

Can AI Help One Beat the Stock Market?

Lucas Rascher

Miramonte High School

ABSTRACT

Artificial Intelligence (AI) algorithms have taken the world by storm with applications being contemplated in a multitude of areas of professional and personal significance. Whether one can ‘beat’ the stock market in terms of the implied average returns of a diversified portfolio over an extended period has been discussed for decades. It may then be a natural question to ask whether AI can help an investor beat the market. This article investigates this question.

This paper examines whether AI can revolutionize investing and help investors beat the market. This article defines what it means to “beat the market” and why understanding this is crucial, and explores why most investors, both ordinary and professional, struggle to outperform the market long-term. The Efficient Market Theory (EMT) is explained and its key assumptions that hinder consistent success in investing. There is a discussion of AI’s potential to assist investors and whether it can challenge any of the EMT assumptions. Finally, an experiment is conducted which assesses AI’s effectiveness in investing, comparing the results of AI-generated portfolios to common index funds and those of other well-known investors. The results suggest that the AI-generated portfolios beat the other funds.

Meaning of Beating the Market

The question of whether an individual can “beat” the market has been debated for decades and can be approached from many perspectives. A varying and fundamental component of the inquiry is what it actually means to beat the market. Does it mean to accurately predict the market or rather to simply see higher returns than an industry standard or the market as a whole? The first option is simply impossible as the market is not systematic but rather is unpredictable and lacks patterns that could be used to accurately calculate future stock value in a consistent manner (Investopedia 2024 a); essentially stock prices follow a trend over an extended period of time while the process fluctuates (unpredictably) around that trend. Given this, this paper will be based upon the second option - beating the market across all sectors means outperforming the collective industry standards (Investopedia 2021). We will use the S&P 500, a fund including the top 500 corporations in the United States, as a representation of the market as a whole due to its inclusion of companies in almost all industries. Empirically, we note that the US stock market increases by approximately 10% annually. Given this fact, what would it mean to ‘beat’ the market? What are the ways, if any, to consistently do better than this average long-term return of 10% of the US stock market? Unfortunately, consistently achieving higher returns than the 10% benchmark is rare. Optimizing returns can be difficult for a typical investor as most people lack the knowledge to analyze information and understand if a stock is a risky investment or not (Money 2024). Even professionals who are well equipped with these skills have difficulty beating the market due to its sheer unpredictability as well as unavoidable flaws in human decision errors regarding sufficient analysis of data, and accounting for professional fees charged for money management. In fact, the vast majority of investors and even hedge funds fail to beat the market with 89% of fund managers being outperformed by the S&P 500. However, the shortcomings of investors isn't necessarily due all to a lack of skills but rather the fact that beating the market requires a large component of luck according to the Efficient Market Theory.

Efficient Market Theory (EMT)

The Efficient Market Theory (EMT) states that share prices reflect all current and available information (Forbes 2022). This statement, therefore, implies that it is essentially impossible to ever beat the market consistently as stock prices merely react to and correlate with new and public information. The EMT provides a significant explanation for investors' inability to beat the market over an extended period of time. Some may be able to outperform the market for a year, or potentially even longer; but due to the unpredictability of the market, consistently achieving such is next to impossible.

For the EMT and its explanations to be true, it must abide by multiple principles, which if broken, can allow one's chances of beating the market to be significantly changed. First, two essential principles of the theory that are correlated are the banishment of insider trading and the requirement that all information regarding the market is publicly available. If new and relevant information regarding a stock is publicly available, the stock will be traded on, and the price will adjust; therefore giving no one an advantage over the other. However, insider trading, when one uses non-published or 'inside information' to make investment decisions, gives an investor a substantial advantage and is illegal due to that fact. Another principle of the theory assumes that investors must follow rational expectations, meaning that all available and accurate information along with previous outcomes and trends are used to predict future financial and economic results. Investors' ability to analyze data must also be uniformly distributed suggesting that all investors have a sufficient but equal ability to comprehend data and make investments based on such knowledge. Lastly, the transaction costs of participating in the market must not be prohibitive but instead should be relatively affordable for all investors to trade on. With these five principles present, the market is extremely difficult to outperform and therefore explains the unpredictability of stocks as well as the lack of success among investors. However, what if one of or potentially even multiple of these principles could be overcome by investors?

