**Carnegie Mellon University**
Tepper School of Business

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## GenAI and Finance

*Gordon Gekko (Wall Street, 1987): "The most valuable commodity I know of is information."*

The film "Wall Street" premiered on December 11, 1987, notably close to the stock market crash of October 19, 1987. Wall Street and the charismatic character Gordon Gekko's line about the importance of information predate not only the advent of ChatGPT and other Large Language Models but also the emergence of the public internet, the iPhone, and the pervasive culture of constant online connectivity. Information has been valuable in finance for centuries. As early as 1850, Julius Reuter utilized carrier pigeons to transmit stock price data between Brussels and Aachen, illustrating the longstanding efforts to enhance and expedite financial information through technology. Given this context, it is helpful to evaluate the impact of emerging AI technologies like ChatGPT on financial markets by focusing on their role in information production.

There are many contexts for which information is important in finance, and it is easy to imagine that many of them will be touched by advances in AI. Here, we will take a look at AI's role in transforming existing information. I have in mind a trader who is using AI and has a "demand" for information. Second, we will ponder the role of AI in the creation of information. Here, we can think of a business model like Moodie's or Compustat that on the "supply" of information. Of course, distinguishing between the "demand" for and "supply" of information is simplistic, as they are interrelated. This approach seems a helpful framework for discussing the impact of AI in finance.

## AI Transforming Existing Information (Demand)

A natural use case for AI models like ChatGPT is document summarization. Sam Altman, head of OpenAI says, "I can't really keep up on my inbox anymore, but I made a little thing to help it summarize for me and pull out important stuff from unknown senders."[1] Feeding a bunch of technical documents to ChatGPT to create a chat-bot for customer support is a standard use-case.[2] In a more focused setting, we can use LLM tools to extract information from financial text like 10K documents or transcripts from management calls with financial analysts.[3] So to

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[1] See: Read TIME's Interview With OpenAI CEO Sam Altman, Edward Felsenthal June 21, 2023. https://time.com/6288584/openai-sam-altman-full-interview/

[2] For example, Andrew Ng has a Jupiter notebook example of document summarization in his DeepLearningAI-ChatGPT-PromptEngineering course. https://github.com/LazaUK/DeepLearningAI-ChatGPT-PromptEngineering/tree/main

[3] See: Meursault, Vitaly, Pierre Jinghong Liang, Bryan R. Routledge, and Madeline Marco Scanlon. "PEAD. txt: Post-Earnings-Announcement Drift Using Text." Journal of Financial and Quantitative Analysis 58, no. 6 (2023): 2299-2326

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structure a discussion of the role of AI and finance, we can first look at AI (meaning generative AI or GenAI and Large Language Models or LLMs) as if they are "just" better information.

