$

GOWTH RATE

We calculate the terminal growth rate with 2.38% by using average of nominal GDP growth rate from 2015 to 2019 since the data in 2020 and 2021 is impact from the pandemic. So we didn't take them into the consideration.

Scenario analysis

Gartner forecasts worldwide semiconductor revenue growth to slow to 7% in 2022 (reference 5) and be -2.5% in 2023. The reason for a sharp decrease in growth rate from 26.3% in 2021



to -2.5% in 2023 is that we can see a bad forecast for the effect of inflation and rising interest rates, which will slow down demand

After carefully considering the comprehensiveness of our analysis, We decide to analyze not only the base scenario but also the optimistic scenario and the pessimistic scenario. And we use the probability weight of price in different scenarios to generate the final price

Our analysis is first based on the product segment and then considers the geography segments. We break the revenue and cost of revenue into different drivers and assume various parameters in different scenarios to get the final value of the company and try to figure out each driver's impact on the final value

For our forecast, we expect the company's market share will change and the market size of

the industry will keep growing since the demand for electronic appliances and electronic vehicles is still growing. The semiconductor industry still has potential for growth until 2028.

Because the company generates revenue from three segments: analog, embedded processing, and other business activities. For the calculation of the revenue from each segment, we used the formula below.

$$\text{Revenue} = \text{Industry market size} * \text{Company market share}$$

And we sum up the segment revenue to the final revenue in each year.

Base scenario

Price 214.63

The base scenario has a high probability, so we believe its probability is 70%. The company is currently growing at a normal rate.

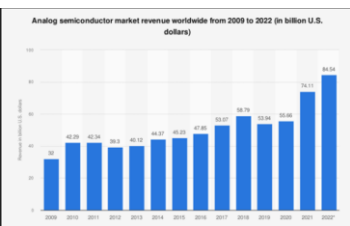
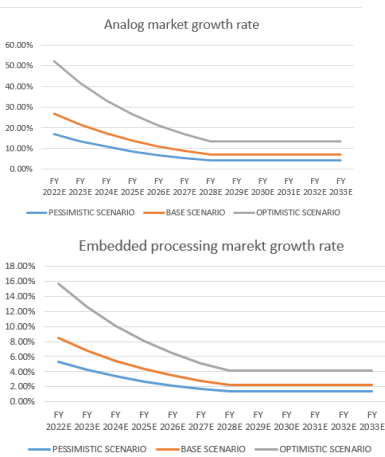
The semiconductors' growth rate is boosted because the \$52.7 billion will go toward the construction and expansion of the semiconductor market. The market growth rate of the electric car market is assumed to be (GAGR) 23.1% based on Reference 3 from 2022 to 2030.

The growth rate of the car analog requirement will increase by 26% in 2023 compared with 2021. So we assumed that the analog requirement will increase by about 17% in 2022, and the growth rate will diminish by 20% per year until 2028, then maintain at 4.46% after the industry matures because of the ongoing electrification trend. Also for the embedded processing system, we assume a 5.3% growth rate and diminish it by 20% annually until 2028, then maintain it at 1.39% after.

For the market share in the analog industry, we assume the company maintains its market share at about 19% in the analog market and 14% in embedded processing

TI will construct RFAB2 (Richardson, Texas) and its 300-millimeter wafer fabrication facility, which plan to begin production in the second half of 2022;

It also purchases a 300-millimeter wafer fabrication facility in Lehi, Utah, to support analog and embedded processing manufacturing, which is expected to begin production in early 2023; and another two 300-millimeter wafer fabrication facilities in Sherman, Texas, are planned to be built in the beginning of 2022. This North Texas site has the potential for up to four fabrication facilities to meet demand over time because semiconductor growth in electronics, particularly in electronic appliances, automotive markets, and smartphones, is expected to continue well into the future. TI's construction and purchasing of the facility make us believe that TI can maintain



its dominant position in the market at 19% in the analog market and 14% in embedded processing.

for the assumption on other business activities, since we don't have the market data for this segment. This segment is not significant since, according to the report, TI pays more attention to and invests more in the embedded processing and analog segments, and we also can see a continually decreasing trend from 2017 to 2020.

