

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.

BYD Company Limited Equity
Research

Bárbara Veríssimo Choon 26209

Ilona Shapovalova 26151

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

Nuno Vasconcelos e Sá

3rd January 2019

BYD Company Limited Equity Research

Abstract

The purpose of this project is to evaluate the equity value of BYD Company Limited. In this sense, it contains a comprehensive financial and strategic analysis of the company, as well as an in-depth understanding of automotive, rechargeable batteries and mobile handset industries in China. A Discounted Cash Flow valuation was performed grounded on the company and industry knowledge, delivering a price target of 42.30 RMB for A-shares and a final recommendation of SELL, with a downside of 11.2% to the current stock price. Further, sensitivity and scenario analysis were carried out to test the key model predictions and assumptions.

Keywords: Equity Research; Valuation; DCF; BYD Company Limited

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BYD COMPAY LIMITED

AUTOMOTIVE | ASIA PACIFIC

BÁRBARA CHOON | ILONA SHAPOVALOVA

COMPANY REPORT

03 JANUARY 2020

Post-subsidy era pain

BYD's potential drowned by subsidy cuts

- We issue a **SELL** recommendation on BYD Company Limited A-shares with a price target of RMB **42.30/sh**, which corresponds to an **11.2% downside** to the current price.
- **The negative impact from subsidy cut:** The gradual phase-out of governmental subsidy for new electric vehicles by 2020 has caused BYD's momentum to slow down while taking a hit on margins. Gross margins are expected to decrease to 23.9% by end-2020 from 25.4% in FY2018.
- **Downtrend of NEV demand:** A harsher competitive landscape resulted in a slowdown in the growth of units sold of BEV and PHEV - estimated to be 6.9% YoY and 0.9% YoY, respectively - from the 141% YoY and 87% YoY recorded in 2018.
- **ICE vehicles extinction:** Due to strict new regulations on internal combustion engines, we expected a further decline of the volume sold, with a 10% CAGR decrease until the complete phase-out by 2040.
- **New 5G era:** We anticipate a strong FY2019 and FY2020 for BYD mobile segment with the 5G introduction, and, hence we are bullish with revenues expectations of RMB 44bn/46bn (6.4 % YoY), driven by 1) rise in assembly services, 2) metal mid-frame recovery, and 3) glass screen steady growth. However, it does not counterbalance the negative outlook for the automobile segment.

Company description

BYD Company Limited operates in the manufacture and sales of transportation equipment, namely traditional fuel-engine vehicles and new energy vehicles. The Company's product portfolio also includes rechargeable batteries and mobile handsets. Founded in 1995, BYD is headquartered in Shenzhen and conducts its businesses mainly in China.

Recommendation: **SELL**

Initial Coverage

Price Target FY19: **RMB 42,30**

Price (as of 30-Dec-19) **RMB 47,64**

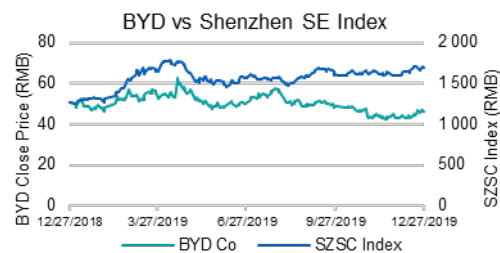
Reuters: 002594.SZ, Bloomberg: 002594:CH

52-week range (RMB) 42.83-62.40

Market Cap (RMB m) RMB 129 968.69

Outstanding Shares (m) 2.728

Source: Thomson Reuters Eikon



Source: Thomson Reuters Eikon

(Values in RMB billions)	2017	2018E	2019F
Revenues	102 651	121 791	148 323
EBIT	7 868	7 679	10 634
EBIT margin (%)	7.66%	6.31%	7.17%
NOPLAT	6 883	6 227	9 303

Revenues per Segment			
Automobile	54 501	71 769	93 718
Mobile handset	39 708	41 341	42 003
Rechargeable batteries	8 442	8 681	10 602

Source: Company's Annual Report; Team's estimates

THIS REPORT WAS PREPARED EXCLUSIVELY FOR ACADEMIC PURPOSES BY BÁRBARA CHOON AND ILONA SHAPOVALOVA, MASTER IN FINANCE STUDENTS OF THE NOVA SCHOOL OF BUSINESS AND ECONOMICS. THE REPORT WAS SUPERVISED BY NUNO VASCONCELOS E SÁ, ACTING IN A MERE ACADEMIC CAPACITY, WHO REVIEWED THE VALUATION METHODOLOGY AND THE FINANCIAL MODEL. (PLEASE REFER TO THE DISCLOSURES AND DISCLAIMERS AT END OF THE DOCUMENT)

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Investment Summary

We issue a **SELL** recommendation on BYD Company (BYD or ‘the Company’) Limited A-shares with a Sum-of-the-parts-based price target of RMB **42.30/sh**, which corresponds to an **11.2% downside** to the current price. Despite being an industrial conglomerate, we believe BYD’s electric vehicle business, as well as associated electric batteries, are its key share price drivers. We acknowledge its market position, upper-streaming integration, a significant expansion in battery capacity and strategic partnerships, reflected in its premium valuation. However, the gradual phase-out of new electric vehicle subsidies by end-2020 and the rising competition will drag down its share price performance. We believe BYD might face profitability challenges in the short term.

Business Description

Company overview

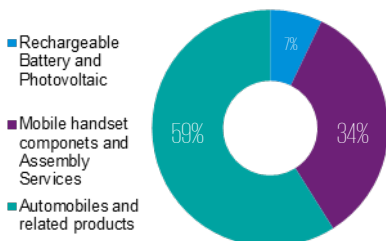
Founded in 1995, BYD Company Limited initiated as a battery producer and entered the automobile market in 2003. Nowadays, BYD is mainly engaged in the automobile business, which includes traditional fuel-engine vehicles and new energy vehicles (NEV). Apart from that, the Company is involved in research, development, manufacture, and sale of rechargeable batteries and photovoltaic business, as well as the production of handset components and assembly services.

The Company has its geographical presence in various regions including Hong Kong, Japan, Europe, India, Mexico, the US, and Brazil, being the core business settled in the People's Republic of China (hereafter ‘China’), which accounts for 87% of the total revenues. BYD is headquartered in Shenzhen, Guangdong, China.

Automobile and related products segment

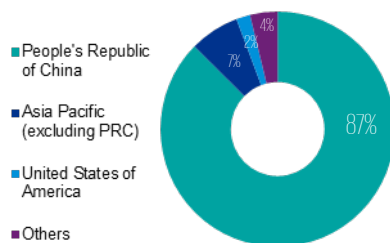
BYD’s automobiles and related products segment is engaged in the manufacturing and sale of automobiles and auto-related components, namely fuel cars, auto parts, dual-mode electric vehicles, and pure electric vehicles. The representative models are conventional fuel cars - F7, S6, and F5 Suri, plug-in hybrid vehicles (PHEV) such as QinPro, Tang and Song, as well as E6 and E5 battery-electric vehicles (BEV). Additionally, the Company has launched commercial vehicles covering “ten market segments: buses, coaches and taxis, logistics, construction, and sanitation vehicles; and vehicles for warehousing, port, airport, and mining operations”¹. In FY2018, the automobiles and related products segment reported revenues of RMB 71,770 million, which represented 59% of the Company's total revenues.

Exhibit 1: Revenue breakdown by product category in 2018



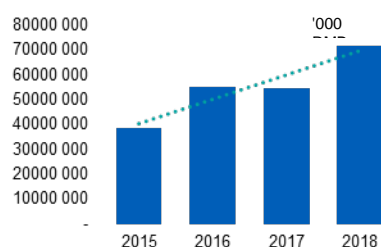
Source: Company's Annual Report

Exhibit 2: Revenue breakdown by locations of customers in 2018



Source: Company's Annual Report

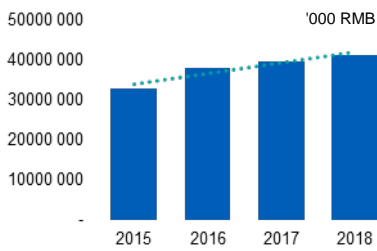
Exhibit 3: Automobile and related products segment revenues (2015-2018)



Source: Company's Annual Reports

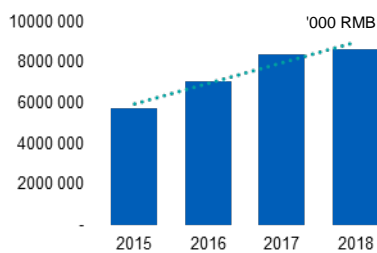
¹ BYD Official Website

Exhibit 4: Mobile handset components and assembly services segment revenues (2015-2018)



Source: Company's Annual Reports

Exhibit 5: Rechargeable battery and photovoltaic segment revenues (2015-2018)



Source: Company's Annual Reports

Mobile handset components and assembly services

The Company's products portfolio also includes handset casings, keypads, and modules with elements such as connectors, microphones, and SIM lid assemblies. Likewise, BYD provides telecommunication related services namely design, testing, assembly, and after-sales. The Company does not produce its brand of whole products; hence, its key clients encompass international cell phone companies such as Nokia, Apple, Samsung, Huawei, HTC, Lenovo, HP, and Toshiba. In FY2018, the mobile handset segment reported RMB 41,340 million of sales, corresponding to 34% of the total revenues.

Rechargeable battery and photovoltaic segment

BYD's rechargeable battery and photovoltaic business segment consist of lithium-ion batteries and nickel batteries applied in electric vehicles, mobile phones, electronic tools, and other portable electronic instruments, along with photovoltaic products. In FY2018, this segment accounted for 7% of total revenues, i.e., RMB 8,680 million.

Company Strategy: Three green dreams - energy acquisition, storage, and application

Green energy solutions, namely electric urban transportation and renewable electricity storage are the core focus of BYD, as part of its vision of a sustainable eco-system to be implemented worldwide, while intending to promote environmentally responsible urban development. BYD positions itself as a pioneer in new energy solutions and is dedicated to build a zero-emission future.

Company SWOT Analysis

Exhibit 6: BYD Company Limited SWOT analysis

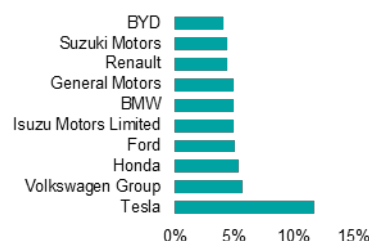


Source: Team analysis

- Operational
- Financial
- Political and Regulatory Environment
- Strategic
- Industry
- Economic Situation

Strengths


Exhibit 7: R&D intensity of selected automakers worldwide 2018 (as % of revenues)




Source: Statista


Robust research and development capabilities: The automotive sector is the world's third-largest industry in terms of R&D, with R&D expenditures being ~5% of revenues of the companies worldwide. BYD's research and development capabilities made it one of the leaders in the global new energy vehicles sector. In FY2018, the Company invested RMB 4,990 million in R&D activities (4.1% of total sales), when compared to RMB 3,740 in FY2017 (3.6% of total sales), in line with the global industry trends. The Central Research Institute, Auto Engineering


Research Institute, and Electric Power Research Institute were founded as a result of strengthened investment in NEV business, focusing on the Company's technological advantages, the introduction of new superior models, as well as enhancement of the battery production capacity.