Rational Expectations

The Rational Expectations Theory proposes that investors make rational and calculated decisions based on all available information and previous experiences (Investopedia 2023). The theory assumes that information is effectively used by people to anticipate future financial outcomes of the market and economic trends. It also holds the idea that past economic results influence current and future ones. For example, if historically the S&P 500 has grown by roughly 10 percent every year, it is implied by the theory that the future growth of the index fund may also fall close to 10% annually. Essentially, outcomes and future expectations have a heavy influence upon each other, explaining the theory's implications into economics and finance. Economists often use the theory to predict future financial aspects such as prices, interest rates, and inflation. The theory is used in many ways in regard to the market to help explain financial trends and investor decision-making. For instance, its principles are fundamental components of asset pricing models and the Efficient Market Hypothesis, which together claim that all current and available information is incorporated into asset prices and that investors use such information to make rational predictions of the future outcomes of the market. The theory supports the EMT's ideas of an unpredictable market by assuming that all market prices accurately and immediately reflect all current information due to unanimous, rational investing; therefore outweighing knowledgeable investors advantages created by superior understandings of prices and inaccurate share values. In essence, Rational Expectations helps explain the nature of investors decision-making and predictions made regarding economic and financial outcomes, claiming that future results can help be anticipated by previous outcomes and investments are made with rational decision making based on available public information.

Insider Trading

Insider trading - illegally buying or trading a public stock using non-public or material information regarding the cooperation - has been an issue within the market for nearly a century. The practice undermines the public's trust in the market, leaving many to be disinterested in investing in an unethical and rigged market. Insider trading negatively impacts honest investors trading on solely public information by shorting them of their returns due to misleading market values. Essentially, the practice promotes unethical trading and places ordinary investors at a disadvantage (Investopedia 2024 b).

The origin of the banishment of forms of insider trading can be traced back to the early 20th century. Before the 1930s, insider trading was not specifically prohibited, and regulations were rather minimal in securities markets. However, the Securities Exchange Act of 1934 was enacted to oversee transactions on the market with the goal of creating an equal environment for investors. Section 10 (b) of the Act and the Rule 10b-5 issued by the Securities and Exchange Commission (SEC) banned fraud regarding the sale of securities (SEC 2001); therefore, fundamentally making general forms of insider trading illegal. Despite this, scandalous instances of insider trading continued to occur such as the case Ivan Boesky in the 1980s. He was found by the SEC to be making investments based on confidential corporate information and was fined \$100 million as well as sentenced to 3.5 years in prison. The Insider Trading Act of 1988 expanded regulations on insider trading and increased the SEC's ability to punish those guilty of the practice. Today, the guidelines of insider trading are still set by the SEC in which the practice remains completely illegal under the law due to the unequal advantages created by its use as well as its negative impact on the honest and ethical principles of the market.

Prohibitive Costs

For the market to be efficient, costs cannot be prohibitively high, meaning the price to trade cannot deter investors from participation. The EMT relies on equal access to information and opportunities for all and high costs would thus hinder the truth in this statement as it may prevent certain investors from trading opportunities. High fees, taxes, or other expenses involved in trading can create a barrier for investors not willing to or unable to pay. In turn, the decreased quantity of investments would thus lead to a less efficient market through reduced market liquidity and less accurate share prices. However, prohibitive costs would be advantageous for those willing to or able to pay as it would allow them to capitalize on opportunities that others could not. Wealthier individuals or corporations would thus outperform smaller investors or those with limited resources. Essentially, having prohibitive costs would create an unequal playing field on the market between those able to pay over those with less access to capital.

