UCD Michael Smurfit Graduate Business School

Recommendation Date: April 18th, 2020.

Vertex Pharmaceutical Company Report

In our assessment, Vertex is under-valued by 5.4%.

Strong current sales growth (18% in 2020) and market control will lead to consistent sales growth.

COVID-19 to impact the development of the pipeline. This will delay the diversification of the product line till 2027, where diminishing returns will hamper the value of Vertex.

Pipeline with significant growth potential to keep an eye on for any investor.

Strong market performance in the past week (+10%) has taken from the potential upside.

Key Metrics:

Ticker: VRTX

NAICS: 325412

Market Cap Current: $70.120B

Implied Equity Value: $74.145B

P/E: 54.68

EPS: 4.51

Dividend Yield: N/A

Share Price: $270.46

Target Price: $284.08

Valuation: -5.4%

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Recommendation:

Hold

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Company Overview:

Vertex Pharmaceutical is a global pharmaceutical company that creates transformative medicines for people with serious diseases with a focus on specialty markets. Their current line of commercial products consists of 4 different Cystic Fibrosis (CF) products. These products are currently approved to treat 90% of patients who have Cystic Fibrosis in their target markets. The main markets for CF are North America, Europe, and Australia.

Vertex Pharmaceutical has a well-diversified pipeline consisting of treatments for other kinds of illnesses and diseases. These have been acquired through internal research and development and acquisitions.

Key Metrics for Growth:

The key metrics for revenue growth for Vertex:

- Gaining further approval for their existing drugs.
- The emergence of new treatments to market.
- New competition in the market.

Effect of COVID-19 on Vertex's Operations

Vertex develops and produces drugs that treat serious and life-threatening diseases. As per the company 10-K report, Vertex outsources its manufacturing to third parties, and so they do not have direct control over the manufacturing facilities. As per an announcement made by the CEO on the 27th of March 2020, Vertex remained confident that they would be able to continue the supply of essential medications to patients who are dependent on them. The manufacturing facilities have remained open and operational and will continue to do so. Vertex also has an "ample supply to meet commercial needs well into the future". We believe the manufacturing facilities are to remain open and there will be a continuous supply of raw materials to these facilities.

The Johnson & Johnson (JNJ) first-quarter earnings call was used as a reference for the potential impact that COVID-19 has had on the pharmaceutical industry. From the earnings call, Johnson & Johnson reported that COVID-19 did not affect their manufacturing performance or the sourcing of raw materials.

Vertex has made proactive changes to the clinical trials that are ongoing, and this is in line with recommendations from the FDA. The clinical trials that are currently ongoing will continue uninterrupted to the best of their ability. Home delivery of medications and virtual clinic visits will try to ensure that testing procedures are still followed. There will be no new enrolments onto existing tests nor will tests commence until further notice by the FDA. Due to the makeup of their pipeline and the risk levels of the patients to COVID-19, we believe that there will be a significant delay in the current development process, and it will delay certification of future products.

Effect of COVID-19 on Vertex's Revenue

COVID-19 should not impact the current sales of Vertex. Due to the known implications that COVID-19 possesses and the extreme impact it can have on patients with respiratory disease, CF patients have been advised to isolate themselves. Using information from the WHO for the Chinese outbreak, patients with chronic respiratory disease had a death rate of 7 times the death rate of patients with no pre-existing conditions. The death rate by age was also examined. The death rate was 0.2% between the ages of 10 and 40, while there were no fatalities reported for those under the age of 10. We expect the CF patients will be vigilant in terms of self-isolating and that the death rate of CF patients to be minimal.

Patients who require CF drugs are regarded as being high-risk patients and the continued supply of these drugs is essential. The candidates for these drugs are known from birth as a simple test is carried out to identify infants who have CF. Once they become of age, as designated by the patent, the patient can start to receive the relevant medication. We do not believe there will be any delay in patients receiving the medication.

Using information from the JNJ earning's call, they found favorable benefits in both the US and European markets. The drugs that were affected were for non-life-threatening conditions and post-surgery. We are confident that COVID-19 will not affect the revenue of Vertex.

Reimbursement is a potential risk for Vertex. In Europe, governments must agree to reimbursement arrangements with Vertex before the drug is made available. In the UK, there was a 4-year standoff over the approval of Orkambi, Symdeko, and Kalydeco. This was due to the high price Vertex was expecting for their drugs. The additional cost of COVID-19 on European Healthcare may result in lower reimbursements in the future.

Future sales of the current pipeline products will be affected by COVID-19. We will discuss this in more detail in the pipeline section.

Company Commercial Portfolio

The current product line can be seen in the table below.

Major Commercial Products	Indication	Initial Year of Approval	United States Patent Expiration	European Union Patent Expiration
Kalydeco	Cystic Fibrosis	2012	2027	2025
Orkambi	Cystic Fibrosis	2015	2030	2026
Symdeko	Cystic Fibrosis	2018	2027	2028
Trikafta	Cystic Fibrosis	2019*	2037**	2037**

* US only. ** Expected Patent Expiration. Source. Company 10-K and Author's work.

Cystic Fibrosis

Cystic Fibrosis (CF) is a life-shortening genetic disease that affects 75,000 people in North America, Europe, and Australia. There are more than 1,700 different mutations of the same disease. The life expectancy of patients before any treatment being available was that of an infant or a young child. Nowadays the average life expectancy is 37.5 years. Patients currently require daily dosages of the treatment.

The Effect of Competition

Vertex's current product line consists only of cystic fibrosis products. Several potential competitors are coming into the market. These include AbbVie, Eloxx Pharmaceuticals, Proteostasis, and Translate Bio. AbbVie is only in pre-clinical development with its product, whereas the other competitors are currently in clinical stage 1/2. These pose the most significant risk to vertex's control of this market. The list of the different competitors and the probability of the drug coming to market, using historical probabilities, can be seen in the table below. The historic probabilities are based on the type of drug being manufactured (small molecule, large molecule, etc.) and were obtained from the American Society of Clinical Pharmacology and Therapeutics. The time to market data was obtained from Van Norman (2016) and adjustments were made to account for COVID-19.