For example, a stock analyst reviews 10K annual reports (surprisingly, only a small number of characters in a 10K financial report are digits - most of the report is text), press releases, phone calls with management, plus boundless industry and macroeconomic reports. Compiling all this into a coherent narrative for a company manually is challenging (and tedious). But doing so better than others can be an advantage. For example, one of the hedge funds that sold Enron short ahead of its collapse in 2001 describes the analysis in detail in a Securities and Exchange Commission panel on hedge funds. They describe their role as a "financial detective" combining clues from disparate sources and "effort we devoted to looking behind the numbers at Enron." What is notable in their explanation is their focus on facts that made sense within a document but were at odds with conclusions from other documents.[4] So it seems likely that automating the combination of documents using a tool like ChatGPT will net new information for market traders. Figure 1 illustrates a simple example of this – combine two documents to calculate a return on investment ratio. Of course, this example is easy; we could do this easily by hand (it is homework 1 in Finance 1). However, doing hundreds of calculations across thousands of documents and then summarizing the output is potentially transformative.
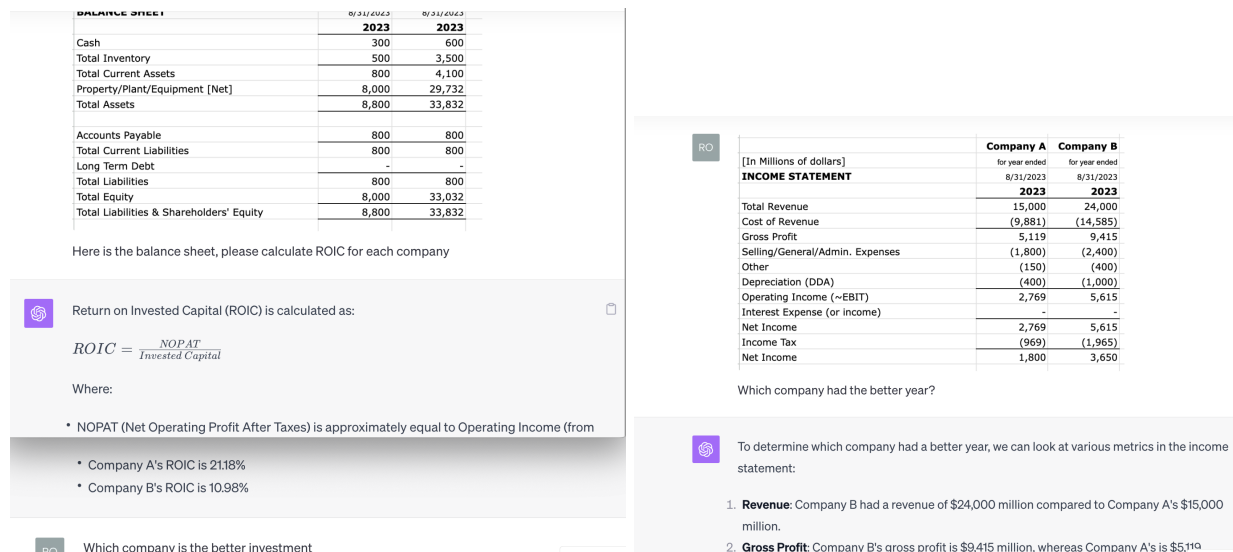


Figure 1: Example from ChatGPT summarizing financial statements

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[4] James Chanos, President, Kynikos Associates, Prepared Statement, U.S. Securities and Exchange Commission Roundtable on Hedge Funds, Panel Discussion: "Hedge Fund Strategies and Market Participation," Thursday, May 15, 2003. https://www.sec.gov/spotlight/hedgefunds/hedge-chanos.htm

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One likely outcome of these new tools is analysts are more efficient, so there are few analysts employed.  However, a better and more comprehensive read of all the available sources will produce better information. How this better information will impact the stock market is a good question. There is a lot of financial economics research about the value of information.[5]  Early empirical research in the 1960s studied the speed at which new information is incorporated into market prices. The result is that information gets into stock prices exceedingly quickly.  This means that it is hard to make money from trading.  And new technology, even AI, is unlikely to undo this conclusion.  The reasoning behind the empirical fact is twofold.  First is competition. Many traders have access to ChatGPT or similar models, and many are developing their own AI algorithms.  Having better information than we have had in the past is not the same as having better information than other traders.  The second reason is more subtle. Even if some traders do have a unique competitive edge from their unique version of an LLM, it can be hard to translate that into profit. Traders are cautious about trading when potentially trading with someone better informed.  This "adverse selection" concern tends to make markets less deep. That means an AI-assisted trader cannot place a large order without moving prices.  Prices go up when they want to buy and down when they want to sell, and that "slippage" can eliminate the potential trading profit.[6]