Uniform Analysis Capabilities

An additional factor necessary for a market to be efficient is that investors' ability to analyze data should be uniformly distributed. Essentially, all participants in the market must be able to access and interpret information relatively equally. This, in turn, leads to more accurate share prices and a fairer market overall. When analyzation capabilities are not evenly distributed, advantages are created for the participants who possess superior analytical and comprehension skills of relevant information. As a result of the inequalities, the market becomes less efficient as liquidity is decreased due to the uneven investment patterns and accuracy of the information being traded upon. Thus, when analytical abilities are uniform and accurate, liquidity of the market is increased and share prices are more accurate due to consistent and accurate trading.

Understanding the Market

To accurately assess AI's impact on the market, it is necessary to understand the degree to which the market is predictable. While we previously noted that the market is unpredictable, how unpredictable is it? Is it as randomized as a casino or does it have indicators that can help investors anticipate future results? Over extended periods of time, a stock follows a general trend that is correlated with the overall performance of the economy while unpredictably fluctuating in smaller increments around the general trend, as stated previously. These short and unpredictable increments can be compared to a casino or the lottery in the fact that there is no strategy to consistently and accurately predict these short term returns (Investopedia 2022). A substantial factor of luck is necessary to be able to predict these day-to-day fluctuations in growth, similar to the entirely luck-based systems of gambling and participating in the lottery. However, over extended periods of time, the comparison of predicting the market to a casino is inaccurate as the market has economic structure rather than gambling which, as noted, has a 100% randomized chance of success. Essentially, the market has fundamental principles that influence and provide explanation to its performance including supply and demand, individual company growth, economic trends, and external influences such as inflation or politics. An investor can use this public information regarding a stock as well as analyze previous performance to make rational investments that result in consistent, long-term returns. Conversely, playing casino games or the lottery has an outcome that is highly dependent upon luck. In addition, portfolio diversification, the act of investing in a variety of stocks with the goal of reducing risk and achieving more consistent returns, is another significant difference between the market and a casino or the lottery. Along with the high-risk nature of casinos and lotteries are the high prices that are required to participate in them; differing greatly from the free access to trade on investment platforms such as Schwab. Furthermore, the market's mean annual growth of 10% a year is not seen within a casino as there is never any long-term, consistent trend of growth to predict potential returns as there is within the market – in fact, on average the casino wins and thus the average returns to gambling are negative. Essentially, while the comparison of the market to a casino may be partially reasonable in the short term due to their shared unpredictability of return, over extended periods of time, this comparison becomes inaccurate due to long term trends of the market and its principles based in economics and rational analysis of information. An investor's additional ability to manage his risk through diversification and trade freely within the market exempt of cost truly separates the nature of casinos and the lottery from the stock market.

Can AI Allow us to Beat the Market?

The main assumptions of the EMT, being public access to all available information/the prohibition of insider trading, the rational expectations theory, uniform ability among investors to analyze data, and free trading on the market, must all be enforced for the market to be consistently unbeatable. Essentially, to beat the market, at least one of the assumptions of the EMT must be disapproved or broken in one way or another. Beginning with the principles that AI fails to beat without question, the assumption that transaction costs on the market are prohibitive. AI, of course, does not have the power to make trading become an expense, which would create an advantage for those who are willing to be charged for trading, and therefore the principle holds regarding the matter. Continuing, AI clearly does not have the legislative power to make insider trading legal nor does AI itself have inside information as it is a language model that compounds information from only public databases; hence, all information traded on remains publicly available.

However, the two assumptions AI has a chance at breaking are that all investors follow rational expectations and that all investors have an equal ability to analyze data. The EMT is a theory and not necessarily reality, meaning that while the majority of its principles are generally true, they are sometimes only accurate to a degree and aren't fully representative of the market and how investors act. For example, not all investors are fully rational in their decision making nor do they all have an equal ability to extract and comprehend the data on the market. Humans are influenced by emotion, biases, and other factors that lead them to often act irrationally, including in their financial decisions. Additionally, while all investors have access to the same public information (or information that one can legally trade

on), some are better at understanding financial data and knowing what to look for when conducting research than others. With these two principles already being flawed to an extent, can AI further falsify these claims? Can I make its users act more rationally than others? Can AI further make analyzation abilities across investors disproportionate through aiding its users research?