Using historic data to calculate the average time of drugs to get approval to market, the expected time of the drugs to enter the market is also presented in the table below.

Major Commercial Products	Company Name	Current Stage	Probability of getting to market [1]	Time to Market (Years)
CF-Combo	AbbVie	Preclinical	3%	12
ELX-02	Eloxx Pharmaceuticals	Clinical Phase 1/2	20%	8
PTI-428	Proteostasis	Clinical Phase 1/2	20%	8
MRT-5005	Translate Bio	Clinical Phase 1/2	20%	8

Source. Author's work and The American Society of Clinical Pharmacology and Therapeutics.

The effect of competition on vertex's sales forecast will be done in line with the findings of Grabowski (2013), where generic competition contributed to a sales decrease in the first year of 11%. Subsequent years saw sales decrease exponentially before steadying off after 5 years at about 10% of the peak sales. Analyzing historical trends of competition in recent years, this trend was followed.

A Relvar/Breo combination drug, which is a respiratory drug of GSK, experienced a 13% drop in sales in 2019 when a generic drug entered the market. Another example of this is Lipitor. Revenue decreased by 8% with the emergence of competition in the US market (the largest market for Lipitor). The patent for the EU expired in 2012. The true rate of decline would have been slightly larger than the 8% reported. This shows that an 11% sales decline in the first year is acceptable. The total revenue of Lipitor was $1.7 billion in 2016, which is slightly more than 10% of the peak sales ($13 billion). This shows that the assumption of 10% of peak sales is generated 5 years after patient expiration holds.

The price of drug products is also affected by generic competition. In a report published by the FDA (2019), with an increase in generic drugs to the market, the cost of producing the drug decreases. For 1 generic drug to enter the market, there was a 39% decrease in the cost of the drug. This increased to 54% with two competitors, and this trend continues as more competitors enter the market. The price of the drugs on the market does not fall until several competitors have entered the market. This was due to wholesalers increasing the price of generic drugs to maximize returns. Once several generic drugs entered the market, the price of the drug would fall significantly.

An example of this is Lipitor, in 2011 it came off patent and faced competition from 2 generic drugs. The price of the drug remained the same (c. $1,939 per annum). Once further competition arrived, the price of the drug declined. The price of Lipitor in 2018 was as low as $3.80 per month in the US and £0.70 per month in the UK. This pricing trend backs up the exponential fall in revenue expected with increased competition.

Breakdown of the individual products and the sales forecasts of the current portfolio.

Sales Forecast

The sales forecast will be done in three parts, the current products that Vertex has on the market, those of its' pipeline, and the out-licensed products. The combination of these will result in the overall sales forecast.

To forecast the sales figures, we used the historical growth figures of Kalydeco and Orkambi as these are the clearest indication of the growth rates expected for CF drugs on the market. The forecast was calculated using the following:

- We forecasted the current portfolio as one product. This is because all the products are sold in one package in foreign markets, the market of patients is the same and the price of the drugs are very similar. This will allow for the growth rate to be calculated more efficiently. We will adjust the growth depending on competition entering the market.
- With the addition of Trikafta, 90% of the current population of patients (75,000) with CF can be treated by the current portfolio. We do not expect all patients to be receiving the treatment due to the high cost associated with the product.
- There would be no potential competition for the market till 2027 due to the impact of COVID-19 and current patent expirations. We will account for this with an 11% decline in revenue in 2028 and 2029. This is in line with the effect of competition as outlined above.

Sales in 2020

We expect the EMA to approve Trikafta in Q4 of 2020. This is in line with the usual period between approval in the US and the EU. Ireland has already made an agreement with Vertex for Trikafta and we believe partial sales for this will be realized in 2020. We do not expect any other European country to make an agreement with Vertex for Trikafta in 2020. Most other European countries will agree with Vertex in 2021. This is in line with historical trends for the other products.

Due to the strong performance of Trikafta in Q4 2019 ($420 million), the sales figure of 2019 increased by 36.9%. We expect strong sales of Trikafta to continue through 2020. We believe that the sales will increase by 180% (equal to that of Orkambi in its second year) to account for the four quarters of the year and patients transferring from other drugs to Trikafta.

We also expect Orkambi and Kalydeco to decline in line with the introduction of Trikafta. The UK patients who got approval for these drugs will cancel out with the Irish patients who will switch to Trikafta. We see a 5% decline in Orkambi and an 11% decline in Kalydeco in 2020. Overall, this should see an 18% increase in sales revenue for 2020.

The predicted sales figure ($4.92 Billion) is lower than the revenue projection that the management have presented ($5.1 Billion) as their expected revenue for this year. We are in line with other analysts' expectations as their average expectation is $4.8 Billion in sales this year.

Subsequent Years

For subsequent years we expect Trikafta to follow the historic growth cycle of Kalydeco. New patients include both patients transferring from other Vertex products and new patients for Vertex. We expect the overall sales growth to start to decline from 13% in 2021 to 5% in 2023 as the sales growth of Trikafta matures. Kalydeco and Orkambi will follow constant growth declines as their patients continue to transfer to Trikafta.

We expect a drop off in sales growth as the products begin to become stale on the market and we expect no additional age class to be added to the patents. From 2024 to 2027 we expect growth rates to be relatively flat over this period (2.3% to 1.8%). This is in line with Vertex beginning to reach market saturation. We expect that Vertex will be below the average CAGR of the industry at this point as they would not have had a new product in 5 years. This is in line with historical data. With no outside competition and patients requiring daily doses, this growth rate is expected. The main driving force of sales at this stage is additional patients coming onto the market.

We then applied the competition effect of -11% growth as mentioned above for 2028 and 2029.

The sales forecast for the current portfolio can be seen below.