Together, we can think of these two reasons as emphasiing the the "zero-sum" aspect of trading.  The profitability of a strategy to  buy-low-sell-high is limited by the need for a counter-party who is willing (and able) to sell low and buy high.  But the information itself is not zero-sum.  More traders using more and better AI algorithms may produce market prices that reflect more and better information.  It is interesting to ponder the implications of asset prices that are more informative.  First, more informative stock prices do not translate to "less volatile" stock prices.   One axiom of finance is that stock prices do not change because of information. They change because of new information.  So, we can imagine a world where AI is using satellite images to infer commodity inventories[7] or an economic sentiment index from large data.[8] This is a bit simplistic of an interpretation: All that AI is doing is moving the timing of information (oil inventories, sentiment) from the quarter-end earnings call to the in-quarter timing when the data happens.   The AI algorithm takes inputs and makes predictions.  At the extreme, that prediction might perfect and render subsequent financial statements or earning calls

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[5] There is such a vast number of papers on the role of information and finance.  A nice overview is the review paper of Malkiel, Burton, G. 2003. "The Efficient Market Hypothesis and Its Critics." Journal of Economic Perspectives, 17 (1): 59-82.

[6] More carefully stated, the returns earned from investments in the new technology cover the cost of the technology.  See Grossman, Sanford J., and Joseph E. Stiglitz. "On the impossibility of informationally efficient markets." The American economic review 70.3 (1980): 393-408.

[7] For example, Market Extra: How oil traders are using satellites to keep an eye on an increasingly unpredictable market," Published: Oct. 7, 2019. https://www.marketwatch.com/story/how-oil-traders-are-using-satellites-to-keep-an-eye-on-an-increasingly-unpredictable-market-2019-10-04

[8] Civic Science is one example of a company selling a sentiment index. https://info.civicscience.com/economic-sentiment-index

uninformative. The randomness in those inputs to the AI algorithm will drive randomness in stock prices.

Recognizing that GenAI will be used for more than just aggregating existing information sources is important.  It is also much harder to consider the impact.  For example, many existing corporate reports like the Management Discussion and Analysis in the annual 10K report or the press-release-like information in the periodic 8K report will be authored using GenAI tools like ChatGPT.  What are the implications of one GenAI algorithm using the output of another GenAI?  Or, how will analysts making forecasts with AI change what CEOs/CFOs earning's calls? There is some evidence that, indeed, these calls are more important as investors have more information.[9]  It it the case that AI analysis drives analyst information to be more homogenous leading to an extra importance placed on the human-centered communications in the calls with analysts?   Finally, how much importance will there be on algorithms used to predict what other algorithms are predictioning?[10]

Beyond the stock market analysts and traders, AI is being used by companies to improve their information.  A company that can forecast demand better can have a more efficient supply chain, for example.[11]  Collectively, if all companies have better information, will that lead to different behavior for stock returns?  Historically, the equity risk premium – the average amount by which stocks outperform bonds – is about 6%.  That number presumably reflects the risk in the U.S. Economy that is borne by equity holders.  This is a significant component to all individual financial/retirement planning. Does that number fall if companies have better information?  One financial economic research driven prediciton would not predict a drop in that number.  Much of the risk that drives that 6% value is "long-run" risk about long-horizon variation in growth rates and not short-term quarterly risk factors.[12]  But, of course, if AI is transformative on the economy, we should be cautious with economy-wide predictions.

## AI Creating New Information (Supply)

So far we have been discussing the impact of GenAI on the demand for information and how that might impact financial markets and the economy.  What of the impact on supply?  Information is valuable and, not surprisingly, is a commodity that companies create.  Many

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[9] Beaver, William H., Maureen F. McNichols, and Zach Z. Wang. "Increased market response to earnings announcements in the 21st century: An empirical investigation." Journal of Accounting and Economics 69.1 (2020): 101244.

[10] Competition between algorithms see, Routledge, Bryan, Genetic Algorithm Learning to Choose and Use Information,  Macroeconomic Dynamics 5, April, 2001 and Routledge, Bryan Adaptive Learning in Financial Markets. Review of Financial Studies 12, 1999.

[11] Veldkamp, L., and  Chung, C. (2023). Data and the Aggregate Economy. Journal of Economic Perspectives (forthcoming).

[12] Bansal, Ravi, and Amir Yaron. "Risks for the long run: A potential resolution of asset pricing puzzles." The Journal of Finance 59.4 (2004): 1481-1509.