 **Broad product portfolio:** BYD manufactures and sells a wide range of products, namely automobiles and related products, electric forklifts, mobile handsets, IT products, batteries, and battery energy storage stations.


 **Robust financial performance:** BYD has experienced healthy financial growth over the last years. The Company recorded revenues of RMB 121,791 million in FY2018, suggesting an increase of 18.6% YoY. The net income has remained around 4 billion RMB throughout the last four years. This financial performance increased the brand name and market share over the previous year.


Weaknesses

 **Heavy dependence on China:** A large part of the Company's revenues derives from the Chinese market – 87% in FY2018. Indeed, this heavy dependence on the domestic market makes BYD vulnerable to shifts in the economic and political situation of the country. The Company is exposed to the Chinese macroeconomic downturns, increasing its business risk.


 **Regulatory constraint:** BYD is highly dependent on Chinese government grants and subsidies; thus, small fluctuations might have a significant impact on profit margins, increasing both variable and fixed costs. Hence, regulations represent a strong constraint for the value of the BYD's business, and complete elimination of subsidies could be seen as a substantial threat for the Company.





Opportunities

 **New product launches:** As a result of its intense R&D program, BYD has been focusing on new product launches for better growth opportunities, as the case of the latest 12-meter e-bus model unveiled in Busworld Europe in Brussels, in October this year. Modernization initiatives aim to enhance customer satisfaction and safety while gaining a customer base and topline.

 **Strategic partnerships:** Strategic initiatives as partnership agreements boost the Company's financial growth and consolidate its market position. For instance, in November this year, Toyota Motor Corp and BYD announced to establish a joint venture to design and manufacture battery-electric automobiles as a result of their efforts to produce zero-emissions vehicles, creating an opportunity for new R&D advancements.

Threats

 **Intense Competition:** BYD faces stiff competition from large automotive manufacturers across various markets, with main competitors being China BAK Battery, Hunan Corun New Energy, and Scud Group Limited, among others. This rising competition may result in lower vehicle unit sales and increased inventory, which in turn leads to downward price pressure and consequent deterioration of the operational result.

-  **Increasing costs of inputs:** The rising costs of raw materials, namely processed metal and steel, could negatively affect the operational costs of the Company, which would not reflect in BYD's prices, given the intense competition. Hence, it would take a hit on margins.
-  **Ceasing contracts with joint ventures:** Currently, BYD has know-how in the industry and operates under efficient target (economies of scale on automobile production), which partially comes from strategic partnerships the Company has. The likelihood of renewing contractual agreements with all joint ventures is high, although a ceasing scenario will imply a considerable drop in profitability and consequently, on the price of the share.
-  **Foreign exchange risk:** As the Company exports to 43 different countries, a significant proportion of sales is denominated in foreign currencies, more precisely, the Company's income and expenditures are mostly settled in RMB and US dollar. BYD is exposed to the currency risk, as any fluctuations in exchange rates will have an impact on its profitability. We believe that the likelihood of this adverse scenario is low since the Company has sufficient foreign exchange to meet its foreign exchange requirements².
-  **US-China trade war:** US-China relationship is at its worse in 40 years, and, as a consequence, consumer confidence is weak. The ongoing trade war between the US and China superpower economies has resulted in a sharp decline in bilateral trade, higher prices for consumers, and trade diversifications effects. Indeed, the current war puts pressure on BYD's sales and profit margins as the overall Chinese industry is expected to slow down due to consumer confidence decline and decrease in exportations. Finally, US tariffs on China caused the Company to lose its competitive position in the US, mostly e-trucks, to other players.

Shareholder structure

The total number outstanding BYD's shares is 2,728,142,855³. Accordingly, 915,000,000 shares are listed on the Stock Exchange of Hong Kong LTD. (H-shares), and 1,813,142,855 are on the domestic Shenzhen Stock Exchange (A-shares), all fully paid up. Exactly, 39.0% and 67.2% of A-shares and H-shares, respectively, free float.

BYD's largest shareholder is its executive director, Mr. Wang Chuan-fu, with 512,623,820 A-shares (18.79% of the Company's total issued capital). Additionally, he holds 3,727,700 A-shares in an Assets Management Plan. The second more significant shareholder is LV Xiang -yang, also a director of BYD, holding 14,73% of the Company's capital.

² BYD Company Limited Annual Report 2018

³ Thomson Reuters Eikon

Regarding H-shares, BYD's largest investor is Berkshire Hathaway, Inc., an American multinational conglomerate holding company owned by Warrant Buffett, which holds 225,000,000 H-shares, corresponding to 8.25% of the Company's capital.

The average 3-month trading volume is 75.35k with a turnover ratio of 0.15%⁴ which points out a low turnover frequency of BYD stocks in the market, being, thus, an illiquid stock.

Dividend Policy

The Company's dividend policy focuses on providing investors with reasonable investment returns while maintaining the sustainable development of the Company. If the cash dividend conditions are satisfied and the capital needs for the normal production operations are met, the profit distributed in each year shall not be less than 10% of the realized distributable profit for the year. The cash dividend conditions encompass positive distribution profit in value and sufficient cash flow for the year, positive cumulative distribution profit, as well as an unqualified audited financial report of the Company for the year.

Corporate Governance

BYD's Board of Directors is composed of six elements, one Executive Director, Mr. Wang Chuang-fu – the founder of BYD –, two Non-executive Directors, one of them being Mr. Lv Xiang-yang – the Vice Chairman of BYD – and three Independent Non-executive Directors. The Board meetings are supplied in a way that can timely comply with the Company's duties (quarterly, interim and annual results, announcements, dividend policies, approval of carryover capital results, among others), discussing matters of the Group's overall strategy, operations, financial situation and review the status of regulatory compliance.

The Company enhances the importance of having good and strong corporate governance to further improve the confidence of current and potential shareholders, investors, employees, and the community as a whole. Moreover, BYD puts in place practices to comply with the Corporate Governance "Code" as well as the Rules Governing the Listing of Securities on the Stock Exchange.

Industry Overview

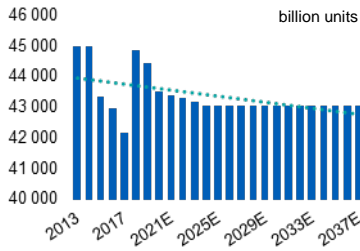
Automobiles and related products

Internal combustion engine (ICE) vehicles slowing down

The automotive industry is being pushed and pulled in several directions, as an effect of strong global trends. Automakers are rushing with the implementation of

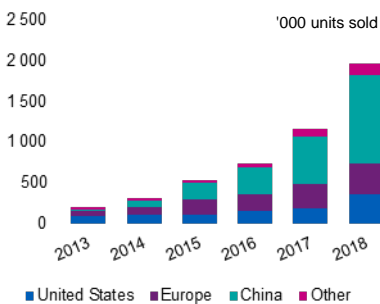
⁴ AASTOCKS Limited

Exhibit 8: Volume for ICE passenger vehicles production in China (2013-2037E)



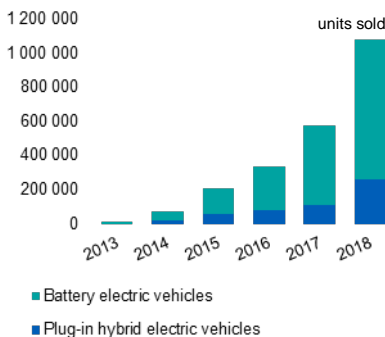
Source: Statista, Team estimates

Exhibit 9: Global electric car sales distribution per region, 2013-2018



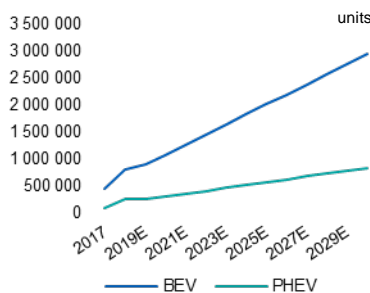
Source: Global EV Outlook 2019

Exhibit 10: Units of new electric cars sold in China (BEV and PHEV) 2013-2018



Source: Global EV Outlook 2019

Exhibit 11: New electric car sales in China (BEV and PHEV) 2017-2030E



Source: Statista; Team's estimates

technological advancements to align their products with the stringent new regulations, while at the same time, maintain their profit margins. One of the most prominent themes in the industry is the cooling down of ICE vehicles, which are being gradually outpaced by new energy cars. Indeed, in the first half of 2019, ICE vehicle sales dropped by more than 5%⁵.

Actions by several countries had been taken to phase-out internal combustion engines, with effective dates ranging between 2025 and 2050. In 2017, the vice-minister of Industry and Information Technology (MIIT) of China, Xin Guobin, announced for the first time that the government was working on a timetable to cease production and sale of fossil fuel cars by 2030 nationwide. In May 2019, the Innovation Center for Energy and Transportation (iCET), released an updated timetable which details the feasibility of the ambitious Chinese goal and puts off the phase-out to 2050. The project aims to decrease China's oil consumption and improve its energy security through investment in renewable energy alternatives. Given this critical disruption, we do not predict a bright future for the ICE industry. In China, production volume has shown a decreasing trend over the years, despite 2018 being an exceptional outlier. A continuous decline is expected, being approximately -3% YoY our estimate for its growth until it reaches a point where the volume of sales of new energy vehicles outnumbers fuel car sales.

NEV nearing the tipping point

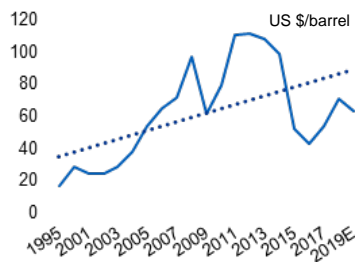
Contrarily, new electric vehicles (NEV) had been on the rise for several years, underpinned by policy measures to promote the deployment of EVs. The global electric car sales exceeded 5.1 million in 2018 when compared to 3.1 million in 2017, almost doubling the number of new registrations recorded in 2017. China remained the world's largest electric car market, with approximately 1.1 million electric cars sold in 2018 and 2.3 million electric vehicles on the road⁵, accounting for almost half of the global EV stock. Europe and the United States followed with, respectively, 0.38 and 0.36 million EV cars sold by the end-2018.

Several factors have shaped NEV attractiveness, mainly governmental policies and regulations, the pump price of fuel, as well as the total cost of ownership (i.e., purchase cost and running costs), and reducing emissions mentality.

Policies and regulations had been the success factor of NEV manufacturers. Measures as the development of power-charging infrastructures, fuel economy standards, and subsidies on low-emissions vehicles are critical economic instruments helping to bridge the cost gap between ICE and new energy vehicles. China, in particular, had an active subsidy program to promote e-mobility.