As a result, we estimate that its revenue will fall by 10% and remain unchanged after 2028. since a small competitor will steal this segment. As we can see from the report

Cost of goods sold

In 2021, the cost of goods sold as a percentage of revenue reached its lowest point, at 33%.The reason for this situation is that the pandemic has influenced the global supply chain and caused a shortage of semiconductor supplies.As a result, the price increased and the margin increased, so we believe that this situation is temporary. However, TI's investment in 300-millimeter wafer fabrication facilities, which will increase the margin of the product because of its scale, So we assume the cost of revenue is 34%.

We also got the evaluation of the ROE and ROIC and found that the ROE will peak in 2026 at 69.26% and decrease after, and the ROIC will peak in 2023 at 52.1% and decrease after. The reason for this is that the company's growth in the analog and embedded processing markets is slowing.

And we can get a 21% return in this scenario.

Optimistic scenario

Price: 278.47

The optimistic scenario is that we assume companies get a relative advantage in the industry and the growth of the market is more optimistic; also, the company's construction and purchase of the new wafer manufacturing facility help them produce high-quality products and reduce the cost of good sales. And we make aggressive assumptions in this scenario.

Since the maturity of the electronic car industry, we assume an analog market growth rate of 20% in 2022 and a 20% per year decline until 2028 at 6.55%, while embedded processing grows at 7.2% and declines 20% per year until 2028 at 1.89%.Also, the market share is assumed to increase since the investment in the wafer manufacturing facility will help reduce costs, help the company achieve cost leadership in the industry, and help it gain more market share on both analog and embedded processing. We assume market share increases by 1% per year until 2027. Furthermore, the company's investment in facilities helps them to decrease the cost of goods sold, and we assume it is 34% at 2022 and decreases to 29% at 2027.

ROE peaks at 82.59% in 2027 and decreases afterward, while ROIC achieves 55.8% in 2027 and decreases afterward. The reason for the decrease is the deleverage of the company from the Dupont analysis, which is a good sign for reducing financial risk. Also, the invested capital is decreasing since the company will be more mature after 2027.

In this scenario, we get a return of 57%.

Pessimistic scenario

Price:139.88

Companies gradually lose their competitive advantage in the industry in a pessimistic scenario. The extremely rapid growth of the semiconductor market and the entry of more competitors will

have a negative effect on the TI market share, according to Statista. We can assume a gradual decrease from 2006 to 2021. The company's management team cannot catch up with the opportunity in the rapid growth of the semiconductor market. New competitors appear and steal TI's market share. Also, the growth of the analog and embedded processing markets is lower than expected because of the supply chain's slow recovery from the pandemic. The investment in wafer fabrication didn't reduce the cost as anticipated because the demand for the semiconductor is not strong and the company cannot produce enough product to achieve economies of scale.

We assume that the market growth rates for analog and embedded processing will be 14% and 3.2%, respectively, in 2022. Both growth rates will fall by 20% per year until 2027 and then remain stable. As for the market share on the analog, It will decrease by 5% per year until 2027, when it will be 13.94%. The cost of goods sold is at 34% and increase to 39% until 2027 and maintain after.

In this scenario ROE is decreased in the forecast, and ROIC peak at 47.8% in 2023 and decrease after. This result is because the increase of the cost of goods sold decrease the margin ratio and invested capital is increase faster and erode the profitability of the company.

In this scenario we get a return of -21%. And we assume the probability of this scenario is 10%

Sensitivity Analysis

To conclude our valuation and account for the impacts that changing key inputs could have on the share price we performed several sensitivity analyses. Considering our DCF, we performed a sensitivity analysis on beta, used to calculate the cost of equity, the WACC, and the long-term growth rate used to calculate the Terminal Value, for each of our three scenarios – Base, Optimistic and Pessimistic. All sensitivity tables can be found in the Excel.