Year	2016	2017	2018	2019
Revenue	1,683,022	2,165,480	3,038,325	4,160,726
(Growth %)	71.328373	28.666173	40.307230	36.9414
Total Patients	5412	6963	9770	13379
Cost per Patient (USD)	311,000	311,000	311,000	311,000

Year	2020 E	2021 E	2022 E	2023 E	2024 E	2025 E	2026 E	2027 E	2028 E	2029 E
Revenue	4,927,316	5,593,045	6,147,344	6,494,803	6,647,209	6,781,869	6,916,408	7,046,798	6,271,650	5,581,768
(Growth %)	18.4244	13.5110	9.9105	5.6522	2.3466	2.0258	1.9838	1.8852	-11	-11
Total Patients	15844	17985	19767	20884	21374	21807	22240	22659	20167	17948
Cost per Patient (USD)	311,000	311,000	311,000	311,000	311,000	311,000	311,000	311,000	311,000	311,000

Pipeline

Vertex is actively trying to diversify its current portfolio to include a broader range of products. They have historically spent significant amounts in their R&D and they are now beginning to realize the results of their hard work.

The pipeline of Vertex can be seen in Table 2 below.

Table 2. The current pipeline of Vertex.

Major Commercial Products	Target Indication	Stage	Probability	Time to market
VX-561	Cystic Fibrosis	Clinical Phase 2	25%	7 Years
VX-12+ Tezacaftor + VX-561	Cystic Fibrosis	Clinical Phase 2	25%	7 Years
VX-150	Pain	Clinical Phase 1	10%	10 Years
CTX-001	Sickle Cell Disease	Clinical Phase 1/ 2	20%	8 Years
CTX-001	Beta Thalassemia	Clinical Phase 1/ 2	20%	8 Years
VX-814	AATD	Clinical Phase 2	25%	7 Years
VX-864	AATD	Clinical Phase 1	10%	10 Years
VX-147	Apol1 – Mediated Kidney Disease	Clinical Phase 1	10%	10 Years

FDA and Vertex Stance on the Approval Process with COVID-19

The current stance of the FDA is that all clinical trials that are currently in process are to continue until completion if possible. There is a suspension on trials starting until further notice and the addition of patients onto an existing trial. This will not affect drugs seeking marketing approval or the rollout of drugs that have already gained marketing approval. The CEO of Vertex in an announcement stated that they were following these guidelines and were conducting trials virtually and were monitoring patients from afar. Vertex's main pipeline is centered around Crispr Therapeutics. In an announcement by Crispr to the SEC, there will be a delay to current testing due to limitations in the number of beds available at hospitals and the potential exposure to COVID-19. We believe this will affect Vertex and its' competitors to the same extent.

We believe this will also delay the approval process of the drugs. It is hard to determine the additional delay that coronavirus will cause. To determine the time to market for each of the drugs we used historical data. From a paper by Van Norman (2016), the range in time to market for the different stages is shown. The average range of Phases I, II, and III is 2-4 years. Due to the impact of coronavirus on clinical trials, we assumed that the time to market for all drugs will be the longest time to market for each stage. This is also in line with the longest timeframes specified by the company in the 10-K report.

Revenue of the Pipeline

To forecast the revenue of the pipeline we used the following:

- Timeframe to market-based on Van Norman (2016) with relevant adjustments for COVID-19.
- The cost of drugs using the price of similar drugs on the market of the same type (small molecule, gene therapy, cell therapy, Etc.)
- A factor will be applied to the number of people suffering from the target disease and it will be divided by the population of patients of the reference drug.

- We only forecasted drugs that are within the timeframe of our forecast (2029). All other drugs are incorporated into the terminal growth rate.

VX-561

This is a treatment for pain developed by Vertex. Using a slightly altered version of their Kalydeco product, Vertex hopes to be able to find a non-opioid pain relief drug. The breakdown of the forecasted sales can be seen in the tables below.

VX-561	
Current Clinical Phase	2
Type of Drug	Small Molecule
Expected Year on Market	2028
Probability of Getting to Market	25%
Drug Reference	Kalydeco

Year	2027 E	2028 E	2029 E	2030 E
Revenue (Thousands)	42,911	92,821	115,938	157,919
Growth Rate (%)		116.3098255	24.90405	36.21003
Number of Patients	138	299	373	508
Cost of Drug (USD)	311,000	311,000	311,000	311,000

VX-12+ Tezacaftor + VX-561

This is a combination CF drug that Vertex has produced in the hope to further advance the treatment of CF. We used Trikafta as this is the other combination drug that Vertex has as a guide for sales growth and the cost of the drug. The forecast for this drug can be seen below.

VX-561+Tezacaftor + VX-12		
Current Clinical Phase		2
Type of Drug		Small Molecule
Expected Year on Market		2027
Probability of Getting to Market		25%
Drug Reference		Trikafta

Year	2027 E	2028 E	2029 E	2030 E
Revenue	105,026	294,074	423,466	525,098
Growth Rate (%)		180	44	24
Number of Patients	338	946	1362	1689
Cost of Drug (USD)	311,000	311,000	311,000	311,000

CTX-001 – Beta Thalassemia

This is a drug in development with Crispr Therapeutics. Beta Thalassemia is a cell therapy candidate and the potential market size for this drug is 60,000 patients. We used historic sales figures for Kymriah, a cell therapy drug from Novartis, as an indicator of the forecast.

CTX-001 Beta Thalassemia			
Current Clinical Phase	1 & 2		
Type of Drug	Cell Therapy		
Expected Year on Market	2028		
Probability of Getting to Market	25%		
Drug Reference	Kymriah		
Reference Sample	3,200		
Drug Sample	60,000		
Year	**2028 E**	**2029 E**	**2030 E**
Revenue	28,125	356,250	1,303,125
Growth Rate (%)		1166.667	265.7894737
Number of Patients	91	1146	4191
Cost of Drug (USD)	311,000	311,000	311,000

CTX-001 – Sickle Cell Disease

This is a drug in development with Crispr Therapeutics. CTX-001 Sickle Cell disease is a cell therapy candidate and the potential market size for this drug is 300,000 patients. We used historic sales figures for Kymriah, a cell therapy drug from Novartis, as an indicator of the forecast.