⁵ Global EV Outlook 2019, prepared by the Energy Technology Policy (ETP) Division of the Directorate of Sustainability, Technology and Outlooks (STO) of the International Energy Agency (IEA)

Exhibit 12: Average annual Brent crude oil price 1990-2018 (in US dollar per barrel)



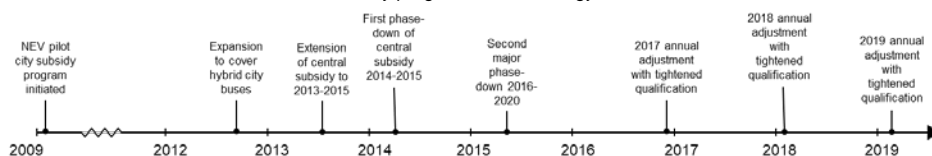
Source: Thomson Reuters

On the other hand, the demand for electric vehicles is driven by increasing concerns with volatile – and rising – petroleum costs. The price of Brent crude oil was used as a benchmark price on the world market. Oil prices climbed steeply in 2017 and 2018, with 24.6% YoY and 31% YoY, respectively, and, despite a slight decrease during 2019 (expected -10% YoY). We believe petrol and diesel prices are likely to rise sharply on the most recent Iran-US tensions⁶. Most of the comparative studies, however, indicate that the total cost of ownership of NEV is still higher than that of ICE vehicles, but it is shrinking rapidly. Indeed, changes in the price of oil and its taxation, as well as more efficient chemistries of batteries, will determine this convergence. By 2030, the total cost of electric cars is expected to be equal to the petrol ones, driving further the demand for electric vehicles.

Industry potential offset by policy headwinds

In 2009, China and the other nine countries initiated a project called New Energy Pilot Cities, which aims at supporting electric vehicle manufacturers through significant central subsidies and other preferential policies. These pilot subsidies and subsequent expansions have strongly impacted the configuration of electric vehicle positioning today. In the past few years, the Chinese government has been continuously reducing its contributions (detailed in **Exhibit 13**) to encourage automakers to compete on their own. The country disclosed its intention to reduce the subsidies in 2019, and ultimately eliminate them by 2020.

Exhibit 13: Timeline of China's central subsidy program for new energy vehicles



Source: The International Council on Clean Transportation (ICCT)

While having aggressive targets for the endorsement of NEVs, paying subsidies is, indeed, an expensive way of government accomplishing its goals. Despite up-to-date data not being publicly available, China's central government announced it handed out 22 billion⁷ RMB in EV subsidies to companies in 2017. Moreover, several local governments offered additional incentives.

The subsidy pressure triggered a downturn of the world's largest NEV auto market, with a slowdown of growth rates in 2019. Indeed, by year-end we expect 8.4% YoY growth from 86.4% YoY in FY2018. Domestic companies are paying for government cut on subsidies losing their competitive advantage, while new foreign automakers are facing a new window of opportunity to push to gain market share in China.

⁶ Ramkumar, A. (2020). Oil Prices Surge After U.S. Strike Kills Iranian Military Leader. *The Wall Street Journal*.

⁷ Bloomberg News (2019). China Considers Cutting Electric-Car Subsidies Again.

Hence, China – the world's leading market player – expects a slowdown in the overall NEV sales. However, we outlook the industry to adapt to the new framework, and, in the long-run, we expect the Chinese BEV and PHEV market to converge to a ~4% YoY growth rate.

Bold public sector electrification program

The global stock of electric buses (e-buses) increased by 25% in 2018, reaching about 460 000 vehicles⁸, pushed by mandates to promote electrification of public transportation and supplemented with subsidies for e-buses.

A complimentary market driver is a lower cost of ownership when compared to diesel buses. Indeed, electric buses traveling between 40,000 and 50,000 km/year are already cost-competitive in regions with high diesel taxation regimes, assuming that battery prices are below USD 260/KWh⁹. Thus, cost reductions resulting from battery technology improvements, as well as ramping up production, results in a negative gap in the total cost of ownership per km between e-buses and ICE buses. Hence, we expect e-buses to substitute the fuel ones gradually and, thus, estimate approximately symmetric growth rates, stabilizing the e-buses long-run rate at ~7%.

China – the most promising country in this sector – accounts for 99% of the global market, summing a total of 400 000 e-buses registered in 2018¹⁰. BYD has a significant presence worldwide, majorly in China, but also in Europe, where it grabs a 20% market share¹¹ of the local e-bus market. Additionally, it exports to Japan, the Republic of Korea, Singapore, and India. Over the last year, BYD broke into the UK, Chile, Jerusalem, Portugal, Chile, and Germany. In October 2019, the Company scored its sizable agreement with Norway as a result of the local electrification program.

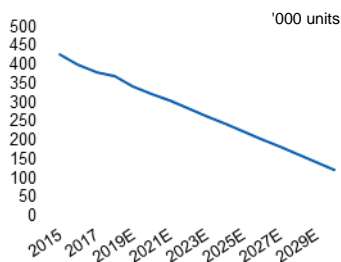
Electric trucks striving for a clean air

We consider the truck industry a homogeneous segment. Since 2010, it has been steady at a 3%¹² growth rate level worldwide, and there is no expectation for significant disruption in the industry.

China remains the world's largest national truck market by volume, presenting in 2017, 1.3 million units sold, which contributes 40% to the global units sold¹².

In recent years, electric trucks (e-trucks) appeared in the market as a cheaper alternative to traditional trucks while also decreasing the amount of local pollution significantly. E-trucks seemed to be the right solution since there was a

Exhibit 14: Total volume of ICE buses manufacturing in China 2015-2030E



Source: Statista; Team's estimates

⁸ Global EV Outlook 2019, prepared by the Energy Technology Policy (ETP) Division of the Directorate of Sustainability, Technology, and Outlooks (STO) of the International Energy Agency (IEA)

⁹ Global EV Outlook 2018, prepared by the Energy Technology Policy (ETP) Division of the Directorate of Sustainability, Technology and Outlooks (STO) of the International Energy Agency (IEA)

¹⁰ PRI. (2019). China dominates the electric bus market, but the US is getting on board

¹¹ BYD Official Website

¹² McKinsey & Company (2018). *Route 2030 - A regional view of truck industry profit pools.*

government stringent on emission norms imposed on commercial vehicles and manufacturers. Hence, we anticipate a substitution of conventional trucks demand by electric ones, although still growing at a steady industry rate of 3%.

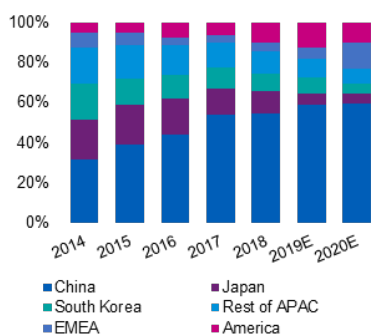
Mobile industry Overview

Over the last years, we have seen China developing into the second-largest economy in the world and penetrating in numerous industries. One of the most critical presences has been the mobile market, where China has a leading position. The Chinese industry is facing a representative growth in 2019, with the launch of the first fifth-generation mobile telecommunications services (5G).

New 5G phones brought a higher share of metal mid-frame, which overcomes the recent declining trend on metal case industry. The metal case is expected to record a high level of growth by end-2019 and 2020 while stabilizing after that.

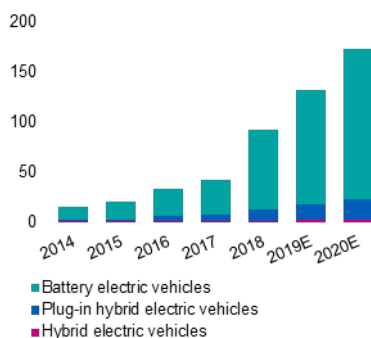
Over 2019, BYD's principal partner, Huawei, has gained significant market share in the market, with a 66%¹³ 3Q19 YoY growth in volume. We expect this strong performance to be held in 2019 4Q and 2020, driving BYD's demand.

Exhibit 15: Global Li-ion battery production capacity split by region (2014-2020E)



Source: Interact Analysis

Exhibit 16: Global electric vehicle lithium-ion battery demand 2014-2020E (in GWh)



Source: Statista, CRU Group, HKExnews

Rechargeable batteries industry in China

Lithium-ion batteries have gained momentum since the turn of the century, and China is in the driver's seat. On the supply side, in early 2019, there were 316¹⁴ gigawatts-hour (GWh) of global lithium cell manufacturing capacity, and China accounted for 59%, with the rest being mainly split between United States, Korea, and Japan. There are currently around 60 manufacturers nationwide¹⁵, with BYD and CATL (BYD's main competitor) concentrating together over half of the total battery market.

From a demand perspective, global lithium-ion battery sales reported a robust increase of 114.6% YoY in FY2018, expecting a 43.0% YoY growth by end-2019. The major factors driving the industry are the emergence of energy storage systems for both commercial and residential applications, declining lithium-ion battery costs, and the increasing demand for new energy vehicles. The energy storage market is predicted significant growth with CAGR of 40.4%¹⁶ over the next five years driven by renewable energy. However, transport is expected to remain the leading market driver, accounting for 68.4%¹⁶ of battery sales, mainly concentrated in the BEV market. Hence, market players are encouraged to expand their battery production capacity, requiring a continuous investment in CAPEX.

¹³ Doffman, Z. (2019). Huawei Shoots Up 66% As Apple Plummets: China Has Given Its Blacklist Verdict. *Forbes*.

¹⁴ Bloomberg NEF

¹⁵ Global EV Outlook 2019, prepared by the Energy Technology Policy (ETP) Division of the Directorate of Sustainability, Technology, and Outlooks (STO) of the International Energy Agency (IEA)

¹⁶ Interact Analysis (2019). *Lithium-Ion battery market poised for strong growth in Europe; Asian players expected to open European factories*.

Valuation

Exhibit 17: BYD Valuation Output

WACC	7,69%
Tax rate	25%
Growth rate (g)	4,94%
Terminal Value	117 699 994
Enterprise Value	149 012 350
Non-operating	25 866 951
Market Value Debt	69 484 030
Cash and Equivalents	10 007 773
Equity Value	115 403 044
# shares ('000)	2 728 142
Price per share (RMB)	42,3

Source: Team's estimates

BYD's operational business was valued using a Discounted Cash Flow (DCF) model. This model yields a price target of **RMB 42.30** for A-shares on the going concern principle. Our assumptions included a **WACC of 7.7%** (beta of 0.50 and a risk-free rate of 3.27%) and a **perpetual nominal growth rate of 4.9%**. Furthermore, in our modeling, non-operational activities were valued at their fair value, leading to an Enterprise Value of RMB 149,012 million. Finally, accounting for excess cash, debt instruments, and other marketable securities, we access the **Equity Value of RMB 115,403 million**. Given negative cash flows in 2019, the Company's cash dividend conditions - required by the Dividend Distribution Policy - are not satisfied. Hence, BYD will not distribute dividends in 2019.

For our valuation and to achieve more accurate forecasts, we have performed an individual analysis for each segment of BYD's activity. Within each segment, the main drivers that better describe its future performance were defined.