Analyzation and Aggregation Abilities

AI has transformed the market through how information is aggregated and analyzed. Essentially, AI is an aggregator of information, reflecting the decisions of millions of investors within the market. It can analyze and process relevant earnings and economic information that eventually determine the stock price.

Previously, understanding these factors and sufficiently analyzing them was a difficult task that often required a degree of expertise, putting ordinary investors at a disadvantage to professionals with access to advanced tools and analytical abilities. While investors may have access to a plethora of information and statistics regarding corporations across the internet, finding and knowing or taking the time to analyze this information is the factor that AI can exponentially assist investors with. AI helps close this gap between ordinary investors and professionals by undermining their advantages through its ability to aggregate information into a comprehensible state to which a typical market participant can understand. It simplifies and compresses the relevant information and provides insight that would likely be a laborious task if done manually. It is like a manufacturing company, taking all the individual pieces and materials and producing it into a final product presented to the buyer in its ready to use form. AI sifts through copious amounts of rather disorganized financial information and simplifies or manufactures it and provides insight about it to answer the user's requests.

However, the collectivization of the information isn't the only advantageous factor about AI's analyzation abilities but also the speed at which it carries out its analysis. As mentioned, efficiently manually analyzing the market requires a degree of comprehension that AI can remove; however, it also removes the time required to conduct such analysis, something that even a professional cannot avoid. Within seconds, AI can provide you with detailed financial information upon a specific request. Beginning with a basic AI such as ChatGPT, it has the ability to supply one with specific stocks or even an entire portfolio catered to that investor's requirements. For example, a user could request for a list of 5 stocks in the technology sector each with a P/E ratio under 30, a profit margin above 10%, and growth of above 15% in the past year and ChatGPT will provide a list meeting these requirements and including each company's percentage of the portfolio that it suggests investing in. While of course other factors influence if the listed stocks are wise investments or not, the model's ability to provide such specific information in a matter of seconds creates a substantial advantage for the user. The same task would take significantly longer for a human alone to scan the market, read financials and statistics, and explore the historical data of the share to eventually find stocks that meet all the given requirements demanded.

Further investment abilities of AI can be seen in investment specific AI models such as Danelfin, a company founded in 2018 in Barcelona. Danelfin AI provides investment suggestions with the goal of enhancing the efficiency of trading on the market for the user (Money 2024). It provides top stocks based on a vast number of financial statistics such as financials, market trends, and historical performance. The model then ranks the stocks on a scale of 1-10 as an overall score and provides further rankings for the stock as both a fundamental and technical investment as well as rankings for its overall risk and the current financial sentiment towards its sector. Additionally, the algorithm used to detect these stocks often results in companies that an investor may not even be aware exists, further enforcing the aspects of AI's analyzation abilities that outperform those of a human as how would one invest in or research a company/fund that they don't know exists? In essence, this company not only uses AI to eradicate the required time and expertise to conduct manual research, but it also additionally analyzes and ranks the stocks for the investor, being a prime example of how AI can help typical investors make financial decisions.

AI vs. Investment Funds

Methods

With AI being capable of providing financial advice and recommending stocks to investors, how do its suggestions perform in comparison to an index fund or well-respected hedge fund? As previously noted, basic models of AI like ChatGPT can create individualized investment suggestions based on the investors stated requirements for the corporations whether that is a demand for companies only in a certain sector of the market or a specific number requisite in the financials, etc. Could these suggested investments by AI be worthwhile and is there a way to test this hypothesis? To attempt to provide an answer, I conducted an experiment in which I requested ChatGPT to create a diverse portfolio including 10 individual stocks. However, I asked AI to do so only based on publicly available information up until August 2023, a year prior to the writing of this article. I requested this date so that the portfolio's performance could be studied over the following year (August 2023 - August 5, 2024) since the information used to create it preceded the start date. AI provided a portfolio consisting of 1-3 stocks from five different sectors of the market, including the percentage each stock made up of the total fund. Taking all aspects of the portfolio into account, I then calculated the overall performance of it in order to compare its growth to both the S&P 500 and Berkshire Hathaway - Warren Buffet's hedge fund consisting of around 50 corporations including financial, consumer goods, and technology companies. In order to gather a wider array of data to potentially validate the previous results, I ran the experiment again from the time span January 1, 2019 - January 1, 2020, a time of higher-than-average growth within the market. Mirroring the first test run, I asked AI to create a portfolio using only information predating January 1, 2019. Using the historical data, I calculated how AI's performance of 10 stocks performed throughout the duration of the one year time span and compared the results to those of Berkshire Hathaway and the S&P 500. This portfolio included large corporations in the technology industry such as Microsoft and Amazon as well as companies in healthcare and consumer goods including Johnson & Johnson and Coca-Cola.

