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Complex Made Simple

Is ChatGPT taking over valuation?

Background

ChatGPT is a chatbot developed by OpenAI Inc. and launched in November 2022. OpenAI Inc. is headquartered in San Francisco, started as a non-for-profit business in 2015, transitioned to a for-profit status in 2019. Currently, ChatGPT is offered in two options: a) free plan; b) ChatGPT Plus for \$20/month. The paid plan provides faster response, priority access to new features and advanced data analysis.

ChatGPT functionality can be integrated into other software applications through API for a fee. Another ChatGPT functionality called DALL·E can generate and edit images from a provided description.

Use of ChatGPT and other similar AI tools sparked concerns about intellectual property rights as well as AI's impact on the job market. Several well-known authors have recently filed a lawsuit against OpenAI, claiming bot's infringement on copyrights resulting from AI's training on their work products.

Currently, approximately 49% of Open AI is owned by Microsoft, following reported \$ 10 billion investment in January 2023. Another 49 % is said to be owned by Andreessen Horowitz, Calif based VC firm. Recent discussions about potential share sale were based on company's valuation of between \$ 80 and \$ 90 billion.

The purpose of this publication is to assess ChatGPT's ability to access certain valuation information, answer specific valuation questions. We specifically focused on valuation topics related to financial reporting. All answers used in our publication were generated by the free version of ChatGPT, not the paid version.

Analysis

Our review of ChatGPT capabilities was performed by asking specific questions and analyzing provided answers. Our analysis of the answers was focused on their precision, accuracy and overall relevance. We divided our question in three categories:

- a) Access to publication, guidance, other sources of valuation knowledge
- b) General valuation knowledge and definitions

c) Practical questions, fact patterns

Questions asked, ChatGPT provided answers and proposed corrections are provided in **Appendix A**, Questions, Answers, Corrections.

Overall, we noted that ChatGPT provides accurate answers to some practical questions, e.g., calculation of future value with continuous reinvestment. ChatGPT was able to explain the relations between weighted average cost of capital (WACC), IRR and the purchase price. However, in one question involving determination of tax amortization benefit, ChatGPT provided incorrect answer. In another case, involving determination of stock volatility, the bot did not provide the correct answer either.

We noted ChatGPT lack of ability to provide succinct and accurate description of specific valuation concepts such as description of the Backsolve method. The bot was not able to provide accurate formula used to determine fair value of cash-or-nothing call option. However, the bot was able to provide the formula used to determine beta of company's assets using beta of company's debt and equity.

We noted ChatGPT is unable to access open resources such as valuation guide published the Appraisal Foundation, valuation standard published by AICPA and guides published by Big Four accounting firms.

We believe that in certain cases when the bot was not able to provide an accurate or a completely accurate answer, the answer provided gave a good introductory understanding of a relevant subject matter. For example, even though the bot was not able to provide a formula showing exact relation between European call option delta, option beta and stock option beta, the provided formula showed key elements of the formula and general relations among the elements. However, in certain instances the bot appears to be "beating around the bush" without providing succinct answer. This is the case when the bot attempted to answer the question of whether tax amortization benefit should be factored into an asset's fair value in a stock purchase transaction as opposed to an asset purchase. In this case the bot made general statements such as "the treatment of tax amortization benefits in the fair value estimation of intangible assets should adhere to applicable accounting standards and should reflect the fair value that would be realized in an open market transaction". The bot went on to state that "It's essential to consult with accounting and valuation professionals who are well-versed in the relevant standards and can provide guidance specific to your situation."

It is important to note that substantial effort required to work with the bot involves knowing what questions should be asked. A question should contain all relevant inputs required for the accurate answer. Our experience of working with ChatGPT is that it will not assess the reasonableness of one's question but rather will do its best to generate the answer given the inputs provided by the user.

Conclusions

Overall, out of 21 valuation questions asked, the bot correctly answered 6 of them or 29%. We believe that accuracy and precision of bot provided answers are as such that a valuation specialist should not rely on the answers without performing additional research. Having said that, answers provided to many questions gave a general background which is relevant and appropriate.

Since the launch of GhatGPT in February 2023, some companies announced plans to create their version of ChatGPT. We will see if any version will be created to handle valuation and other specialized accounting and finance questions.

Appendix A: Questions, Answers, Corrections

Access to publications, guidance, other sources of valuation knowledge:

Question 1: How many Business Valuation Advisories or guides were issued by the U.S. The Appraisal Foundation as of now?

ChatGPT answer (truncated): I do not have access to real-time data, and my knowledge is based on information available up to September 2021. The number of Business Valuation Advisories or guides issued by The Appraisal Foundation may change over time, and I do not have the ability to provide the most current count.