Automobiles and related products

For the automobile segment, we performed an individual analysis for each product of the Company's sales mix (ICE, BEV, and PHEV, E-buses, and E-trucks). BYD's automobile sales were forecasted as a **function of units sold** – taking into consideration industry trends – and **average selling price**, while also accounting for the **government subsidy cut**.

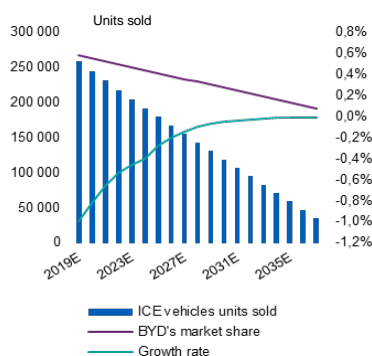
Negative outlook for ICE vehicles

BYD believes that the transition to electric vehicles is an essential step to a less pollution technology and environment, as well as lower dependence on oil supply. Indeed, when considering China's economy size, its domestic reserves are modest, and its dependency on importation leaves space for much volatility in prices. The Company's vision is to phase out the sale of internal combustion vehicles by 2040, which is in line with the Chinese governmental policies.

Based on our trend analysis of the volume of ICE vehicles produced in China, between 2013 and 2019, we estimate a gradual decline of this market, ranging from -0.8% YoY to -0.1%YoY for the forecasted period, grounded on the globally declining demand for internal combustion vehicles.

Taking into consideration BYD's announcement on the phase-out timeline for the ICE vehicles, we expect its market share to decrease over the years. In 2018, BYD accounted for a 0.6% share of the total volume produced, which is suggested to decline ~0.03% each year until reaching zero revenues by 2040.

Exhibit 18: Units of ICE vehicles sold; BYD's market share and growth rates, 2019E-2037E



Source: Team's estimates

China’s government power cut

The subsidy cut for NEVs in 2019 has caused BYD's momentum to slow down while taking a hit on margins. On average, we outlook a 17% subsidy decrease for BEV, a 55% decrease for PHEV, and 45% for e-trucks, while subsidies on e-buses are supposed to nearly triple over the next year (**Annex 2**). In 2020, subsidies for BEV and PHEV are forecasted to be zero. BYD's significant and concentrated EV exposure combined with notable government cuts, makes it a victim in an era of declining government subsidies, with consequently dropping margins. Rolling over to 2020, further reductions on EV subsidies will erode potential demand growth, bringing the gross margin to 23.9%. We believe the margin will stabilize at ~27.3%, as the Company might capitalize on its vertical integration and in-house production of more cost-efficient batteries.

BEV & PHEV drowned

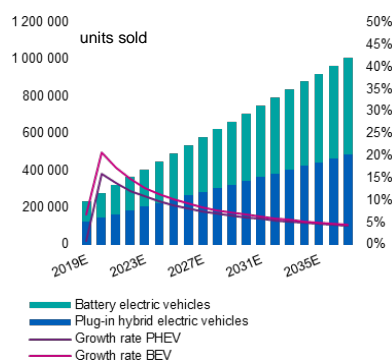
Some strong competitors, like Volkswagen, are leveraging top-tier battery suppliers, namely CATL and Nidec, to bring highly competitive products to the market. Also, the newly built Tesla's Shanghai plant puts BYD under pressure. All factors combined resulted in a slowdown in the growth of units sold of BEV and PHEV. By end-2019, the growth rates are estimated to be 6.9% YoY and 0.9% YoY for BEV and PHEV, respectively, from the 141% YoY and 87% YoY recorded in 2018.

However, we acknowledge BYD's market position while an industrial conglomerate, its upper-stream integration, and brand perception in China, expecting a positive growth over the next years after the subsidy cut recovery, in line with the industry trend. Hence, we believe Chinese industry variations mainly explain BYD's NEV revenues since it is the major market. Given our forecasts for the new electric car sales in China, we predict BYD's revenues as a function of those. Our guidance is for 17.3% and 13.8% YoY growth by end-2021 for BEV and PHEV, respectively.

Apart from its vertical integration and economies of scale, BYD has been leveraging its strategic partnerships. In November this year, BYD and Toyota Motor Corporation announced that they had signed an agreement to establish a joint R&D company for battery electric vehicles. Tie-up with Toyota, although only at the R&D level, opens the door for BYD into Toyota's EV supply chain, which means a revenue opportunity for BYD as well as better preparation to compete against global players. This cooperation could assist the Company to weather through industry challenges in the long-run.

We remain positive on the NEV market prospects and anticipate that a continuous demand from customers, supplemented by innovation and investment

Exhibit 19: Total units of NEV and PHEV sold; and growth rates, 2019E-2037E



Source: Team's estimates

in technology will accelerate the NEV hike in the long-term with both units' growth and revenues stabilizing at ~4%. We outlook for 525 thousand units of BEV sold by 2037, along with 485 thousand units of PHEV, corresponding to ~96 billion RMB and ~134 billion RMB of revenues, respectively.

Electric trucks on a stable rise

By October 2019, BYD's electric truck sales volume has not shown significant signs of improvement, experiencing an increase of 231 units since December 2018, which corresponds to a 3% CAGR.

We outlook the electric trucks segment as a promissory market, which will remain growing at a moderate rate of approximately 3.7% YoY. This growth rate derives from the constant substitution of distribution companies of fuel trucks by electric trucks, as mentioned before.

E-buses hit the road

BYD is the leader in the e-buses market segment, with 12 960 units sold in 2018, slightly down from the 14 873 units in 2017. Overall, we outlook the in-country sales to remain stable while leveraging foreign procurement and continuous government support.

The e-buses boom derives mainly from the environmental regulation strictness and consequent reduction of ICE buses. Based on the declining trend of fuel buses, we anticipate a 6.8% YoY growth for e-buses by year-end. Consistent increases in sales are expected in the foreseeable future, scaling to ~47k by 2037.

Average selling price

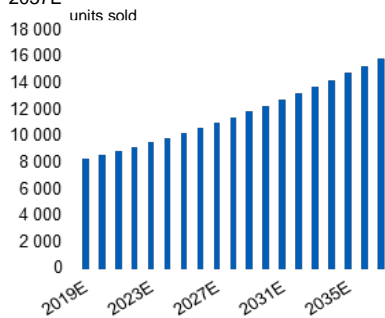
To accommodate different price levels of distinct vehicle types in our revenue forecast, the average selling price (ASP) was estimated for each category, based on the most sold models. As such, ICE passenger cars account for RMB 80k, RMB 180k, and RMB 270k for BEV and PHEV passenger vehicles. As for the commercial vehicles, ASP of e-buses amounted to RMB 550k, while trucks set at RMB 700k per vehicle. We assume the real ASP to remain flat over the years, as with the introduction of new models, i.e., more expensive, older ones devalue. However, we acknowledge inflation to obtain nominal revenues. Based on the past analysis, the inflation rate was assumed to be 2.08% in each year – the average inflation over the last eight years.

Mobile Handset Components and Assembly Services

The major drivers for the mobile segment revenues are the **demand for mobile phones** and the **average price per unit of mobile phones in China**.

On the demand side, we outlook a stable ~1.5% growth of the total volume of mobile phones in China over the years, with a slight increase in 2019, 2.3% YoY,

Exhibit 20: Units of e-trucks sold, 2019E-2037E



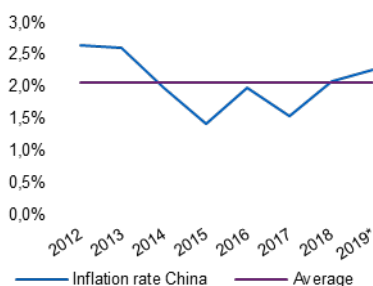
Source: Team's estimates

Exhibit 21: Units of e-buses sold 2019E-2037E



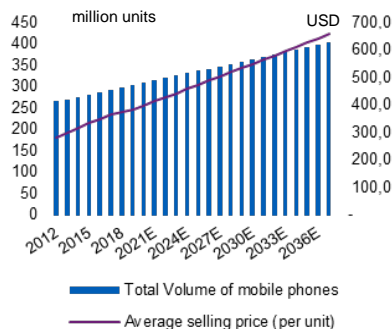
Source: Team's estimates

Exhibit 22: Inflation in China



Source: National Bureau of Statistics of China

Exhibit 23: Total volume of mobile phones sold in China and average selling price 2012-2037E

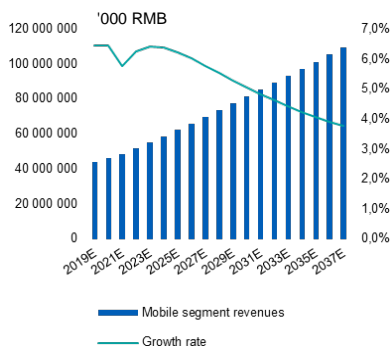


Source: Statista; Team's estimates

due to a robust 5G product pipeline. As for the ASP, similarly, a consistent increase of ~2.5% is expected for the future years.

We anticipate a strong FY2019 and FY2020 for BYD, and, hence, we are bullish with revenues expectations of RMB 44bn/46bn (6.4 % YoY), driven by 1) rise in assembly service to Huawei, Samsung, Xiaomi (main clients), given also the increase in revenues, as a consequence of China's mobile volume and price increase; 2) metal recovering from previous stabilization with the rise in metal mid-frame adoption and the metallic plastic casing with CNC, Computer Numerical Control, in this new era of 5G mobile devices; and 3) glass presenting a steady increase following the previous year's trend of glass screen transformation.

Exhibit 24: Total revenues of mobile segment 2019E-2037E



Source: Statista; Team's estimates

Huawei and Apple partnership in the 5G era: We expected BYD to benefit from the penetration on new Apple's product line, as well as outlook a growth in Huawei's casing and assembly supplied by BYD and expansion of Huawei to India, Brazil and Hungary, which will benefit BYD.

Multiple market integration: BYD growth will come from numerous markets, including tablet, computing, and consumer application, given BYD's diversified product portfolio. It will deliver a higher gross margin and help to stabilize the future growth.

BYD's revenues were forecasted as a function of the industry's volume and prices, embodying the major industry trends. As a result, a growth of 6.4% YoY is estimated by end-2019, while stabilizing ~4% YoY by the end of the forecasted period.

Researchable Batteries Segment

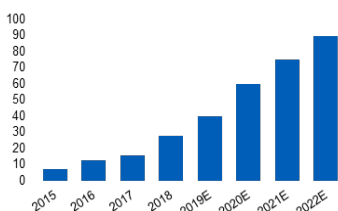
In line with the industry trends, BYD's rechargeable batteries segment is driven by battery capacity expansion, as well as more cost-efficient types of batteries (**Annex 1**).

Battery expansion continues

BYD's power battery capacity - the primary revenue driver - has been increasing throughout the years to address the rising demand and to reap the benefits of economies of scale.