Sensitivity Analysis for the share price						
WACC	6.21%	6.99%	7.77%	8.54%	9.32%	
1.90%	271,7051	227,882	195,7271	171,1426	151,7477	
2.14%	283,3251	235,6256	201,1523	175,0885	154,7023	
2.38%	296,3876	244,1685	207,0569	179,3391	157,8596	
2.62%	311,1791	253,6414	213,5072	183,9311	161,241	
2.86%	328,0671	264,2047	220,5826	188,9074	164,8714	

Throughout all scenarios, our analysis suggests that our share price has a higher sensitivity to changes in WACC than to our growth rate. While our share price decreased by an average 13.26% throughout the different scenarios, decreasing the WACC by 10%, the same percentage change of the growth rate yields only a share price increase of 3.08% on average. Similar results were found increasing both metrics by 10%.

Sensitivity Analysis for the share price						
Recommendation	WACC	6.21%	6.99%	7.77%	8.54%	9.32%
1.90%	BUY	BUY	BUY	SELL	SELL	SELL
2.14%	BUY	BUY	BUY	SELL	SELL	SELL
2.38%	BUY	BUY	BUY	HOLD	SELL	SELL
2.62%	BUY	BUY	BUY	HOLD	SELL	SELL
2.86%	BUY	BUY	BUY	HOLD	SELL	SELL

As Tables 3 and 4 show the share price varies between \$151 and \$328, yielding return levels between -14.27% and 85.35% for different WACCs and growth rates. While 60% of the recommendations would be "BUY", 28% would be "SELL" leaving 12% "HOLD"

recommendations for the base case.

Table 4

Sensitivity Analysis for the share price						
Recommendation	WACC	6.21%	6.99%	7.77%	8.54%	9.32%
1.90%	-1.34%	-16.67%	-27.93%	-36.55%	-43.37%	
2.14%	2.71%	-13.97%	-26.04%	-35.18%	-42.34%	
2.38%	7.26%	-10.99%	-23.98%	-33.70%	-41.24%	
2.62%	12.41%	-7.70%	-21.74%	-32.10%	-40.06%	
2.86%	18.29%	-4.02%	-19.27%	-30.37%	-38.80%	

The pessimistic scenario, on the other hand, predicts a worse outlook as 21 out of the 25 recommendations are "SELL" for the input changes. The overall share prices vary between \$100.23 and \$209.37 yielding expected returns between -43.37% and 18.29%, of which only four were positive (Table 5).

Table 5

For the optimistic case, the recommendation didn't change throughout the whole sensitivity analysis, as it was a "BUY" for every input combination. Expected returns varied between 11.05% and 143.37%, for different levels of WACC and growth rates.

The scenario analysis for the beta was based on the 25th and 75th percentile thresholds of our regression, used for the calculation of the beta. Increasing beta from 1.06 to 1.07 yielded a share price decrease of 1.12% on average throughout the different scenarios. The sensitivity to a decrease of beta from 1.06 to 1.05 was almost similar. Decreasing the beta yielded an average share

		Sensitivity Analysis for the share price				
		Beta				
		1,04	1,05	1,06	1,07	1,08
G	1,90%	200,13	197,91	195,73	193,59	191,50
	2,14%	205,85	203,48	201,15	198,88	196,65
	2,38%	212,08	209,54	207,06	204,63	202,25
	2,62%	218,91	216,18	213,51	210,90	208,35
	2,86%	226,41	223,46	220,58	217,77	215,03

price increase of 1.14% considering all different scenarios (Table 6).

Changes in the beta were not influencing the share price significantly enough to change the recommendations. The sensitivity analysis yielded the same recommendation for every input combination as the original inputs did, throughout the different scenarios.