To find the most up-to-date information on Business Valuation Advisories or guides issued by The Appraisal Foundation, I recommend visiting their official website or contacting them directly. Their website should have a list of publications and guidance documents, and you can inquire about the current number and availability of these resources.

Corrections to ChatGPT answer: No answer was provided. Four guides have been issued so far. All four guides can be accessed at www.appraisalfoundation.org/imis/TAF/Resources/Current_Appraisers/Valuation_Advisories/TAF/Valuation_Advisories.aspx?hkey=d74f24ae-8dcb-412e-947f-6df153626ae2

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Question 2: How many statements on standards for valuation services were issued by American Institute of Certified Public Accountants?

ChatGPT answer (extract): As of my knowledge cutoff date in September 2021, the American Institute of Certified Public Accountants (AICPA) had issued a total of five Statements on Standards for Valuation Services (SSVS). ...

Corrections to ChatGPT answer: the answer is incorrect. One standard has been issued so far. The standard is referred to as Statement on Standards for Valuation Services No. 1, Valuation of a Business, Business Ownership Interest, Security, or Intangible Asset.

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Question 3: Can you list different types of Market Approach methods discussed in Statement on Standards for Valuation Services No 1 issued by AICPA?

ChatGPT answer (extract) ...the market approach includes several methods for estimating the value of a subject interest, and these methods can be categorized into two main groups: 1. Guideline Public Company Method (GPCM)... 2. Guideline Merger and Acquisition Method....

Corrections to ChatGPT answer: The answer is considered incorrect. According to par. 0.36 of the AICPA valuation standard, three frequently used valuation methods under the market approach are: 1) Guideline public company method, 2) Guideline company transactions method

and 3) Guideline sales of interests in the subject entity, such as business ownership interests or securities.

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Question 4: What are AICPA eligibility requirements applicable to CPAs to obtain destination Accredited in Business Valuation (ABV)?

ChatGPT answer (truncated)

1. **CPA License:** You must hold an active and valid CPA license issued by a U.S. state or territory. The CPA license must be in good standing, and you must meet any state-specific requirements for continuing education.

2. **Experience Requirements:** You must have a minimum of 1,500 hours of experience in business valuation over the previous five years. This experience should be relevant to the business valuation discipline and may include aspects such as valuing businesses, intangible assets, and more.

3. **Education Requirements:** You must meet one of the following education requirements
 - Hold a master's degree or higher in business administration, finance, or economics from an accredited college or university, OR
 - Hold a business degree (bachelor's or higher) from an accredited college or university and have successfully completed specific business valuation coursework....

5. **Ethics Exam:** Successfully complete the AICPA's ethics exam, which is called the AICPA's Comprehensive Course on Professional Ethics.
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7. **Peer Review:** Participate in a peer review program, which is required to demonstrate that you meet professional standards in your practice as a business valuator. The peer review should be conducted by a qualified organization and is typically required every three years

Corrections to ChatGPT answer (truncated): The above answer is not correct. Items 5. and 7. do not apply. Information presented in item 3 is not correct. See <https://us.aicpa.org/membership/join/abv-eligibility-requirements> for the list of relevant requirements.

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Question 5: Do you have access to any publicly available on-line valuation tools that can calculate fair value of the so called exotic equity options, including binary or binominal options?

ChatGPT answer (truncated) I don't have direct access to external websites or online tools, including specific valuation tools for exotic equity options like binary or binomial options....

Corrections to ChatGPT answer: A valuation specialist can use <https://www.hoadley.net/option> to calculate the fair value of binominal options. Fair value of binominal, binary and other “exotic” options can also be calculated using DerivaGem software available at https://media.pearsoncmg.com/ph/bp/bridgepages/bp_hull_bridgepage/index.html.

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Question 6: What Big Four firms issue their interpretative guidance covering application of fair value concept per FASB's Accounting Standard Codification 820?

*ChatGPT answer (extract)....*To find the most current interpretative guidance issued by these firms on ASC 820 or any other financial reporting matters, I recommend visiting the official websites of the respective firms and searching for relevant publications, thought leadership, or technical guidance related to fair value accounting.....

Corrections to ChatGPT answer: No answer was provided. Deloitte, PwC and EY each issue their interpretive guides covering definition and application of ASC 820 fair value concept. KPMG issued a handbook covering fair value measurements in U.S. GAAP and IFRS. All these guides are made available to the public.

General valuation knowledge and definitions:

Question 1: What are specific key differences in definition of fair market value generally used for tax valuations and fair value used for financial reporting purpose?