According to China Lianhe Credit Rating Co., BYD's battery capacity expanded from 9GWh in 2015 to 28GWh in 2018, with three significant plants, namely: Huizhou (2GWh), Shenzhen (14GWh) and, newest opened 24GWh power battery factory in Western China's Qinghai province, which grasped 12GWh capacity in 2018 (first phase of implementation). As stated in BYD's 1H19 interim report, the second phase of the total 24GWh design capacity project will be ready

Exhibit 25: BYD's power battery capacity (GWh) 2019E-2022E announcements



Source: Company's data and announcements

by the end of 2019, with the full investment made in 1H19. Therefore, we expect the overall capacity to hit 40GWh by year-end, suggesting a 42.9% YoY increase for battery capacity in 2019.

Currently, a battery factory in Chongqing is under construction and will have an annual capacity of 20GWh, increasing total battery power to 60GWh in 2020. Likewise, BYD announced its plan to construct a plant with a yearly capacity of 30GWh in Xi'an. We anticipate that it will be implemented in two phases as the Qinghai project, namely increasing the total capacity to 75GWh in 2021 and hitting 90GWh in 2022.

Taking into consideration the growing demand for lithium-ion batteries and the robust performance of the business segment, we forecast a significant increase of power capacity for the upcoming years, with consistent investment being made, stabilizing at approximately 4% YoY growth.

Optimistic prospects

When analyzing the segment performance between 2015 and 2018, a considerable portion of revenues, nearly 75%, is explained by variations in the battery capacity of BYD, being the rest 25% split between average selling price changes and other non-recurrent factors. As a result of significant investment, BYD's revenues in the rechargeable batteries segment has been showing a positive trend with an 18.9% YoY increase in FY2017 and 2.8% YoY in FY2018.

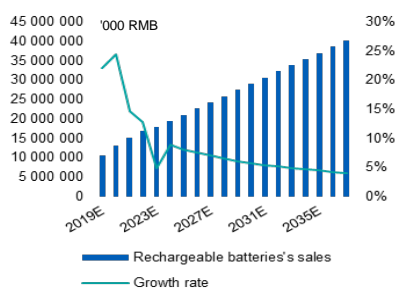
The energy capacity utilization rate remained stable throughout the past years, around 76%; hence, we forecast it to persist continuously for the future period, being the installed capacity the primary determining factor.

The segment revenues were forecasted as a **function of battery capacity utilization** (GWh). As such, we are positive on short-term prospects for the revenues growth, growing roughly ~20% in the next three years, with smoother growth after 2021.

Optimistic forecasts have been built around not only in-house demand arising from new energy vehicles hike, but also the estimated NMC battery sales to external clients, which are expected to take off starting in 2020. In August 2019, the Airbus China Innovation Center (ACIC), a battery lab in Shenzhen, was open in collaboration with BYD to push technology for electric-powered aerial vehicles. Moreover, Volkswagen AG's Audi luxury-car brand is in negotiations to add BYD as a supplier of batteries. With Audi as a customer, BYD will need to step up its investments in battery production capacity once again.

On the costs side, considering the current shifts in the cost structure of batteries produced, a complementary study was conducted (for a more in-depth analysis,

Exhibit 26: BYD's rechargeable batteries segments sales and growth rates, 2019E-2037E



Source: Team's estimates

see Annex 1). Costs of the goods sold were forecasted as a **function of raw material prices** – following a trend analysis – while accounting for **different battery chemistries**. Gross margins are expected to increase from 11.7% in 2019 up to 24% in 2023, as a result of cost efficiencies and economies of scale.

WACC

Since BYD operates in distinct industries, to find an accurate cost of capital, we estimated two distinct WACCs - one for the electronic component (mobile segment) and one for the automobile and batteries segment. It is worth notice that the automobile and the battery segments were not distinguished in our calculations since they could be seen as an integrated industry. The rationale used was identical for both - based on each peer geographical area and operational activity.

As such, the peers' sample, which we believe better defines the industry, was selected based on several criteria. Firstly, we restricted the potential Company's peers only to Chinese ones, given that BYD's operations are mostly centralized in China. Secondly, companies with similar risk-return profiles were selected. Therefore, we do not consider international peers since they would be in a significantly different steady-state position from BYD, with distinct capital structures and risk-returns.

Additionally, for the electronic part, we selected peers that operate in the components and mobile servicing industry, whereas in the automobile/battery segment, peers on the electric automobile industry were selected.

The final WACC was calculated by a weighted average of the electronic and automobile/battery component, considering the weight of the business revenues, which led us to a WACC of 7.7%.

Risk-free rate & Market risk premium: The estimated risk-free rate was 2.29%, using the 10-year China Treasury bond return as a proxy for the risk-free rate and adjusting for the existent country risk premium of 0.98%¹⁷. The market risk premium (MRP) was estimated to be 9.8%, based on the Shenzhen Composite Index. The tax rate considered for our calculations was 25%, the Chinese statutory tax rate, as the companies elected for our estimations are based in China.

Cost of equity: The cost of equity was estimated considering 11 BYD's peers, which were elected based on their raw beta as long as comparables with an entirely different beta from BYD would not be a good estimator for the industry

Exhibit 27: WACC inputs

B unlevered auto & battery	45,08%
B unlevered electronic	59,54%
BYD auto & battery % of total revenues	66,06%
BYD electronic % of total revenues	33,94%
Bu	49,99%
Tax rate	0,25
BYD D/E	0,50
BI	0,69
Risk free	3,27%
Country risk premium	0,98%
Risk free adjusted to country risk	2,29%
MRP	9,37%
Cost of equity (re)	9,69%
Cost of debt	4,89%
WACC	7,69%

Source: Team's estimates

Exhibit 28: Peers sample for Cost of equity calculation

BYD CO Ltd	β_u	Market cap. '000 000
Great Wall Motor Co Ltd	0,45	61 196
Geely Automobile Holdings Ltd	0,58	110 165
Brilliance China Automotive Holdings Ltd	0,40	36 383
Dongfeng Motor Group Co Ltd	0,38	44 657
Zhengzhou Yutong Bus Co Ltd	0,46	32 478
Faw car	0,52	15 160
Harbin Dongan	0,96	2 010
Zotye Automobile Co Ltd	0,57	5 220
Byd Co Ltd	0,35	120 986
Total	0,45	428 255

BYD Electronic	β_u	Market cap. '000 000
Sunny Optical Technology Group Co Ltd	0,48	114 162
Hangzhou Hikvision Digital Technology Co Ltd	0,66	291 032
China Healthcare Enterprise Group Ltd	2,08	260
Byd Electronic	0,39	24 030
Total	0,60	429 484

Source: Team's estimates

¹⁷ Damodaran

forecast. Raw beta was calculated based on the last five years' closing prices monthly data of each stock.

The unlevered beta of the industry was computed by the weighted average of each stock's beta with the market capitalization, prompting a beta of 0.69. In this estimation, BYD was also included to define the forecasted industry. The beta levered was calculated according to the Modigliani Miller formula and used to estimate the cost of equity, according to CAPM. The appraised cost of equity was 9.7%.

Exhibit 29: Cost of debt inputs

Type of firm	1
EBIT 2018	7 678 926
Current interest expenses	2 962 957
Current long term government bond rate	3,27%
Country risk premium	0,98%
Risk free rate	2,29%
Interest coverage ratio	2,59
Estimated Bond Rating	Baa2/BBB
Estimated Company Default Spread	2,00%
Estimated County Default Spread	0,60%
Estimated Cost of Debt	4,89%

Source: Team's estimates

Cost of Debt: In order to derive an adequate cost of debt for the Company, a synthetic rating model was used, which resides in rating a firm based on its financial characteristics. Given the BYD's interest coverage ratio of 2.59 and taking into consideration, it is a developed market firm with a market capitalization of over 5 billion US dollars (Type 1 firm), a Baa2/BBB rating was attributed, which corresponds to a company default spread of 2%. The country default spread for China is 0.6%, which leads us to a 4.9% cost of debt (Cost of debt = Risk-free rate + Company default spread + Country default spread).

As the Company's capital structure and its financial ratios are not expected to suffer any significant changes, the bond's rating will remain approximately constant and, thus, the BYD's cost of debt.

Exhibit 30: Target Debt to Equity Peers

BYD CO	D/E
Great Wall Motor Co Ltd	0,36
Geely Automobile Holdings I	0,08
Brilliance China Automotive Holdings Ltd	0,08
Dongfeng Motor Group Co Ltd	0,22
Zhengzhou Yutong Bus Co Ltd	0,3
Faw car	0,36
Harbin Dongan	0,53
Zotye Automobile Co Ltd	0,44
BYD Electronic	D/E
Sunny Optical Technology Group Co Ltd	0,6
Hangzhou Hikvision Digital Technology Co Ltd	0,2
China Healthcare Enterprise Group Ltd	0,07

Source: Team's estimates

Capital Structure: The capital structure was forecasted to converge to a target industry D/E ratio of 0.5, which goes in line with BYD's strategy to reduce the gearing ratio as low as possible. The target ratio was calculated by a weighted average of the capital structure of each peer, previously selected, and their market capitalization. For consistency, to compute de capital structure, both segments, mobile and automobile/battery, were taken into consideration. Indeed, the target D/E ratios obtained were very similar, 0.4 and 0.6 for mobile and automobile/battery, respectively.

Cash Flow Growth and Terminal Value

The growth rate has significant fluctuations over the forecasted period, however, converging to a stable rate in the long-run of around 4.9%, the terminal growth rate of our valuation.

Accordingly, the terminal value was derived with a WACC of 7.7% and a terminal growth rate of 4.9%, arriving at RMB 113,149 million.

Sensitivity Analysis

In order to verify the accuracy of our final recommendation, a sensitivity analysis was performed regarding our main assumptions. Our analysis aimed to study the effect of a different set of growth rates and WACCs on the share price, i.e., the final output variable. BYD is expected to have a constant terminal growth rate of

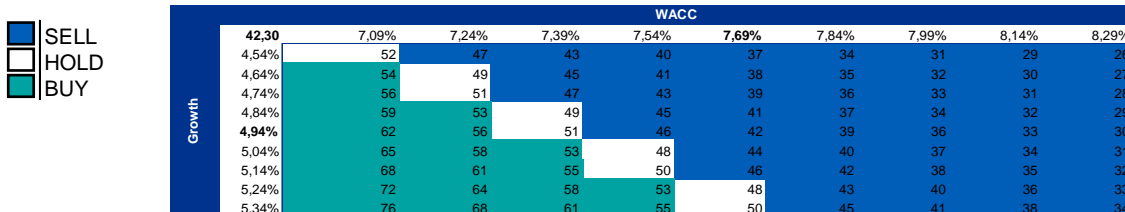
approximately 4.9%, sustained by BYD’s three segments growth. For both WACC and growth rate, a sensitivity test was conducted, with incremental fluctuation of 0.15% and 0.1%, respectively, in both upper and lower directions.

Despite the opposite effects on the share price, our valuation model is more sensitive to changes in WACC. Indeed, considering a stable terminal growth rate of 4.9%, and with incremental variations of WACC (0.15%), only a cumulative decline of 0.3% will change our rating decision to BUY with a share price of RMB 50.79 RMB.