Table 6

Relative Valuation

To assess whether TI is currently undervalued we concluded a relative valuation based on the EV/EBIT and P/E multiple. These multiples were calculated by calculating the P/E and EV/EBIT ratios for each of TI's peers before averaging them. This gave us a P/E multiple of 19.54x and an EV/EBITDA multiple of 19.37x. For the relative valuation, we used the most current market caps available and LTM values for TI.

Target from EV/EBIT	
EV	203.974
Net Debt	-1.153
Equity Value	205.127
Share Price	219,15
Expected Return	23,8%

Applying the EV/EBIT multiple to TI's LTM EBIT yielded a share price of 219.15 indicating a 23.8% return compared to TI's current share price (Table 7). Doing the same for the P/E multiple indicates a return of 5.3% (Table 8).

Table 7

Target from P/E	
EPS	9,54
Share price	186,34
Expected Return	5,3%

These results can be interpreted in line with the DCF for 2023, supporting the valuation results. Both valuation methods indicate an undervaluation of TI by the market representing therefore an interesting investment opportunity. The fact that the relative valuation yields lower results

Table 8

on average, has two main reasons. On the one hand, are we looking at the share price as of today and not in one year's time as in DCF. Secondly, it is a relative valuation less reliant on assumptions, and therefore less volatile. What is more important, is the fact that both valuation methods yield the same trend supporting each other. Assuming a moderate growth in TIs, EBIT, and earnings per share over one year, leaving the multiples unchanged, a rather conservative approach would consequently yield a higher valuation closer to the findings of the DCF. Overall, it is difficult to compare these findings based on the timing difference, but the findings seem to support the DCF, more than to contradicting it.

Recommendation

Texas Instruments is one of the biggest mature players in the semiconductor industry, which catches lots of investors' eyes. The rapid growth rate of the electric vehicle market is expected to be 23.1% from 2022 to 2030. This rapid growth can be attributed to government policy; for example, the Chinese government compensates its citizens to purchase electric vehicles. Also, people's eco-friendly awareness is rising, and they prefer using electric vehicles. Thus, this market can be seen as a big revenue driver for the semiconductor industry and TI.

The rapid growth rate of the demand market creates more space in the industry, enabling players to increase their market share without sacrificing margin. TI has a relatively large market share (13.1%) and a long history, meaning it has a robust group of lock-in clients. Furthermore, its recent acquisition of wafer fabrication facilities will aid in economies of scale and increase the product's competitiveness.

However, the impact of the pandemic on the global supply chain has damaged almost all industries, and we can see a sharp price decrease from peak prices in this whole industry. Advanced micro devices decreased by 57%, Intel Corp.

decreased by 58%, Applied Materials decreased by 38%, and NXP semiconductors decreased by 28%. We can see a smaller decrease for TI at 15%. This makes us believe that investors are still confident in TI.

After considering various scenarios (pessimistic, base, and optimistic scenarios with probabilities of 10%, 70%, and 20%), we obtain a target price of 212.38 in 2023, and if we invest today, we will obtain a 20% return in 1 year. As a consequence, our final recommendation is to buy.