ChatGPT answer (truncated): The key differences in the definitions of fair market value (FMV) used for tax valuation and fair value (FV) used for financial reporting purposes are rooted in their distinct purposes and regulatory frameworks. Here are specific differences in their definitions:

The tool went on to describe differences in purpose, regulatory framework, market conditions, etc. However, it still did not clearly indicate any specific differences in the two definitions.

Corrections to ChatGPT answer: No answer was provided. Definition of FV used for financial reporting purpose incorporates a number of attributes not included in the definition of FMV listed below:

- FV is based on the exit, not entry price. Exist price is the price that a seller would accept to sell the asset, or a debtor would be willing to pay to transfer a liability.
- FV is an exit price in the principal market, or, in the absence of a principal market, the most advantageous market in which the reporting entity would transact.
- Fair value is a market-based measurement, not an entity-specific measurement.
- FV measurements should not be adjusted for transaction (selling) costs

Definition of FMV includes a willing buyer and a willing seller, reasonably knowledge of both parties, not included in the definition of FV.

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Question 2: Can you describe the general idea of the Backsolve method in valuation of company's equity?

ChatGPT answer (truncated): The backsolve method, also known as the reverse engineering method, is a technique used in the valuation of a company's equity. This approach is particularly useful when you want to determine the implied assumptions about a company's future performance based on its current market value (stock price). Here's a general idea of how the backsolve method works in the context of equity valuation:

1. Start with the Market Price: Begin by observing the current market price of the company's equity, which is the price at which its shares are trading in the stock market. This is the known variable that you start with.
2. Estimate Future Cash Flows: Next, you need to estimate the company's expected future cash flows. This involves forecasting the company's revenue, expenses, taxes, and other financial metrics over a certain period (usually multiple years) into the future.
3. Select a Discount Rate: Determine an appropriate discount rate, often referred to as the required rate of return or cost of capital.
4. Discount Future Cash Flows: Use the estimated cash flows and the chosen discount rate to calculate the present value of those cash flows.

Corrections to ChatGPT answer: The above answer is considered incorrect. Items 2. through 4 do not directly apply. The main idea behind the Backsolve method is to use recent transaction price for one of the classes of shares, Black-Scholes option pricing model and other additional information that can be derived from company's capital structure to determine estimated fair value of equity.

Application of the Backsolve method is performed using the following steps:

- Step 1 - Identify pricing terms of the recent equity transaction;
- Step 2 - Identify relevant dividend/distribution rights and related "breakpoints";
- Step 3 - Prepare FV equity equation;
- Step 4 - Estimate required inputs for option pricing model: risk-free rate, expected terms, volatility;
- Step 5 - Calculate estimated FV of equity using "trial and error" approach;

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Question 3 Can you list, in the order of relevance, i.e., from the most relevant to the least relevant, three main valuation methods, i.e., income, market and cost method used to determine fair value of customer related assets, e.g., customer relations?

ChatGPT answer (truncated): Income Method is most relevant, Market method is moderately relevant, Cost Method is the least relevant.

Corrections to ChatGPT answer: the above answer is considered incorrect. The order of relevant should be as follows: Income method, cost method, market method. Cost approach may be used when the entity can estimate direct, indirect and opportunity costs incurred to replace or recreate current customer related assets. Use of the cost approach may be appropriate when customer related assets are not a primary asset of the business. Customer-related assets are not transacted on a stand-alone basis, and, in most cases, any observable historical transactions will not be comparable (Appraisal Practice Board VFR Valuation Advisory 2: Valuation of Customer-related assets, p. 57) Therefore, the use of the market method in valuation of customer-related assets is limited.

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Question 4 Can you provide standard formula used to estimate fair value of a cash-or-nothing call option?

ChatGPT answer (truncated):

Certainly! The fair value of a cash-or-nothing call option can be estimated using the Black-Scholes formula, which is a widely used formula for pricing European-style options. For a cash-or-nothing call option, the formula is modified to account for the fact that the option pays a fixed cash amount (the "cash-or-nothing" feature) if the underlying asset's price is above the strike price at expiration, and it pays nothing if the underlying price is below the strike price.

Here's the standard formula for the fair value of a cash-or-nothing call option:

Fair Value of Cash-or-Nothing Call Option = Cash Payment * Probability of the Option Being in the Money.

Where:

Cash Payment: This is the fixed cash amount that the option holder receives if the underlying asset's price is above the strike price at expiration.

Probability of the Option Being in the Money: This probability is calculated using the cumulative distribution function (CDF) of the standard normal distribution and represents the likelihood that the underlying asset's price will be above the strike price at expiration.