Results

In the time span of August 2023 - August 5th 2024, the AI generated portfolio grew 21.7% - as compared to Berkshire Hathaway's 18.2 percent growth and the S&P 500's 15.8% growth. Thus, ChatGPT's financial advice resulted in greater growth over a one-year period, according to the experiment. Similarly, in the second period, while Berkshire Hathaway grew 9.2% and the S&P 500 grew 19.2%, AI's suggested portfolio grew an astounding 31.9% during the one-year span. In essence, AI can provide a portfolio meeting the users specific requirements and, as indicated by the data, outperform index and hedge funds such as the S&P 500 and Berkshire Hathaway.

Limitations

However, can it be assumed that AI is capable of consistently outperforming these funds? In order to gather a wider array of data to potentially validate the previous results, I ran the experiment again from the time span January 1, 2019 - January 1, 2020, a time of higher-than-average growth within the market. Mirroring the first test run, I asked AI to create a portfolio using only information predating January 1, 2019. Using the historical data, I calculated how AI's performance of 10 stocks performed throughout the duration of the one year time span and compared the results to those of Berkshire Hathaway and the S&P 500. Similar to the first test run, while Berkshire Hathaway grew 9.2% and the S&P 500 grew 19.2%, AI's suggested portfolio grew an astounding 31.9% during the one-year span. It included large corporations in the technology industry such as Microsoft and Amazon as well as companies in healthcare and consumer goods including Johnson & Johnson and Coca-Cola. However, was the information used by AI to create these portfolios all truly before January 1, 2019, or August of 2023? Unfortunately, there is no definite way to easily

provide an answer to this question but there were indicators to help support that the gathered data did indeed precede the start dates of the experiments. For example, during both trials, AI provided stocks which happened to decrease significantly over the following year such as Pfizer or Johnson & Johnson. Additionally, using the trial beginning in January 2019, as an example, all stocks provided by AI for that portfolio were previously successful or already large corporations in 2018, lowering the chance AI didn't use post-January 2019 data to select corporations which grew popular following the start date.

Comparing AI to HFT

As touched on, AI can analyze and provide insight on information within seconds. However, this trait is not unique to AI and similar technological processes have been used in finance for a few decades now. These analyzation abilities of AI are like the complex algorithms used in high frequency trading.

High frequency trading (HFT) is a type of trading that involves using complex computer systems to execute numerous trades in a fraction of a second (Investopedia 2024 c). The origins of this practice trace back to 1983 when the NASDAQ stock exchange went fully electronic. In the late 1990s, the first high frequency trading firms were developed and over the next decade the practice continued to grow and increase in efficiency. By 2009, HFT accounted for 70% of trades on the market in which these transactions were able to be completed in milliseconds. How exactly do these companies profit and how are they able to trade at such high speeds and large volumes? HFT corporations identify market movements and rapidly place and cancel trades with the goal of profiting from small price movements. Essentially, HFT firms acquire profits through the small price increases that add up over the numerous transactions. The high volume of trades results in increased liquidity in the market and more accurate and up to date share values. However, due to the sheer quantity of trades occurring from HFT, it can cause severe spikes within the market at random. For example, on May 6, 2010, the Dow Jones dropped 10% in just 20 minutes, causing increased criticism towards the practice (Investopedia 2023 c).

The main benefit of HFT is the quick transaction speed and therefore the time saving and human involvement eliminating capabilities due to the algorithm's ability to rapidly analyze markets. Further, its high-speed technology and automated decision making has allowed it to replace brokers and remove human decisions from the trading process. These abilities of HFT algorithms are evidently quite comparable to the efficient analyzation skills of AI.