Appendix

Financial Statements

Reformulated Balance Sheet in millions

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	LTM 2022		
Core Business								
Operating Cash	299.22	315.68	287.66	289.22	366.88	403.8		
Accounts Receivable - Trade	1,278.0	1,207.0	1,074.0	1,414.0	1,701.0	2,040.0		
Inventories	1,957.0	2,217.0	2,001.0	1,955.0	1,910.0	2,404.0		
Prepaid Expenses and Other	1,030.0	440.0	299.0	302.0	335.0	238.0		
Property Plant & Equipment - Net	2,664.0	3,183.0	3,303.0	3,269.0	5,141.0	6,485.0		
Goodwill	4,362.0	4,362.0	4,362.0	4,362.0	4,362.0	4,362.0	20	FY 2021 LTM 2022
Other Intangible Assets	946.0	628.0	340.0	152.0	0.0	0.0		
Capitalized Software Net	110.0	89.0	69.0	122.0	85.0	75.0	.0	18,344.0 20,190.0
Accounts Payable - Trade	-466.0	-478.0	-388.0	-415.0	-653.0	-780.0		
Accrued Compensation/Postretirement Oblig	-722.0	-724.0	-714.0	-767.0	-775.0	-662.0	86	14050 15559
Accrued Expenses and Other	-442.0	-420.0	-475.0	-524.0	-520.0	-734.0	05	1245 1443
Income Taxes Accrued/Payable	-128.0	-103.0	-46.0	-134.0	-121.0	-123.0	70	3049 3188
Operating Lease Liabilities	0	0	-259	-249	-383	-382		
Invested Capital in Core Business	10888.2	10716.7	9853.66	9776.22	11448.9	13326.8	.0	9,188.0 9,460.0
Non-Core-Business								
Investments	3,081.0	2,046.0	3,250.0	3,510.0	5,108.0	5,921.0	.0	5,968.0 6,156.0
Other Noncurrent Assets	86.0	140.0	468.0	569.0	748.0	799.0	.0	1,554.0 1,625.0
Prepaid Pensions/Postretirement - Net	119.0	-26.0	125.0	115.0	313.0	204.0	.0	1,666.0 1,679.0
Other Noncurrent Liabilities	-1,303.0	-1,190.0	-1,255.0	-1,056.0	-984.0	-771.0	.0	9,156.0 10,730.0
Deferred Income Taxes Net	186.0	253.0	119.0	253.0	176.0	199.0	.4	1,922.8 2,253.3
Invested Capital in Non-Core Business	2,169.0	1,223.0	2,707.0	3,391.0	5,361.0	6,352.0	.4	-776.0 -765.9
							.0	8,009.2 9,242.6
Financial								
Excess Cash	1,356.8	2,122.3	2,149.3	2,817.8	4,264.1	2,765.2		
Borrowings	-4,077.0	-5,068.0	-5,803.0	-6,798.0	-7,741.0	-7,937.0	.0	-143.0 -64.0
Net financial Assets	-2,720	-2,946	-3,654	-3,980	-3,477	-5,172	.0	-142.0 0.0
							.0	-54.0 -263.0
Equity	10,337	8,994	8,907	9,187	13,333	14,507	.0	-53.0 -199.0
	10,337.0	8,994.0	8,907.0	9,187.0	13,333.0	14,507.0	.0	-53.0 -199.0
<i>Check</i>	<i>TRUE</i>	<i>TRUE</i>	<i>TRUE</i>	<i>TRUE</i>	<i>TRUE</i>	<i>TRUE</i>	1	-11.13 -41.79
tax adjustment		583.68	274.126	51.552	-6.017	53.514		0
ner actuarial losses of defined benefit plans								
adjustment		92	-98	88	-41	175		0
Recognized within net income		56	50	38	29	29		0
prior service credit of defined benefit plans		-7	-9	0	-1	-1		0
Derivative instrument		1	-2	0	0	0		0
non-core result		-606.8	-509.3	13.6	64.9	107.6		-157.2
financial result								
interest expense		-78.0	-125.0	-170.0	-190.0	-184.0		-203.0
statutory tax		-27.3	-26.25	-35.7	-39.9	-38.64		-42.63
financial result		-50.7	-98.8	-134.3	-150.1	-145.4		-160.4
total comprehensive income		3,826.5	5,523.8	5,143.7	5,582.8	7,971.4		8,925.0

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Report Recommendations

Buy	Expected total return (including expected capital gains and expected dividend yield) of more than 10% over a 12-month period.
Hold	Expected total return (including expected capital gains and expected dividend yield) between 0% and 10% over a 12-month period.
Sell	Expected negative total return (including expected capital gains and expected dividend yield) over a 12-month period.

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