CTX-001 Sickle Cell	
Current Clinical Phase	1 & 2
Type of Drug	Cell Therapy
Expected Year on Market	2028
Probability of Getting to Market	25%
Drug Reference	Kymriah
Reference Sample	3,200
Drug Sample	300,000

Year	2028 E	2029 E	2030 E
Revenue	140,625	1,781,250	6,515,625
Growth Rate (%)		1166.666667	265.7894737

Number of Patients	67	849	3103
Cost of Drug (USD)	2,100,000	2,100,000	2,100,000

VX-814

This is a small molecule candidate drug for AATD, which is a genetic disease that affects the liver and lungs. We have used Kalydeco as a guide due to the similar make-up of the drug and it is also manufactured by Vertex. The sample size of VX-814 is 200,000 patients. Using this information, the following forecast was found.

AATD	
Current Clinical Phase	2
Type of Drug	Small Molecule
Expected Year on Market	2028
Probability of Getting to Market	25%
Drug Reference	Kalydeco
Reference Sample	75,000
Drug Sample	200,000

Year	2028 E	2029 E	2030 E
Revenue	114,430	247,523	309,167
Growth Rate (%)		116.3098	24.90405
Number of Patients	368	796	995
Cost of Drug (USD)	311,000	311,000	311,000

Outlicensed Products

Vertex Pharmaceutical has entered into several collaboration and manufacturing agreements with other pharmaceutical companies, these include Janssen and Merck KGAA. The list of out-licensed drugs and the current stage of testing can be seen in the table below. The percentage of revenue obtained is based on historical contracts for similar agreements. Vertex has not released information as to the royalties they would receive for the performance of the out-licensed drugs. 25% is used as a rule of thumb for royalties in the pharmaceutical industry. There is a significant variance in this value. We believe this will be a rough forecast of the royalties we expect Vertex to receive.

Vertex's main benefit from the out-licensing of these products was to generate cash flow for the expansion of its current pipeline. These drugs did not conform to the type of drugs they were interested in further exploring. For this reason, we do not expect the negotiated royalty obtained to of significant value to Vertex as they would deem that they have already obtained most of the value from the initial fee paid. To account for the royalty, we added 2% to the overall revenue from 2022 to 2029. This is in line with the amount of royalty they would have received historically.

Commercial Products	Target Indication	Licensed to	Stage	Probability of Getting to Market	Time to Market (Years)
VX-787	Influenza	Janssen Pharmaceuticals	Clinical Phase 3	50%	4
VX-970	ATR	Merck KGAA	Clinical Phase 2	25%	8
VX-150	Pain	Merck KGAA	Clinical Phase 1	10%	10

Key Performance Indicators (KPIs)

Metric	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Sales Growth Rate	-42%	41%	884%	8%	-21%	-52%	78%	65%	46%	22%	37%
COGS to Sales	14%	9%	6%	18%	11%	11%	12%	12%	11%	13%	13%
Gross Margin	86%	91%	94%	82%	89%	89%	88%	88%	89%	87%	87%
SG&A to Sales	128%	131%	28%	29%	29%	53%	36%	25%	20%	18%	16%
R&D to Sales	540%	445%	50%	53%	73%	147%	96%	62%	53%	46%	42%
Operating Margin	-603%	-486%	8%	0%	-50%	-119%	-45%	1%	5%	21%	29%
EBITDA Margin	-573%	-464%	11%	3%	-46%	-108%	-39%	4%	7%	23%	31%
D&A to Sales	30%	21%	2%	3%	4%	11%	6%	4%	2%	2%	3%
EBIT Margin	-603%	-486%	8%	0%	-50%	-119%	-45%	1%	5%	21%	29%
Net Profit Margin	-630%	-526%	2%	-7%	-37%	-127%	-54%	-7%	11%	69%	28%
Pre-tax Profit Margin	-630%	-526%	4%	-1%	-52%	-127%	-54%	-4%	-1%	20%	34%
CAPEX	-	36	85	326	322	51	102	113	197	114	281
Net Working Capital	1022	582	939	1157	1191	1178	901	1039	1842	2723	3488
Current Ratio	5	2	3	4	4	4	3	2	3	3	4
Debt to Equity	13%	104%	41%	35%	5%	31%	26%	26%	2%	13%	11%

Sales YoY Growth Rate

The abnormal growth rate in the past 10 years was 884% in 2011, attributable to sales of INCIVEK (launched in May 2011) in the United States. Sales started increasing since 2015 and are now 6 times of the 2014 value. The good sales performance was driven mainly by the net product revenues from ORKAMBI (approved by the FDA in July 2015).

In 2020, sales are expected to be primarily driven by the uptake of Trikafta. In the fourth quarter of 2019, the drug generated $420 million in sales in just around two months of its launch. Trikafta is crucial for Vertex's long-term growth as it has the potential to treat up to 90% of CF patients[1].

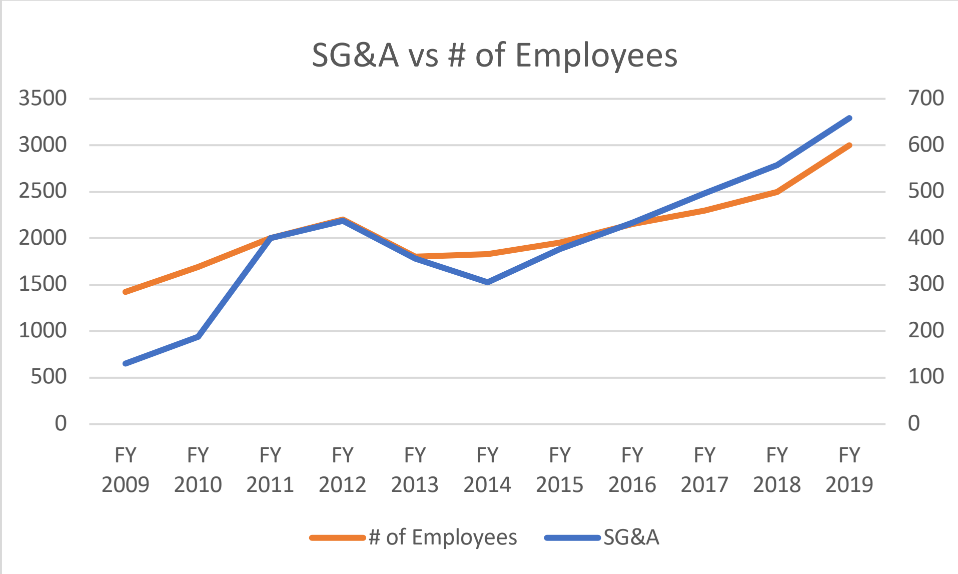
COGS to Sales

Cost of Goods Sold to Sales was very stable around 12% in the past 7 years. Vertex expects the 2020 ratio will be similar to the 2019 ratio[2]. We expect it will stay flat for the next few years.