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businesses create information but do not directly use it to trade. These financial services are brokering information. Reuters and Bloomberg are examples. Information, unlike a physical good, is "non-rival" – the same fact can be sold to many people. Of course, the value to the buyer will depend on who else has access. To frame how GenAI might reshape this landscape, Figure 2 has a stylized figure of the "information supply chain."
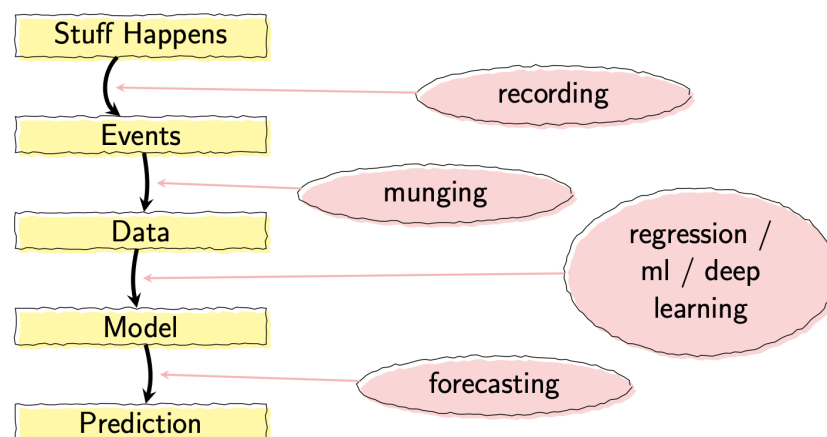


Figure 2: The Information Supply Chain"

Figure 2 lays out the steps that happen on the way to a forecast or prediction. At the top, some physical, social, or economic item occurs. For that to be useful as data it must be recorded to be an "event." Much of the internet or mobile phone usage has transformed what gets recorded. The events are aggregated into a data set. This "munging" is aligning the time-stamps, organizing by user and so on to transfer the collection of events into a dataset. Next is the machine-learning modeling stage. This could be a simple regression or, now, an deep neural netorwok model that is augmented with GenAI (e.g., interpreting the sentiment of text using ChatGPT). Finally, the model is run on an instance to produce a prediction. The prediction might be low dimensional like a yes/no approval of a loan or a high dimensional text report characterizing the risk profile of a potential borrower.

There two things that are interesting to note. First, at each stage there is a market for these components. You can buy raw events such as raw satellite images or a list of mortgage transactions. Many vendors will sell you a database of hundreds of attributes on millions of consumers. Finally, skipping over the estimation stage for a moment, there are many companies that will provide the prediction. For example, a FICO score or a Moody's bond rating. Understanding how GenAI models will change the market for this data is interesting. Does the value of all this input data increase because it is needed to make better AI models?

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Or does the value decrease since any value in that data has already been extracted and is available via existing AI models?

The second feature from Figure 2 that is interesting is that new AI models, like OpenAI's ChatGPT, let users buy access to the model directly.  The ability to access an AI model like ChatGPT through an API is significant. It might be as significant as the development of the model itself.  It is important since it lets users "rent" an AI model rather than having to "buy" one.  This is analogous to the role cloud computing companies like Amazon Web Services has had on business start ups.  Cloud computing significantly lowered the capital need for young companies to get underway.  Renting space on an AWS server and using an open-source software means access to venture capital was less important.  Surprisingly, cloud computing has a significant impact on venture capital.  With less need for a large initial round of funcing, venture capital pivoted to fund more start-ups with many more and smaller bets.  That is an example of technology (cloud computing) changing finance (venture capital) in unanticipated ways.  A focus on how AI changes information is interesting. What will be more interesting will be seeing how the "rental" aspect of AI will also have a broad impact on finance.[13]

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[13] "Amazon.com has altered the VC business as we know it" GeekWire, April 2012, https://www.geekwire.com/2012/amazon-transformed-venture-capital-business/