The probability of the option being in the money can be calculated as follows:

Probability of the Option Being in the Money = $N(d_2)$

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Corrections to ChatGPT answer: The above answer is considered incorrect. Although the tool correctly described the general approach to valuation of cash-or-nothing cash option, it did not correctly identify all relevant variables used in the formula. Specifically, the tool did not

mention that the formula should use *the present value* of the fixed cash payment, not just fixed cash payment. Overall, the formula used to determine fair value of a cash-or-nothing call option is as follows:

$$Ze^{-r(T-t)}N(d_2)$$

$$d_2 = \frac{\ln\left(\frac{S}{X}\right) + (r - 0.5\sigma^2)(T-t)}{\sigma\sqrt{T-t}} - \sigma\sqrt{T-t}$$

Where:

- Z- fixed cash amount;
- r- risk free rate;
- T-overall option term;
- t- time passed through the valuation date;
- S- stock price
- X- exercise price
- σ – stock volatility

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Question 5: What is the formula used to determine beta of company's assets using beta of company's debt and equity?

ChatGPT answer (truncated): To determine the beta of a company's assets using the beta of the company's debt and equity, you can use the following formula:

$$\text{Beta of Assets } (\beta_A) = (\text{Weight of Debt} / \text{Total Capital}) * \text{Beta of Debt } (\beta_D) + (\text{Weight of Equity} / \text{Total Capital}) * \text{Beta of Equity } (\beta_E)$$

Corrections to ChatGPT answer: The above formula is correct.

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Question 6: How to calculate THETA, used to measure sensitivity of an equity option?

ChatGPT answer (truncated): The most common method for calculating theta is to use an options pricing model like the Black-Scholes model. Here's the basic formula for calculating theta using the Black-Scholes model:

$$\text{Theta} = - (dV / dt);$$

Where:

- Theta is the time decay of the option's value.
- dV is the change in the option's value.
- dt is the change in time.

Corrections to ChatGPT answer: the answer is correct.

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Question 7: What is the mathematical formula showing the relation between European call option delta, European call option beta and beta of the underlying stock?

ChatGPT answer (truncated): In practice, if you have the delta of a call option and the beta of the underlying stock, you can use the formula:

$$\text{Beta(Call Option)} = \text{Delta(Call Option)} * \text{Beta(Underlying Stock)}$$

Corrections to ChatGPT answer: The above formula is incorrect. The formula showing the relation between European call option's delta, stock beta and stock option beta is as follows:

$$\text{Beta(Call Option)} = \text{Delta(Call Option)} * \text{Beta(Underlying Stock)} * \text{Stock Price} / \text{Call Option}$$

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Question 8: What is the reason for applying natural logarithm to two stock quotes when calculating volatility of stock to be used as an input in a stock option pricing model? For example, if day 1 stock price is \$ 10, day 2 stock price is \$ 12, stock volatility is calculated by taking natural logarithm of 12/10.

ChatGPT answer (extract):

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4. Continuous Compounding: Taking the natural logarithm of the price ratio is equivalent to calculating the continuously compounded return. This is a more accurate representation of returns in a continuously changing market, as it assumes returns are compounded infinitely often within a given time period. It is particularly useful for modeling assets like stocks, where prices can change continuously during trading hours.

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Corrections to ChatGPT answer: The above answer is considered correct.

Practical questions, fact patterns:

Question 1: When estimating fair value of an intangible asset for financial reporting purpose should tax amortization benefit be factored into an asset's fair value in cases when the accruing entity assumes acquiree's tax basis and no step up of the intangible asset's tax basis occurs?

ChatGPT answer (extract):Ultimately, the treatment of tax amortization benefits in the fair value estimation of intangible assets should adhere to applicable accounting standards and should reflect the fair value that would be realized in an open market transaction. It's essential to consult with accounting and valuation professionals who are well-versed in the relevant standards and can provide guidance specific to your situation.

Corrections to ChatGPT answer: the above answer is considered incorrect. The answer to the above question is a yes. Tax amortization benefit is factored into an asset's fair value irrespective of the tax attributes of the transaction, i.e., whether the transaction is taxable or nontaxable.

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Question 2: Ignoring the timing of the exercise, what is the key difference in valuation of a warrant as compared to a European call option?

ChatGPT answer (extract): ...In summary, the key difference in valuation between a warrant and a European call option, when ignoring the timing of exercise, is their origin, issuer, and the associated ownership and trading characteristics. Warrants are typically issued by the company and may confer ownership rights, while European call options are standardized financial contracts traded on secondary markets. These differences can affect the valuation and use of these instruments.