SG&A to Sales

SG&A to Sales was decreasing in the past 5 years mainly driven by the faster growth of sales (SG&A has growth rate smaller than 20% in the past years).

[1] Vertex to Halt Enrollment Due to Coronavirus, Keeps Sales View, Newstex Blogs
[2] 10-k, 2019

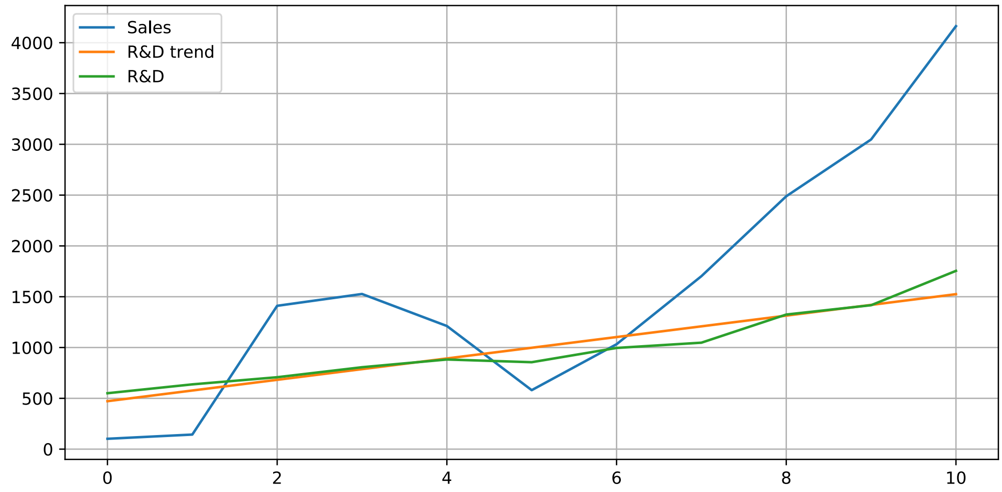


The company did not spend anything at all on direct to consumer advertising and spent little on marketing. The company has a "tiny" US sales force of just 20 reps[3]. The growth of SG&A thus depends more on the expense of salaries and then the number of employees. After Vertex cut jobs in 2013 due to a negative sales growth, the SG&A expense decreased around for two years (-18% and -14%).

R&D to Sales

The company invests more than 70% (fluctuate around 72% since 2013) of its operating expenses into R&D, well above the pharma industry average of around 17-20%[4]. The company managed to keep the R&D investment even during periods with decreasing sales. The only year Vertex decreased its R&D investment (only 3%) was 2014, after two years of negative sales growth (-21% and -52%). We calculate the trend of R&D expense and the annual increase (105 million) using the Hodrick Prescott filter (lambda = 10,000). As seen in the figure below, the actual R&D is slightly lower than the trend after big decreases in sales and slightly higher than the trend after years of continuous sales growth. If we expect future growth will not experience an extreme increase or decrease, the historical trend could be treated as a good benchmark/target for the future R&D forecast.

[3] Vertex CEO Defends Salary After Company Is Slammed For Orkambi Pricing, Scrip Intelligence
[4] Vertex CEO Defends Salary After Company Is Slammed For Orkambi Pricing, Scrip Intelligence

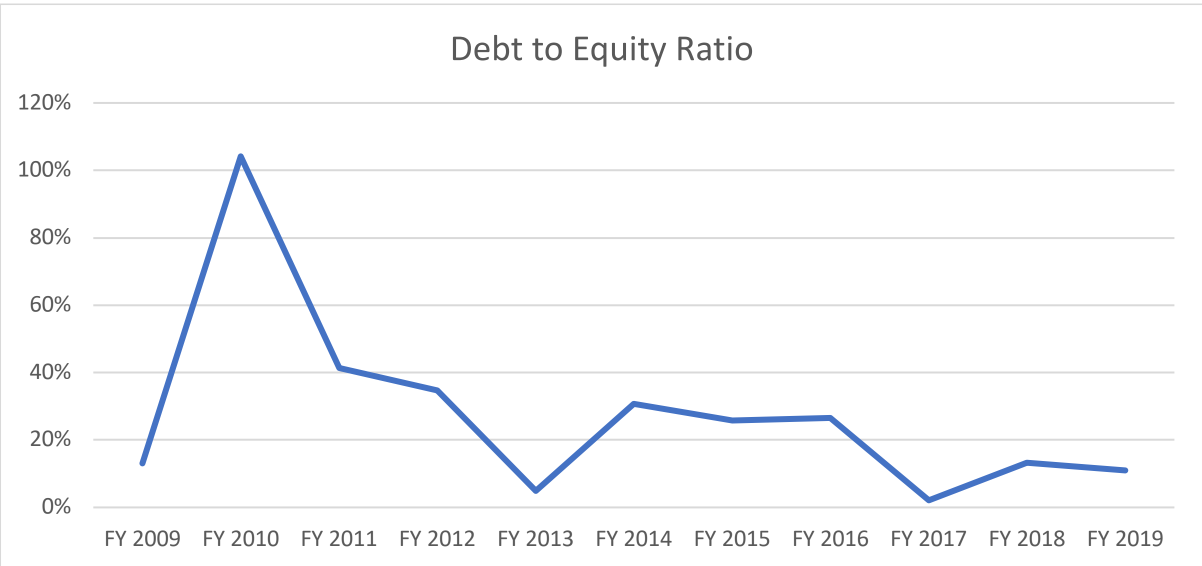


Net Profit & Pre-tax Profit Margin

Vertex started generating positive net income since 2017 and started paying tax since 2018.