However, there are considerable differences between the two technologies. HFT's high powered technology and complex algorithms are typically only found at professional institutions. AI, on the other hand, is publicly available for all citizens with access to ordinary devices meaning it can benefit regular investors whereas HFT's benefits are often limited to financial professionals rather than the public. Additionally, the variety of functions AI can perform differs from the more specified focuses of HFT algorithms. AI models like Chat GPT are still algorithms but are trained on a wide variety of texts and data sets to build pattern recognition. This allows for the models to have a broad skill set with the ability to understand and execute human directions. These models are extremely complex and unique in their ability to comprehend both numerical and subjective matters. However, HFT models are simpler in their capabilities and solely focus on market analysis and rapid trading with the only goal being profit. While AI and HFT algorithms overlap in their analyzation abilities, AI's easy accessibility and its diverse skill set of both general and personalized information makes it a unique and potentially more beneficial tool for a typical investor without access to the complex computer systems required for HFT.

Shortcomings of AI

While AI may have qualities that certainly bend the principles of the EMT, there remain flaws within the operation of AI that hinder a user to consistently beat the market. Returning to the EMT, markets continue to be efficient and thus AI, operating off of current or past information, simply cannot outperform the market (Matson Money 2024).

Additionally, many AI's, including ChatGPT, operate off information only up until a certain date and therefore are not fully up to date on what is currently happening in the market during a given period.

Furthermore, AI cannot predict external factors that often have a heavy influence on the market or the economy such as political events, wars, etc. While having no human emotions or potentially biased predictions has its benefits in investing, AI's lack of these traits may result in it being unaware of the general sentiment towards or regarding something. For example, if two nations were on the brink of war (which war usually has a profound impact on the economy), a human would likely be aware of this whereas AI, with a lack of access to real-time data and a lack of human thought, would likely not be able to predict such.

Another shortcoming of AI is the quality of the data and the accuracy of the models. As stated, AI like ChatGPT is not always accurate for a variety of reasons. First, as stated, AI does not pull from real time-data and therefore the answer could become incorrect between the latest information AI has access to versus actual present information. Secondly, AI does not always fully understand the context of what the user is asking and can thus give a skewed response that may be false. Additionally, AI may pull information from data that could potentially be biased but still plausible sounding and convincing, therefore misleading the user. Although these limitations are not in most responses, they can potentially wrongly inform an investor and it is highly advised to double check information from AIs like ChatGPT, especially for important topics including financial advice.

An additional setback of ChatGPT is that it operates more within the lines of adaptive expectations rather than rational expectations. Rational expectations is prediction of the market based on analyzing all information, both past and anticipated, whereas adaptive expectations is only an analysis of past information. AI's generate responses based on the data they were trained on and the patterns they learn. This, in combination with their lack of real time data, can put AI at serious disadvantage when attempting to consistently predict future movements in the economy or market.

Conclusion

This paper analyzes the capabilities and limitations of AI in regard to aiding investors. In the current state of technology, AI is unable to fully break any assumptions of the EMT and thus fails to beat the market consistently as a whole. However, its advanced analyzation and aggregating abilities can certainly make AI an advantageous tool for investors as seen through the increased efficiency of investing by vastly reducing the manual research necessary for conducting rational trades. According to the experiment conducted, AIs like ChatGPT are even capable of synthesizing portfolios that can outperform funds such as S&P 500 or Berkshire Hathaway.

However, AI has a variety of flaws, ranging from its lack of real time data or its periodically inaccurate statements to its susceptibility to biased sources. Currently, AI is not a forward-looking technology and has no ability to predict future events like wars, political factors, etc. Issues such as these make AI incapable of consistently beating the market and a work in progress for use as a reliable source of financial advice.