On the other hand, while assuming a stable WACC of 7.7%, only fluctuations over 0.2% on growth will change our recommendation to HOLD the stock, however never issuing a BUY rating.

Concisely, while assessing the riskiness of our model, we confirmed that it is grounded on reasonable input variables and assumptions since most of the computed values do not alter our final recommendation.

Exhibit 31: Sensitivity Analysis with Terminal Growth Rate and WACC as inputs



Source: Team’s estimates

Scenario Analysis

As complementary research, we performed a scenario analysis, considering a bear (more conservative market, i.e., with 0.1% decrease in segment revenues throughout each period), a basic (our key market predictions) and a bull scenario (more optimistic market, i.e., with additional 0.1% of segment revenues in each period).

Our forecast is more sensitive to variations in the automotive business; hence, positive movements in this segment will materially add value to the Company. A bull scenario in the automobile market will result in a 267.7% increase in the share price, while a bear scenario will push the price down by 66.0%.

The rechargeable batteries segment has a lower impact on the Company’s valuation, given its reduced relative share in the sales mix (7%). In a bull rechargeable batteries market, the target price increases by 11.4%, while decreasing 8.5% in a bear scenario.

Mobile segment changes in the opposite direction, meaning that in a bull scenario, the share price drops 4.3%. Indeed, the upside impact on operational results originated by the increase in profit is more than offset by the rise in the

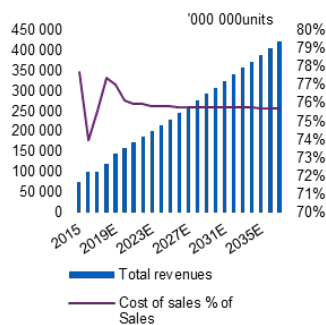
Exhibit 32: Scenario Analysis: Bull and Bear

Bull Scenario	Variation	Price of share	Absolute change	Percentual change
Mobile Driver	+0.1%	40,49	-1,82	-4,3%
Automobile Driver	+0.1%	155,55	113,25	267,7%
Battery Driver	+0.1%	47,10	4,80	11,4%
Actual Price		42,30		

Bear Scenario	Variation	Price of share	Absolute change	Percentual change
Mobile Driver	-0.1%	42,88	0,58	1,4%
Automobile Driver	-0.1%	14,38	-27,93	-66,0%
Battery Driver	-0.1%	38,70	-3,60	-8,5%
Actual Price		42,30		

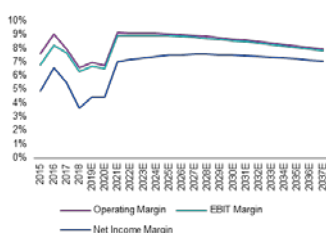
Source: Team’s estimates

Exhibit 33: Total revenue and Cost of sales % of sales



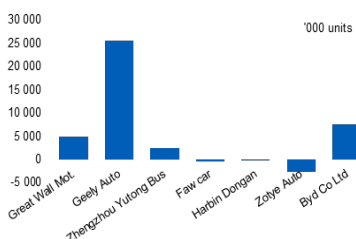
Source: Company's data; Team's estimates

Exhibit 34: EBIT margin & Operating Margin & Net Income margin



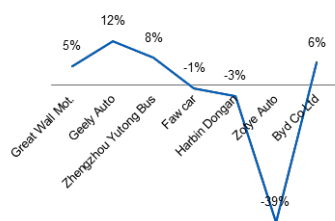
Source: Company's data; Team's estimates

Exhibit 35: Peers EBIT



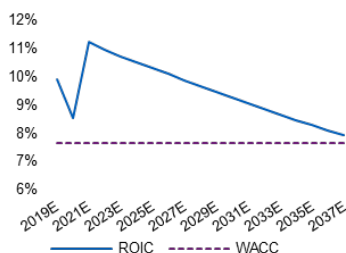
Source: Thomson Reuters Eikon

Exhibit 36: Peers EBIT Margin (2018)



Source: Thomson Reuters Eikon

Exhibit 37: Valuation Model WACC and ROIC



Source: Team's estimates

invested capital. Thus, an increase in the mobile segment will not bring additional value since the invested capital marginal increase counterbalances its marginal benefit.

Financial Analysis

BYD has presented a stable and consistent financial performance over the past years, with positive operating results of around RMB 8 billion (before taxes) in FY2017 and FY2018.

Revenues have been steadily increasing in all business segments, despite a flatter growth rate of rechargeable batteries and mobile segments, 2.8% YoY, and 4.1%, respectively, in FY2018.

In the Company's cost structure, costs of goods sold (COGS) have the most material weight, being ~77% of revenues in FY2018. There is evidence of a slight pressure on operating margins, with an increase of ~3% of COGS weight from 74% in FY2016. The gross profit margins shrank from 26% to 23%, and respectively 8% to 5% on operating margins.

Selling and distribution expenses, as well as Administrative expenses, remained stable throughout the years. Contrarily, Research and Development costs have grown at a rapid pace, increasing ~150% since FY2015. Currently, R&D costs represent 4.1% of sales, being the exponential increase grounded on the necessary investment to be a pioneer in the new energy market and to deliver innovative products.

Overall, costs are estimated to remain stable in the forecasted years. Costs of goods sold of the automobile and related products will remain at ~83.4% of sales while expecting ~72.7% of sales for the mobile segment. Taking into consideration the Company's improvements in battery components and raw materials used in production, rechargeable batteries are projected to decline, pushing the gross margin to ~23.7% by FY2024.

Regarding EBIT, EBIT margin, which ranges between 6% and 8%, goes in line with its competitor's values of 7.5% on average in 2018. For future periods we estimate the margin to follow the past trend, ranging between 7% and 9%.

ROIC/ WACC

A company's fundamental governing objective is to allocate capital efficiently so that the return on capital exceeds the cost of capital. A core test of success is whether one dollar invested in the business generates more than one dollar in the marketplace, which Warrant Buffett calls the 1\$ test. In the terminal year of modeling, BYD's ROIC is 8.05%, whereas the WACC is 7.7%, hence passing the 1\$ test.

By looking at the Company from an ROIC standpoint, it converges to WACC over the forecasted period, despite some fluctuations in between, which is supported by the macroeconomic theory. Indeed, abnormal ROIC over the WACC is not sustainable in the long-run, as there will always be new entrants in the industry due to existent incentives, until there are no more economical or growth profits to be made, converging the industry to regular profits.

Furthermore, ROIC decomposition was performed to identify whether the Company has a competitive advantage and what lies in the foundation of that advantage. ROIC was broken down into NOPAT margin and invested capital turnover, being respectively 7% and 115% in the terminal year, which confirms the BYD's low profit per unit, although high capital efficiency. Hence, we conclude that BYD has a production advantage within the industry.

Despite being a good measure of a company's efficiency when allocating capital, ROIC has some limitations since it provides the rate of return generated on capital that already has been invested, sometimes a long time ago. In our analysis, we considered the return on incremental invested capital (ROIIC) as it properly accounts for irrelevant sunk costs, providing the relationship between additional earnings and incremental investments. In the long-run, BYD's ROIIC converges to 2%, which means that the Company generates a 2% return on each additional unit of capital invested.

Investment Risks

Possible upside risks: 1) Unexpected increase in New Electric Vehicles, beating market expectations, and leading to better than forecasted revenues. 2) The battery composition transition from NCM 532 to NCM 811 to be faster than expected, decreasing battery costs in a faster-than-expected way. 3) A smaller decrease in government subsidies than expected, causing a smaller-than-expected negative impact of Chinese government cuts in subsidies. 4) Postponement of ICE vehicles phase-out.

Possible downside risks: 1) Weaker demand for NEV, which can cause the computed NEV volume unit sales to be overestimated. 2) An unexpected sharp increase in Nickel price, leading to higher battery costs than estimated. 3) Lower than expected growth in production capacity missing BYD's growing expectations and leading to a substantial decrease in batteries revenues. 4) Highly disruptive scenarios of shared mobility and autonomous vehicles establishments.

Annex 1 | Lithium-ion Rechargeable Battery

Rechargeable Batteries Industry Overview

The cobalt market prepares for another ride

The growth in EV battery demand – particularly in China – has been directly affecting all the raw materials involved in the production. In particular, the performance of cobalt has been impacted, raising concerns regarding the long-term supply availability of this mineral. In March last year, cobalt has hit its highest level in 10 years of 95,250USD/MT, before crashing to 25,760USD/MT in July 2019, due to excessive supply and the impact of the U.S.-China trade war.

The global production footprint of cobalt is ushered by the Democratic Republic of Congo (DRC), with nearly 60% of the commodity supply concentrated in the country and being more than 90% of the production shipped to China for refining and processing. In August this year, the multinational trading and mining company Glencore announced it would shut its Mutanda mine, in DRC, from year-end for two years due to low cobalt prices. Since then, cobalt prices have risen almost one-third, and a similar trend is forecasted in the future, with CAGR of 40% by end-2019 and, approximately, 10% in the following five years. As a consequence, rising prices have hit the Li-ion battery producers' margins.

A shift in battery chemistry

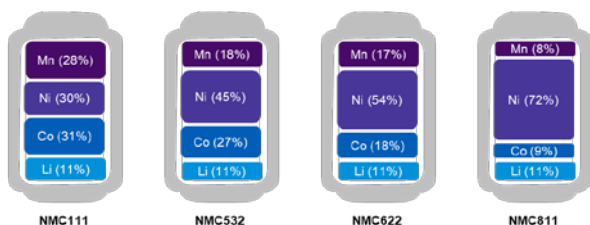
Given the nature of cobalt production, there is a severe dependence of the DRC supply, making it unpredictable and highly susceptible to political and economic risks. Thus, a highly inelastic price-demand relationship drives battery producers to shift to a low-cobalt cathode mix. The general profitability "recipe" used to decrease cost and, at the same time, increase energy density has been to replace the cobalt content of the cathode with nickel.

Cathodes composition is the main differentiating factor between Li-ion batteries. Currently, there are five main types of Li-ion technologies, using a different blend of raw materials. These batteries use lithium ions as the charge carriers between the anode and the cathode, with commonly graphite as the anode. The five leading technologies are:

1. **Lithium cobalt oxide (LCO):** it is applied in portable electronics and has a great performance, being relatively safe. Nonetheless, due to a high concentration of cobalt, it is expensive and thus, not used in EV applications.
2. **Lithium nickel cobalt aluminum (NCA):** it was the first attempt to substitute the cobalt usage in LCO for increased nickel content. It has a good energy density and an affordable price.
3. **Lithium nickel manganese cobalt (NMC):** this technology has several forms, based on the proportion of atoms of each constituent. NMC 111 (equal amounts of the three elements' atoms); NMC532 and NMC622 (with higher energy density and lower prices due to a lower cobalt proportion); and the most recent and advanced one NMC811 (with higher performance). NCM chemistries are mostly used in EV applications.
4. **Lithium iron phosphate (LFP):** it is safer than other cathode chemistries with high power density.