Debt to Equity

Vertex managed to decrease its leverage since 2010 and pay most of their debt with a cycle of around 4 years. A low Debt to Equity ratio was appreciated by stock analysts. From the 2019 10-k, Vertex might borrow up to 500 million in the future which would make the total debt up to 1.2 billion, however, the total equity also increases. We believe the future debt to equity ratio will not fluctuate too far from the current level. The low leverage levels in comparison to the industry also minimize the effects of a financial crisis.



Valuation

Given the assumption that the debt to equity ratio is approaching a target level, we decide to use WACC in the DCF valuation.

WACC

We estimate WACC at 5.4%. To calculate WACC using equation (1), we first estimate the value of each element according to our analysis.

$$WACC = d\_e/(d\_e + 1) * (1 - tax) * r_d + 1/(d\_e + 1) \cdot r_e \qquad (1)$$

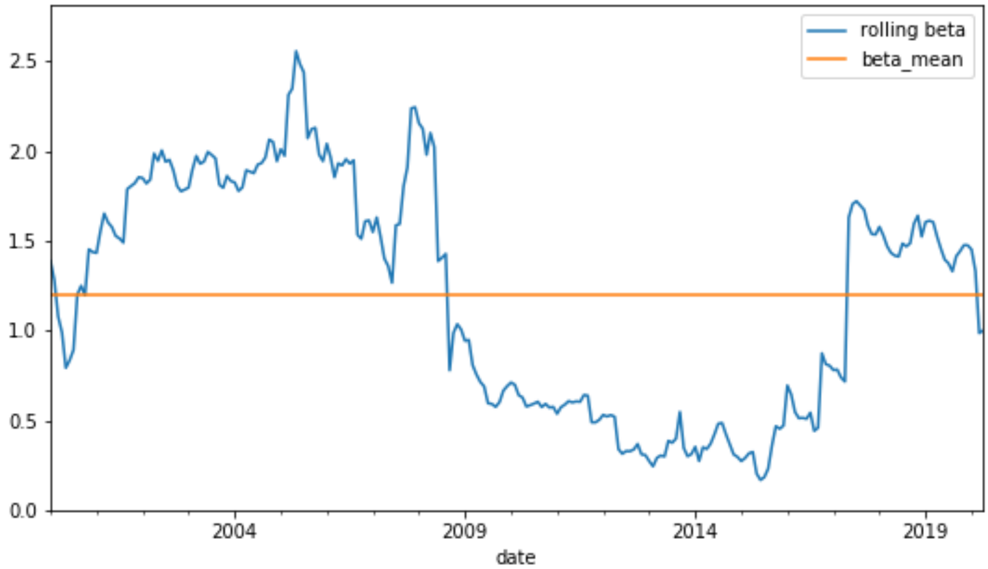
d_e refers to the debt to equity ratio, which was estimated as 11%. tax refers to the tax rate for Vertex, we estimate the tax rate as 21%, which was the effective tax rate. r_d refers to the cost of debt, which was estimated as the historical average of 7.5%.

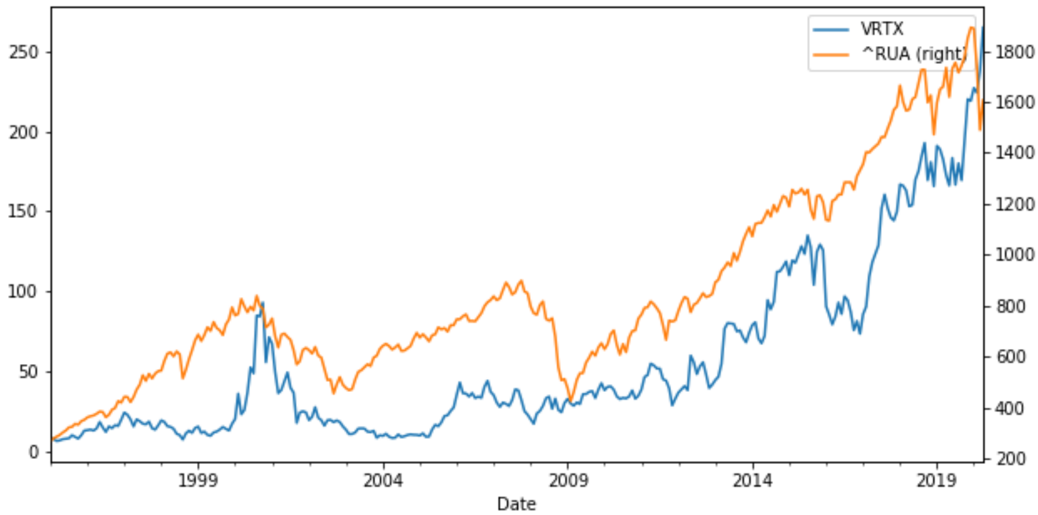
r_e stands for cost of equity estimated using CAPM as in equation (2), where $leveraged\ \beta$ was estimated from regression (3) on a rolling basis (60-month window). $r_m$was the return of Russell 3000 Index[5] and r_f was the risk-free rate proxied by the 13-week treasury bill rate. The series of beta is plotted in the figure below. Vertex's performance is in general positively related to the market. There are clear structural breaks in the time series of beta making it larger or smaller than 1. After the burst of the Internet Bubble, Vertex was hit more than the market raising the beta around 2. The 2008 crash also raised the beta to around 2. A possible reason is that Vertex was very small at that moment and was more vulnerable to systematic risk than the market. After the 2008 crash, the Beta kept lower than 1 for around 9 years, a possible reason is that comparing with the market, Vertex stopped crash earlier (a downward pressure to beta) and left the smaller increasing room (long-term lower beta). This situation is very similar to the current one. Since the outbreak of coronavirus, after a sudden drop along with the market, Vertex started increasing and reached its historical high. We expect the beta will be back within its historical range during 2009 and 2017. We estimate the beta in the future 10 years be close to the 75-percentile of the rolling beta (0.7) during this period. We didn't use the average value because as the firm size increases, beta is naturally approaching 1. We then estimate r_e as 5.3% given the market risk premium 5.75% as recommended by KPMG[6].