Corrections to ChatGPT answer: The answer is considered incorrect. Exercising of a warrant is accompanied by company's issuance of new shares while exercising of a call option is generally not. Issuance of new shares at the exercise price less than shares fair value results in dilution. When determining fair value of a warrant, the valuation professional should consider the dilutive impact, resulting from issuance of additional shares.

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Question 3: Using the following five stock price quotes, can you determine estimated annualized volatility as used as an input in standard Black-Scholes formula, assuming the following a) five stock quotes occurred on five consecutive days are \$ 100, \$ 101.5, \$ 98, \$ 96.75, \$ 100.5; b) the amount of business days in a year is 250?

ChatGPT answer (truncated):

To calculate the estimated annualized volatility using the given stock price quotes, you can follow these steps:

1. Calculate the daily returns:

$$\text{Daily Return} = (\text{Today's Price} / \text{Yesterday's Price}) - 1$$

Here are the daily returns for your data:

$$\text{Day 1: } (101.5 / 100) - 1 = 0.015 \text{ (or 1.5\%)}$$

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$$\text{Day 4: } (100.5 / 96.75) - 1 = 0.0387 \text{ (or 3.87\%)}$$

2. Calculate the average daily return:

$$\text{Average Daily Return} = (\text{Daily Return Day 1} + \text{Daily Return Day 2} + \text{Daily Return Day 3} + \text{Daily Return Day 4}) / 4$$

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3. Calculate the daily standard deviation of returns:

$$\text{Daily Standard Deviation} = \sqrt{\frac{\sum (\text{Daily Return} - \text{Average Daily Return})^2}{(N - 1)}}$$
4. Convert daily volatility to annualized volatility:

$$\text{Annualized Volatility} = \text{Daily Standard Deviation} * \sqrt{\text{Number of Trading Days in a Year}}$$

$$\text{Annualized Volatility} \approx 0.9719 \text{ (or 97.19\%)}$$

Corrections to ChatGPT answer: The above answer is incorrect due to at least one error made in calculations in section 3 and not applying natural logarithm when calculating daily returns. Annualized volatility used as an input in the Black-Scholes calculations equals 51.09%, not 97.19%.

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Question 4: Can you calculate tax amortization benefit for the asset using the following variables: pre-tax asset value is \$ 1,000,000, discount rate: 10%, income tax rate: 40%, tax amortization period: 15 years. Calculate amortization benefit using mid-year conversion adjustment factor.

ChatGPT answer (truncated): ...the tax amortization benefit for the asset using the mid-year conversion adjustment factor is approximately \$6,504.65. This represents the tax savings realized each year due to the amortization of the intangible asset over its useful life.

Corrections to ChatGPT answer: The answer is incorrect. Total tax amortization calculated using tax amortization benefit (TAB) formula with a mid-year convention factor is \$ 270,218 or approximately \$ 18,015 per year.

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Question 5: How do cash dividends impact the fair value of an equity call option?

ChatGPT answer (truncated):In summary, cash dividends can impact the fair value of an equity call option by leading to a decrease in the underlying stock's price and an adjustment to the option's strike price. These adjustments are made to ensure that the option remains economically equivalent. As a result, the option premium tends to decrease, reflecting the reduced value of the option due to the dividend payment. Traders and investors should be aware of these adjustments and the ex-dividend date when trading options on stocks that pay dividends.

Corrections to ChatGPT answer: the answer provided by the tool is long winded but is generally correct. Future cash dividends decrease the fair value of an equity call option.

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Question 6: What is the future value of \$100 at the end of 2nd year invested at 10% annual rate, assuming continuous reinvestment, i.e., reinvestment of infinite amount of times during the 2 year period?

ChatGPT answer (truncated): To calculate the future value of \$100 invested at a 10% annual interest rate with continuous compounding for 2 years, you can use the formula for continuous compounding: $FV = PV * e^{rt}$. $FV \approx \$122.14$

Corrections to ChatGPT answer: the answer is correct.

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Question 7: If Internal Rate of Return (IRR) applied to acquiree's prospective financial information was determined to be 10% while acquiree's Weighted Average Cost of Capital (WAAC) was determined to be 15%, what does the relation between IRR and WAAC say about the reasonableness of the purchase price paid for the acquired business?

ChatGPT answer (extract): ...In summary, an IRR lower than the WACC suggests that the purchase price paid for the acquired business may not be reasonable from a financial perspective, as it may not generate returns sufficient to cover the cost of capital...

Corrections to ChatGPT answer: the answer is correct. Assuming that prospective financial information of the acquired business reflects market participant expectations and other variables being equal, the purchase price was overstated. In other words, it appears that the acquirer overpaid for the business.

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