5. **Lithium manganese oxide:** it was used in the first electric vehicles since it has high reliability and lower cost. However, when compared to other technologies, it has low durability.

Exhibit 38: NMC lithium-ion battery types and their key constituents



Source: Developed by team, based on the data provided by the British Geological Survey on battery raw materials

Considering the rising pressure on operating margins, the NCM (Nickel Manganese Cobalt) type of lithium cells has been on the rise, with NCM811 rapidly gaining market share over NCM532 and NCM622. In China, NCM811 already reached a 4% market share. Globally, it is at 2%.

White gold turning into white dust

Additionally, lithium prices have suffered some shifts. Despite the expected increase in lithium demand mainly due to the skyrocket sales of electric vehicles, the metal prices have been falling approximately 4.63% since the beginning of 2019, due to an oversupply problem triggered by the avalanche of new lithium suppliers. A bearish future is expected for the battery raw material lithium, pushing prices further below over the next years, by approximately 10% CAGR.

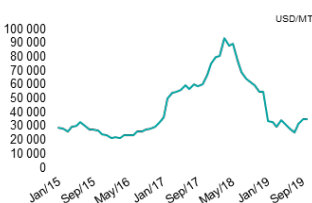
Rechargeable Batteries Valuation

Better Batteries, Better Costs

The main drivers for the costs of batteries sold are the raw material prices and the proportions of those used in production, i.e., different chemistries of cells.

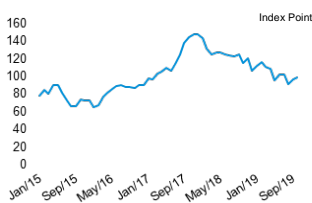
Attending to price fluctuation of lithium and cobalt, a trend analysis approach was adopted for the key raw materials: manganese, cobalt, lithium, and nickel. In particular, a 10% YoY increase in cobalt prices is foreseen in 2020. Likewise, nickel and manganese prices will slightly increase, ~6%, and ~8%, respectively. A further slump in lithium is expected.

Exhibit 39: Cobalt Price



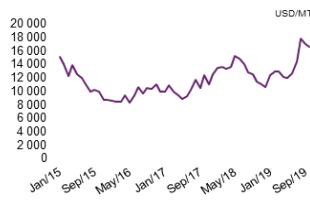
Source: Thomson Reuters Eikon

Exhibit 40: Lithium Price



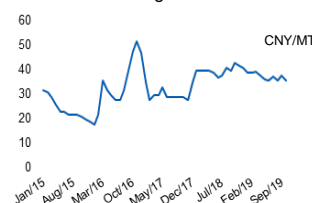
Source: Thomson Reuters Eikon

Exhibit 41: Nickel Price



Source: Thomson Reuters Eikon

Exhibit 42: Manganese Price



Source: Thomson Reuters Eikon

Our model prices-in the gradual introduction of NCM811 batteries to mass-production, which is expected to achieve full-scale in 2024, according to BYD’s announcements. In 2018,

Exhibit 43: Rate of use of different lithium-ion types of batteries by BYD

Type	2019	2020	2021	2022	2023	2024
NCM 532	70%	40%	15%	10%	0%	0%
NCM 622	30%	45%	35%	25%	20%	0%
NCM811	0%	15%	30%	65%	80%	100%

Source: BYD announcements

BYD accounted for 70% production share in NCM 532 batteries and 30% in NCM622.

Different impacts on costs will arise from distinct battery chemistries. We are cautiously positive on the full implementation of NCM811 by 2024, resulting in a slighter cost increase of 5.88% YoY onwards, derived from the increasing prices for raw materials. Gross margins are expected to increase from 11.7% in 2019 up to 24% in 2023, as a result of cost efficiencies and economies of scale.

Annex 2 | Government subsidies estimation

On March 26, 2019, China's Ministry of Finance, Ministry of Industry and Information Technology (MIIT), Ministry of Science and Technology, and National Development and Reform Commission jointly announced a further reduction of government subsidies for new energy vehicles. To qualify for the subsidy, vehicles must meet minimum technical and performance requirements, which are stricter in 2019 for all vehicle types and technologies except for plug-in hybrid commercial passenger vehicles and trucks (Table).

Exhibit 44: Technical and performance requirements

Vehicle type	Technology	Year	Design parameters			
			ER (km)	BD (Wh/kg)	SP (km/h)	FS (%)
Passenger Car	BEV	2018	≥150	≥105	≥100	
	BEV	2019	≥250	≥125	≥100	
	PHEV	2018	≥50			>35
	PHEV	2019	≥50			>40
Commercial Passenger Vehicle	BEV	2018	≥200			
	BEV	2019	≥200			
	PHEV	2018	≥50			>60
	PHEV	2019	≥50			>60
Truck/Vocational	BEV	2018		≥115		
	BEV	2019	≥80	≥125		
	PHEV	2018	≥50			≥40
	PHEV	2019	≥50			≥40

Source: The International Council on Clean Transportation (ICCT)

The majority of BYD vehicles models qualify for the 2019 subsidy, as 1) The electric range is at least 300km for BEV vehicles and 80 km for PHEV vehicles; 2) The batteries used in BYD vehicle models are ternary lithium-ion NCM 523(120 Wh/kg) and NCM 622 (160Wh/kg); 3) The maximum vehicle speed for passenger cars ranges between 140 km/h and 210 km/h; 4) As for PHEV vehicles passenger vehicles produced, their fuel saving compared with standards for conventional fuel vehicles is greater than 40%.

Passenger Cars

The subsidy for battery electric passenger cars is conditioned not only by its electric drive range and battery capacity, but also battery energy density, energy consumption, and ownership type (i.e., privately owned or not). For cars that meet the minimum requirements, the base subsidy is given by the minimum between the subsidy level derived from the electric drive range and the value derived from battery capacity. The final subsidy is subject to three multipliers – a battery energy density multiplier, an energy consumption multiplier, and an ownership type multiplier, as given in the following equation:

$$(1) \text{ Subsidy} = \min(\text{Subsidy}_{ER}, \text{Subsidy}_{BC}) * F_{BD} * F_{EC} * F_{OS}, \text{ where:}$$

Subsidy_{ER} = base subsidy determined by an electric range

Subsidy_{BC} = base subsidy determined by battery capacity

F_{BD} = battery energy density multiplier

F_{EC} = energy consumption multiplier

F_{OS} = ownership type multiplier, 1 for private cars and 0.7 for non-private cars

The portion of the base subsidy derived from the electric drive range was derived, given the different mileage bins. The part of the base subsidy derived from battery capacity is a linear function of battery capacity, CNY550, for each kilowatt-hour (kWh). The battery energy density multiplier is also indexed to different battery density bins.

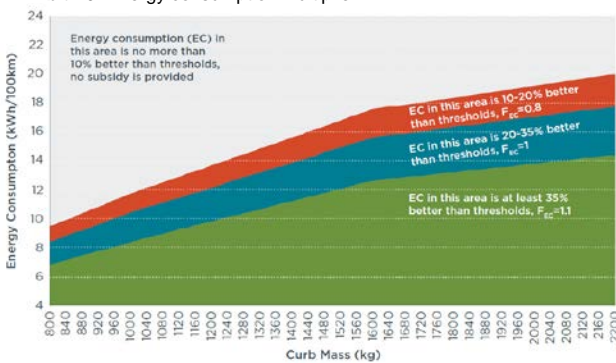
Exhibit 45: Electric drive range and battery capacity determinants

	BEV electric range (R, km)				PHEV electric range (R, km)	
	150≤R<200	200≤R<250	250≤R<300	300≤R<400	R≥400	R≥50
2019	-	-	18 000	-	25 000	10 000
2018	15 000	24 000	34 000	45 000	50 000	22 000

	BEV battery energy density (Wh/kg)				
	105≤BD<120	120≤BD<125	125≤BD<140	140≤BD<160	BD≥160
2019	0	-	0,8	0,9	1
2018	0,6	-	1	1,1	1,2

Source: The International Council on Clean Transportation (ICCT)

Exhibit 46: Energy consumption multiplier



Source: The International Council on Clean Transportation (ICCT)

The energy consumption multiplier is determined by the percentage improvement of a BEV's electricity consumption compared with pre-defined thresholds. The thresholds themselves are a function of vehicle curb mass.

Commercial Passenger Vehicles

BYD produces non-fast charging battery commercial passenger vehicles, which meet the minimum requirements for battery density and energy consumption per kilometer. As such, the base subsidy is the smaller value between the subsidy derived from battery capacity and the maximum subsidy allowed by vehicle length. The final subsidy is then adjusted by a technical parameter relevant to the vehicle type, in BYD's case, the vehicle length.

(2) $Subsidy = \min(Subsidy_{BC}, Subsidy_L) * F_{EC}$, where:

$Subsidy_{BC}$ = base subsidy determined by battery capacity

$Subsidy_L$ = base subsidy determined by vehicle length

F_{EC} = energy consumption multiplier

Exhibit 47: Commercial vehicle subsidies

Technology	Technology	Base subsidy (CNY/kWh)	Max. Subsidy by vehicle length		
			6m≤L<8m	8m≤R<10m	L≥10
Regular BEV	2019	500	25 000	55 000	90 000
	2018	1 200	55 000	12 000	18 000

Source: The International Council on Clean Transportation (ICCT)

Trucks and Vocational Vehicles

The subsidies for battery-electric and plug-in hybrid trucks and vocational vehicles are determined as a function of their battery capacity and are further subject to various ceilings dependent on the type of technology and vehicle weight class (Table)

The per-kWh subsidy rates for BEVs and PHEVs are CNY350 and CNY500, respectively. BYD produces mainly BEV trucks.

Exhibit 48: E-trucks and vocational vehicles subsidies

Technology	Base subsidy (CNY/kWh) 2019	Max. Subsidy by gross vehicle weight (M, kg)			
		M≤3500	3500≤M≤12000	M>12000	
BEV	350	20 000	55 000	55 000	
PHEV	500	-	-	35 000	
Technology	BC (kWh)*	Base subsidy (CNY/kWh)	Cap	Energy consumption multiplier	
Regular BEV	BC ≤ 30	850		0.35≤EC<0.4	0,2
	30< BC ≤ 50	750	100 000	EC≤0.35	1
	BC >50	650			

Source: The International Council on Clean Transportation (ICCT)

* The base subsidy rate is a tiered structure by vehicle battery capacity. A vehicle's total base subsidy is the sum of subsidies of all battery capacity tiers, and the CNY/kWh rate only applies to its correspondent tier.

Estimation of the impact of subsidy reduction

For each of the vehicles type, the most popular models were used as an approximation, namely **BEV** (Yuan; Qin; Song; E6; E5), **PHEV** (QinProDM; Tang; Song), **e-buses** (40' and 60' Electric Transit Buses; 35' and 45' Electric Motor Coaches; 35' and 45' Double Decker Electric Buses) and finally, **e-trucks** (Class 8 Day cab, Terminal tractor; Class 5 and 6 trucks; Class 6 and 8 Refuse trucks).