$$r_e = \beta \cdot mrp \qquad (2)$$

$$r_i - r_f = \alpha_i + \beta_i(r_m - r_f) + \varepsilon \qquad (3)$$

[5] We believe Russell 3000 is a better proxy of the market as it includes more alternatives.
[6] https://assets.kpmg/content/dam/kpmg/nl/pdf/2019/advisory/equity-market-research-summary-300619.pdf



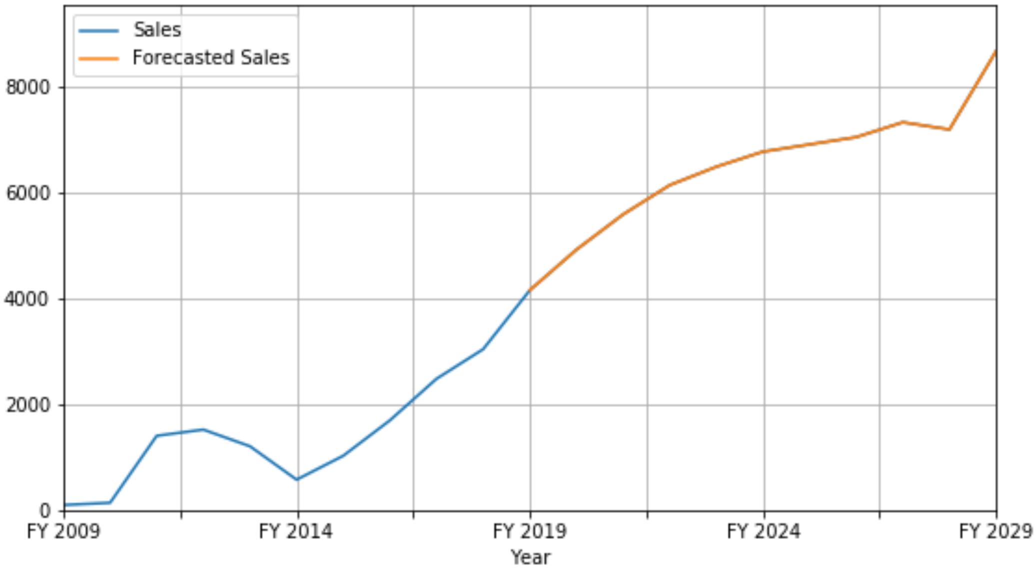


Forecast Assumptions

(1) Sales Growth Rates

As described earlier, the Sales forecast is summarized and plotted as follows.

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Current Portfolios	4,160,726	4,927,316	5,593,045	6,147,344	6,494,803	6,647,209	6,781,869	6,916,408	7,046,798	6,271,650	5,581,768
Pipeline									147,938	803,168	2,986,070
Collaborative and Royalty						132,944	135,637	138,328	140,936	125,433	111,635
Total Revenue	4,160,726	4,927,316	5,593,045	6,147,344	6,494,803	6,780,154	6,917,506	7,054,737	7,335,671	7,200,251	8,679,474
YoY Growth Rate		18%	14%	10%	6%	4%	2%	2%	4%	-2%	21%



(2) COGS to Sales

We expect the COGS will continue increasing along with Sales, thus we expect the COGS will be flat around 12% of Sales.

(3) SG&A growth rate

We estimate the SG&A will have a 10.5% growth rate (calculated by the last five years' growth rate of employee number) in the next 10 years except only 2020, in which, we believe, Vertex will not increase its employee base due to the impact of coronavirus. The only time in the past ten years Vertex cut jobs is 2013, in which Vertex suffered from a large sales decrease (-21%). Evidence shows that sales during the outbreak will not be largely influenced, however, the outbreak of coronavirus prevents Vertex to recruit more during the period. The only year Vertex will experience a sales decrease in our forecast window is 2028, given the decreasing scale is not large enough to force Vertex cut jobs, but the humble Sales performance for several years is likely to prevent Vertex hire more employees, we forecast there will be no SG&A change in that year.

(4) R&D

As Vertex has a strong commitment to invest in R&D and increase its R&D investment at a steady pace, we use the historical trend of R&D as a benchmark for the R&D forecast. We generate the R&D benchmark using the Hodrick Prescott filter (lambda = 10,000) and extend the trend to the future 10 years. Based on the observations that Vertex invested more (less) than the trend when they continuously increase (decrease) sales, according to our Sales forecast, we forecast R&D will be 230 million higher (observed from 2019) than the trend for the next 8 years and the same as the trend for 2028 and 2029.

(5) CapEx to Sales

Capital Expenditure highly depends on the business strategy to invest in PP&E, Vertex relies on third parties to meet their commercial and clinical supply needs and hasn't invested largely on PP&E for 6 years, which cause the CapEx to Sales ratio lower than 10 percent. Vertex hasn't announced any new investment projects on PP&E (i.e. for expansion). We thus expect CapEx will be 7% (calculated based on the last 6 years' data). of total sales for the next ten years.

(6) NWC to Sales
Similarly, NWC highly depends on the business strategy in the future years, which is not available at the moment. Vertex has current ratios larger than 4, thus the NWC depends more on current assets, of which 90% are Cash and Cash Equivalents and Marketable Securities. We then believe the change of NWC is highly correlated with product sales. As observed in the historical data, during the years in which the sales were driven by a strong licensed product portfolio, the NWC to Sales ratio was around 77% percent. We believe the next ten years will be within a similar situation.

(7) D&A to Sales
We observed that Depreciation and Amortization had a constant relative level to Sales (2.5%) during the years in which the sales were guaranteed by a strong licensed product portfolio. Given that the current situation is similar to such historical periods, we believe the ratio will be flat as 2.5% in the next years.

(8) Tax Rate
As describe in the WACC calculation, we use an effective tax rate of 21%[7].