While AI cannot currently outperform the market, the answer is dynamic and will continue to change over time as technology improves and AI's capabilities expand. AI is rapidly evolving, and the research conducted in this paper leading to the final answer of no is done as of 2024. In order for AI to become a consistent tool to beat the market in the future, its multiple caveats must be improved, and AI must advance enough to fully break at least one assumption of the EMT consistently. When will these improvements be made? Will the answer still be no a decade after writing this? There is no way to currently know, but it is in the best interest of the financial world that research continues to be conducted on the development of AI and its applications.

Others continuing the research of AI within the market should continue to run experiments, in a similar format to the one conducted for this paper, over longer periods and in a significant quantity to get an accurate gauge of how successful AI produced portfolios truly are. Additionally, research on the impacts of different types of AI's should be conducted, taking note of which ones have the greatest benefit for investors and why that is, as the research in this paper was generally confined to AI's like ChatGPT and Danelfin. Lastly, additional investigation on AI's uses in

different sectors of finance should be carried out, branching out further than the sole focus around the stock market within this paper.

Acknowledgements

I would like to thank Dr. Shabbir at the Wharton School of Business and Dr. Rascher at the University of San Francisco for their unwavering guidance and commitment to the development of this paper and my growth as a student. Both professors proved to be invaluable through thoughtful feedback and guidance in the writing process that helped shape the direction of my work. I am deeply grateful for their mentorship and the time they dedicated to helping me research and create this paper.

References

- Anderson, S. (2021, January 29). What does it mean when people say they "beat the market"? *Investopedia*. Retrieved from <https://www.investopedia.com/ask/answers/03/100903.asp>
- Baldrige, R. (2022, May). What is the efficient market hypothesis? *Forbes*. Retrieved from <https://www.forbes.com/advisor/investing/efficient-market-hypothesis/>
- CFI Team. (n.d.). Rational expectations. *Corporate Finance Institute*. Retrieved from <https://corporatefinanceinstitute.com/resources/economics/rational-expectations/>
- Chen, J. (2024, May 10). High-frequency trading (HFT): What it is, how it works, and example. *Investopedia*. Retrieved from <https://www.investopedia.com/terms/h/high-frequency-trading.asp>
- Chussler, J. (2024, June 28). Can AI tools for picking stocks help investors beat the market? *Money*. Retrieved from <https://money.com/ai-for-picking-stocks-beat-market/>
- Matson Money. (2024, May 30). Deciphering the AI hype: Can artificial intelligence beat the market? *Matson Money*. Retrieved from <https://www.matsonmoney.com/deciphering-the-ai-hype-can-artificial-intelligence-beat-the-market/>
- Ferri, R. (2012, March 12). Why smart people fail to beat the market. *Forbes*. Retrieved from <https://www.forbes.com/sites/rickferri/2012/03/12/why-smart-people-fail-to-beat-the-market/>
- Ganti, A. (2024, May 15). What is insider trading and when is it legal? *Investopedia*. Retrieved from <https://www.investopedia.com/terms/i/insidertrading.asp>
- Geeseok Oh, F. (2024, April 25). How AI can help take the emotion out of investor decisions. *Kiplinger*. Retrieved from <https://www.kiplinger.com/investing/investing-decisions-how-using-ai-can-avoid-the-emotions>
- Phung, A. (2024, January 3). How can random walk theory be applied to investing? *Investopedia*. Retrieved from <https://www.investopedia.com/ask/answers/08/random-walk-theory.asp>
- Qlik. (n.d.). AI analytics. *Qlik*. Retrieved from <https://www.qlik.com/us/augmented-analytics/ai-analytics>
- Sebastian, A. (2023, September 3). Arguments for and against insider trading. *Investopedia*. Retrieved from <https://www.investopedia.com/articles/markets-economy/092216/why-insider-trading-bad-financial-markets.asp>
- Tardi, C. (2023, September 19). Rational expectations theory definition and how it works. *Investopedia*. Retrieved from <https://www.investopedia.com/terms/r/rationaltheoryofexpectations.asp>
- United States Congress. (1934, June 6). *Securities Exchange Act of 1934*. United States Statutes at Large, vol. 48.
- U.S. Securities and Exchange Commission. Retrieved from <https://www.sec.gov/rules-regulations/statutes-regulations>