Given the technical parameters of each of the vehicles, respective subsidies were calculated for 2018 and 2019. Furthermore, an average subsidy for each vehicle type was computed and assumed to be representative in each year. Then, multiplied by the number of vehicles sold in that year, the amount of government subsidies received was computed. The impact of the subsidy reduction was incorporated into the model as an additional cost for the Company.

Similarly, impacts from the further phase-out in 2020 were derived, taking into consideration that NEV subsidies will be discontinued, although subsidies for e-buses and e-trucks will remain similar to 2019.

Exhibit 49: Impact of subsidy reductions (2019 and 2020)

RMB '000					
Type of vehicle	Regulation 2019	Regulation 2018	Impact 2019	Regulation 2020	Impact 2020
BEV	2 315 765	2 800 667	(484 902)	-	(2 315 765)
PHEV	1 249 727	2 749 399	(1 499 672)	-	(1 249 727)
E-buses	975 415	268 239	707 176	1 031 961	56 546
E-trucks	454 512	826 385	(371 873)	471 329	16 817
Total			(1 649 272)		(3 492 129)

Source: Team's estimates

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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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Autonomous Vehicles and the
Potential Impact on BYD

Bárbara Veríssimo Choon 26209

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

Nuno Vasconcelos e Sá

3rd January 2019

Autonomous Vehicles and the Potential Impact on BYD

Abstract

The performance of BYD is very dependent on the automobile segment, making it crucial for an investor to make a more in-depth analysis of the global trends in this area and how that might affect the company's performance. The introduction of Autonomous Vehicles, even though it is still in progress and there is still a long way to be fully implemented, will reshape the traditional automobile market and this way, challenge BYD's leadership position. The competition is getting fierce with new players aggressively investing, and BYD has to be willing to adapt to this new context.

Keyword

Autonomous vehicles, Level of Driving Automatism, Autonomous Vehicle Readiness Index, BYD Company Limited

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Introduction

The world is on the cusp of a large-scale technology revolution. Technology and innovation are transforming the automobile industry at an accelerated pace, and there are two major trends in the market, automated vehicles (AV), and on-demand mobility.

In my individual analysis, I decided to write about self-driving cars, when it is expected to be implemented and the impact it will have in today's shape of the automotive market. Despite the fact that most of us recognize the potential benefits that autonomous vehicles transformation will generate, it is still in an early stage of development and implementation.

I intend to start by identifying the essential landmarks of autonomous vehicles and have a sense of its level of implementation and development. Formerly, I will analyze the impact it can potentially have on our model valuation, more specifically on the automobile segment valuation, and this way understand how the autonomous vehicle in China could affect future conditions of BYD. Finally, I will structure different scenarios, including this impact, and discuss the likelihood of each one as well as its consequences on forecasted periods of each one of the scenarios.

Obstacles and benefits

The implementation of autonomous vehicles is recognized by governments around the world to be a valuable change that could bring several social benefits, namely increased transportation security, efficiency and on the top of that greener cities. But it is also a challenging industry with many obstacles to be mitigated, such as engineering developments, regulatory constraints, lack of automobile industry with standardized technology, and issues regarding consumer acceptance and trust.

The race is on

Self-driving vehicles have their primordial experiments at the end of 20th century, but it is only in 2016 that we start to see significant actions in this field with the beginning of the process of

creation of the Innovation Strategy Development for Connected and Automated Driving, CARTRE and SCOUT by the European Commission.

In 2017 there were two major events in this regard: Audi implementation of the first model with automated driving component at a limit speed of 60 km/h maximum, and Waymo announcement of the beginning of first tryouts of driverless cars, declaring that its cars throughout the year covered approximately 6.5 million kilometers in public roads.

In recent years (2018 and 2019), we saw a more significant move towards this with a dozen countries joining this project. From Volvo, BMW, Mercedes Benz, Chrysler, and Ford to Bosch, Uber, and Apple, started working individually or in collaboration on this highly competitive and rapidly advancing, autonomous vehicle race. It is considered by the IHS Markit that the global sales of AV will increase from 51 thousand units to 33 million, between 2021 and 2040.

In this field, with increasing attention from both traditional automakers and leading innovators from the tech industry, which already accounts for billions of dollars invested in the development of a higher level of automation, several measures, and tools of analysis and evaluation were developed. In my analysis, I will give a deeper view of two of them, the ones I think are of major importance, and that better describe the stage of implementation that AV is positioning, which are the level of driving automation and the Autonomous Vehicle Readiness Index (AVRI).

Levels of driving automation

SAE, the Society of Automotive Engineers, plays a vital role in the interpretation of the level of implementation of this innovative market since it created a map (Annex 1), where it characterizes in which stage, from 0 (fully manual) to 5 (fully autonomous), of automatism an automobile is inserted, this metric serves as the industry most-cited reference for automobile intelligence level and automation capabilities level.

Despite the investment and beliefs in the future of autonomous vehicles, it was only reached private vehicles qualified as level 2, the Autopilot Tesla, the Cadillac Cruise System, and the Traffic Jam Pilot Audi A8. At this level, there is some level of automation being the automobile able to manage both steering and acceleration and deceleration of advanced driver assistance systems (ADAS) capabilities autonomously. And level 4 ridesharing vehicles, for example, NAVYA is already selling level 4 shuttle and cabs in the U.S., with a maximum range of speed of 55 km/h, and WAYMO recently launched a self-driving taxi service. The level 4 vehicles already have high driving automation, where the automated system monitors the driving environment.

There is still no evidence of level 5 cars, not because of technological developments but because of regulatory, technical, safety, behavioral, and legal issues.

The AVR Index

The AVRI is an index design to concede a level of preparation and openness to AV technology among 25 countries.

This index is calculated taking into account the following indicators: Policy and Legislation, Technology and Innovation, Infrastructure, and Consumer Acceptance. It combines 25 variables among the four pillars to come up with a single score for each country (Annex 2).

China positioning and stage of implementation

Autonomous vehicles are revving up in China, despite the latecomer to the self-driving cars that only happened in 2018. China started investing a lot in this area and is showing relative improvements in the technology and innovation on autonomous driving technologies.

Regarding the level of driving autonomous in 2019, China is producing vehicles of level 3 of driving automation, and the optimists believe it would exist a mass deployment of level 4 and above cars, meaning vehicles considered to have automated driving features.

If these beliefs turn out to be a reality, they will represent extensive adjustments in the automobile industry, shifting the market share of the mobility market value away from products

(producers and sellers) towards mobility services providers (paying for transportation, e.g., "robo-taxis"). Additionally, it will represent significant changes in the volume of units sold, considerable restructuring in automobile companies' technological standards, and a sizable increase in competition between the traditional automobile producers and new autonomous vehicle producers.

Respecting to AVRI, China is positioning in the 20th place in the ranking, and it is considered to have a lot of policy and legislation constraints still and to be a good positioning country with regards to consumer acceptance. There are countries with much better prospects of implementation of AV shortly, for example, the Netherlands, the readiest country in the world, already implemented autonomous vehicles on public roads in 2019.

In 2018 China started to show essential movements in this area, with the Chinese government allowing for the first time to conduct official tests of AVs on public roads.

IHS Markit, a research firm, predicts that by 2040 China will sell 14.5 million units of autonomous cars out of the 33 million units estimated. Nevertheless, some specialists believe that the introduction of AV could be slower due to China's complex traffic and the high number of cars. AV has to be able to adapt to road conditionings and aggressive driving behaviors.

Impact of Chinese implementation of AV in BYD

BYD's total revenues in 2018 depended 59% on the Automobile and related product segment, hence it is expected to face many changes in future periods related to this implementation. I predict the introduction of AV in the Chinese market to harm BYD revenues in this segment, mostly because of two reasons.

Firstly, we see a lot of new Chinese companies entering this market, both traditional and high tech companies that are investing much more aggressively in this area than BYD; some of them are already performing tryouts of autonomous vehicles. BYD, with a leadership position in China, is probably going to lose some market share with all this competition.

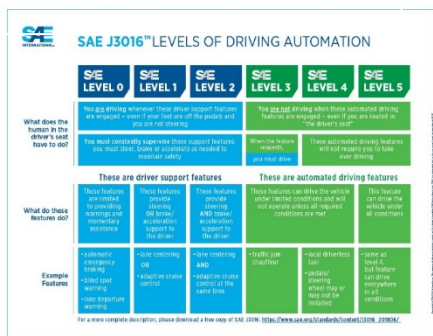
Additionally, autonomous vehicles will likely shift a lot of market share from the automobile product itself toward transportation services. This change will create drastic changes in the conceptual automobile business model, causing a decline in the sales volume in China.

For my analysis, I created two different scenarios. In the first scenario, I considered an optimistic view where I believe that the market share declines both due to competition (entering of tech companies) and due to the increase in automobile servicing which will cause a decrease of 0.02% per year from 2030 onwards until it reaches a cumulated 1% loss and it stabilizes. This impact starting in 2030 is consistent with the consensus of the implementation of AV in China 10 years from now. The second scenario will be more conservative, which believes that the same impact will occur, but due to environmental complexity and regulations constraints, the AV will only be implemented in 2032. In both scenarios, the decrease in automobile segment revenues will reflect in a reduction of the share price to RMB25 (Annex 3).

Conclusion

Summing up, the implementation of autonomous vehicles in China is a concerning topic for BYD, since it challenges BYD's dominant position in the automobile segment. This change will disrupt the current automobile industry; nevertheless, despite the optimists, it is still a reality that is far from being implemented.

Annex 1: Level of Driving Automation



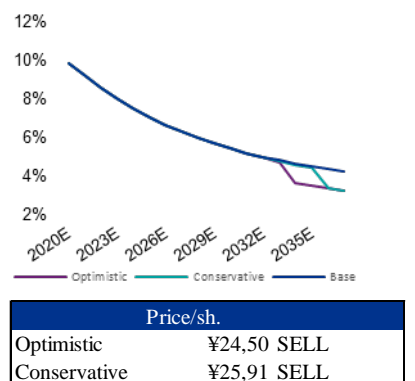
Source: 2019, SAEJ3016

Annex 2: AVRI Ranking

Rank	2019	2018	Country	2019 score
1	1		The Netherlands	25.05
2	2		Singapore	24.32
3	n/a		Norway	23.75
4	3		United States	22.58
5	4		Sweden	22.48
6	n/a		Finland	22.28
7	5		United Kingdom	21.58
8	6		Germany	21.15
9	8		United Arab Emirates	20.69
10	11		Japan	20.53
11	9		New Zealand	19.87
12	7		Canada	19.80
13	10		South Korea	19.79
14	n/a		Israel	19.60
15	14		Australia	19.01
16	12		Austria	18.85
17	13		France	18.46
18	15		Spain	15.50
19	n/a		Czech Republic	14.46
20	16		China	14.41
21	n/a		Hungary	11.99
22	18		Russia	8.55
23	19		Mexico	7.73
24	20		India	6.87
25	17		Brazil	6.41

Source: 2019, "Autonomous Vehicles Readiness Index". KPMG International

Annex 3: Forecasted Growth for Automobile Segment



Source: Own estimates