[7] Q4 Earnings Call

Forecasts

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Sales	102	143	1411	1527	1212	580	1032	1702	2489	3048	4163
g		41%	884%	8%	-21%	-52%	78%	65%	46%	22%	37%
COGS/Sales	14%	9%	6%	18%	11%	11%	12%	12%	11%	13%	13%
-COGS	14	13	81	280	130	61	125	210	275	410	548
-SG&A	130	188	401	437	356	305	377	433	496	558	658
-R&D	550	637	708	806	882	856	996	1048	1325	1416	1755
R&D/Sales	540%	445%	50%	53%	73%	147%	96%	62%	53%	46%	42%
EBIT	-614	-696	114	2	-610	-692	-467	10	123	635	1198
D&A	30	30	35	38	48	63	62	61	61	72	107
EBITDA	-584	-666	149	41	-562	-629	-405	71	185	708	1305
Capex		36	85	326	322	51	102	113	197	114	281
Tax	0	0	19	39	-122	7	30	17	-107	-1487	218
NWC	1022	582	939	1157	1191	1178	901	1039	1842	2723	3488
NWC_diff		-440	357	218	34	-12	-277	138	803	881	765
FCFF		-261	-312	-542	-795	-675	-260	-197	-708	1199	40

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Sales	4930	5596	6150	6498	6784	6921	7058	7339	7204	8684
g	18%	14%	10%	6%	4%	2%	2%	4%	-2%	21%
COGS/Sales	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
-COGS	592	672	738	780	814	831	847	881	864	1042
-SG&A	658	728	804	888	982	1085	1199	1325	1325	1464
-R&D	1861	1967	2073	2179	2285	2391	2497	2603	2479	2585
R&D/Sales	38%	35%	34%	34%	34%	35%	35%	35%	34%	30%
EBIT	1819	2230	2535	2651	2703	2615	2515	2531	2536	3593
D&A	123	140	154	162	170	173	176	183	180	217
EBITDA	1942	2370	2689	2813	2872	2788	2692	2714	2716	3810
Capex	345	392	431	455	475	484	494	514	504	608
Tax	353	433	492	515	525	508	489	492	493	698
NWC	3796	4309	4736	5004	5223	5329	5435	5651	5547	6687
NWC_diff	308	513	427	268	220	106	106	216	-104	1140
FCFF	936	1032	1339	1576	1653	1689	1604	1493	1823	1365

Items	value
PV of FCF	10,775
terminal value	101,855
PV of terminal value	60,234
Intrinsic Enterprise Value	71,009
-Net Debt	-3,135
Intrinsic Equity Value	74,145
Current Equity Value	70,120
% of overvaluation	-5.4%

As seen from tables above, our valuation generates an intrinsic equity value as 74.1 billion dollars, comparing with the current market cap 70.1 billion, we conclude that the equity of Vertex is 5.4 % under-valued.

Sensitivity Analysis

We then conduct sensitivity analysis to see the sensitivity of our valuation to different setting of WACC and terminal growth rates. From the values we used for the base cases, we add five values greater and smaller than the base values respectively. We run the valuation model using different pairs of WACC and terminal growth rates and export both the intrinsic values and corresponding percentage of over/undervaluation ratio in tables below.

		Terminal Growth Rate										
	Mn $	2.5%	2.8%	3.1%	3.4%	3.7%	4.0%	4.3%	4.6%	4.9%	5.2%	5.5%
WACC	2.9%	282739	1143936	-496753	-194002	-116476	-80987	-60637	-47442	-38192	-31349	-26081
	3.4%	127257	184438	358527	-15459545	-315571	-152491	-97348	-69627	-52946	-41806	-33838
	3.9%	83314	102367	135828	209974	514065	-894527	-224178	-123102	-82278	-60202	-46370
	4.4%	62551	71766	85256	106893	147251	249150	1005169	-435142	-169367	-101309	-70154
	4.9%	50441	55757	62850	72794	87736	112714	162943	315866	-13579036	-276276	-133023
	5.4%	42500	45901	50191	55773	63331	74145	90892	120303	185474	452760	-785342
	5.9%	36887	39216	42046	45557	50028	55915	64020	75885	94915	130409	220030
	6.4%	32704	34379	36359	38737	41644	45279	49957	56200	64951	78101	100081
	6.9%	29464	30713	32160	33856	35870	38301	41296	45074	49988	56645	66167
	7.4%	26878	27836	28929	30186	31646	33365	35418	37911	41004	44944	50132
	7.9%	24765	25517	26364	27323	28420	29685	31162	32908	35004	37567	40772

	Terminal Growth Rate											
	Mn $	2.5%	2.8%	3.1%	3.4%	3.7%	4.0%	4.3%	4.6%	4.9%	5.2%	5.5%
WACC	2.9%	-75%	-94%	-114%	-136%	-160%	-187%	-216%	-248%	-284%	-324%	-369%
	3.4%	-45%	-62%	-80%	-100%	-122%	-146%	-172%	-201%	-232%	-268%	-307%
	3.9%	-16%	-32%	-48%	-67%	-86%	-108%	-131%	-157%	-185%	-216%	-251%
	4.4%	12%	-2%	-18%	-34%	-52%	-72%	-93%	-116%	-141%	-169%	-200%
	4.9%	39%	26%	12%	-4%	-20%	-38%	-57%	-78%	-101%	-125%	-153%
	5.4%	65%	53%	40%	26%	11%	-5%	-23%	-42%	-62%	-85%	-109%
	5.9%	90%	79%	67%	54%	40%	25%	10%	-8%	-26%	-46%	-68%
	6.4%	114%	104%	93%	81%	68%	55%	40%	25%	8%	-10%	-30%
	6.9%	138%	128%	118%	107%	95%	83%	70%	56%	40%	24%	6%
	7.4%	161%	152%	142%	132%	122%	110%	98%	85%	71%	56%	40%
	7.9%	183%	175%	166%	157%	147%	136%	125%	113%	100%	87%	72%

With the results of the sensitivity analysis, we are more confident to recommend a “hold” to Vertex as the valuation is very sensitive to both WACC and terminal growth rates. Given the fact that the price increased recently to its historical high minimizing the space of future return and the valuation is centered around a small percentage of undervaluation, we recommend a “hold” position.

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