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LLM Reasoners for Financial Statement Analysis

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Abstract

Comprehensive financial statement analysis with a long-term value investing perspective has traditionally remained accessible only to a limited group of highly experienced investors, due to the significant expertise, time, and analytical rigor it demands. This study presents the **Value Investing Agents (VIA)** framework—an agent-based system powered by multi-modal large language models (LLMs)—which simulates a structured team of specialized financial analysts capable of processing both qualitative and quantitative information. Each agent assumes a dedicated role within the analysis pipeline, enabling systematic evaluation across financial statements, industry metrics, and valuation models.

To ensure factual precision and analytical reliability, the framework incorporates robust data verification techniques, including multi-modal extraction, cross-source validation, and iterative self-critique mechanisms. Additionally, it employs Chain-of-Thought prompting strategies to emulate the reasoning patterns of professional human analysts. Comparative evaluations demonstrate that the VIA system consistently outperforms leading agentic baselines such as Manus and DeepResearch, particularly in terms of data accuracy, report professionalism, and readability.

Moreover, this work introduces a novel implementation of value investing within an LLM-based framework—an area rarely explored in academic research due to its complexity and long evaluation horizon. Results indicate that VIA can produce abnormal returns and identify sustainable growth opportunities, thereby offering a credible approach to long-term, fundamental investment strategy using artificial intelligence.

Declaration

I declare that this dissertation represents my own work, except where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation, portfolio, individual project or report submitted to this University or to any other institution for a degree, diploma or other qualifications.

Signed: _____

Li Xiaoxu

24 Apr 2025

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1. Introduction

Financial analysis for long-term value investing remains one of the most challenging frontiers for artificial intelligence. Fundamental analysis – the Buffett-style practice of deeply evaluating a company's financial statements, competitive position, and intrinsic value over a multi-year horizon – has been underexplored in NLP and AI research. Unlike short-term trading or sentiment analysis, this domain demands understanding complex, unstructured data and waiting years to judge outcomes, making it difficult to model and evaluate with conventional AI techniques. There is a pressing need for advanced AI systems that can address the complexity and time horizon of fundamental investing, expanding these capabilities beyond the rare experts who traditionally excel at them.

In this work, we introduce the **Value Investing Agents (VIA)** framework, an agentic AI system designed to perform comprehensive fundamental analysis and long-term investment decision-making. VIA is composed of multiple specialized LLM-based agents, each simulating a distinct role in an investment research team. For example, one agent acts as a data specialist, aggregating and cleaning financial reports; another serves as a financial analyst, interpreting accounting metrics and trends; a third operates as an industry researcher, contextualizing company performance within market and economic conditions; and a fourth functions as a valuation and trading expert, formulating investment recommendations and timing portfolio decisions. By coordinating these expert agents, the framework mirrors the workflow of human analysts and investors, ensuring that every aspect of fundamental analysis is covered with domain-focused expertise.

To enhance performance and reliability, the VIA framework leverages several advanced techniques:

- **Multimodal Input Processing**: Enables agents to interpret and synthesize both quantitative data (e.g., financial tables, ratios, and time-series) and qualitative content (e.g., earnings call transcripts, news articles, and regulatory filings).
- **Chain-of-Thought Prompting**: Guides language models through structured, step-by-step reasoning to improve the clarity, coherence, and explainability of analytical outputs.
- **Self-Critique and Refinement Loops**: Allows agents to iteratively review and revise their own outputs, identifying and correcting logical or factual inconsistencies.
- **Cross-Source Data Verification**: Ensures analytical accuracy by validating key facts and figures against multiple independent sources before final conclusions are drawn.

Comparative evaluations demonstrate that the VIA system consistently outperforms leading agentic baselines such as Manus and DeepResearch, particularly in terms of data accuracy and report professionalism. Moreover, this work introduces a novel implementation of value investing within an LLM-based framework—an area rarely addressed in academic research due to its analytical complexity and the difficulty of long-term evaluation. Results indicate that VIA can generate abnormal returns and identify sustainable growth opportunities, offering a credible and effective approach to long-term fundamental investing through artificial intelligence.

2. Analysis of Problem

Fundamental analysis and value investing have historically been regarded as intellectually demanding, resource-intensive disciplines that require deep expertise, extensive reading, and significant domain knowledge. As a result, this investment approach has been largely inaccessible to ordinary investors and is traditionally dominated with legendary figures such as Warren Buffett and Charlie Munger. The barriers to entry in value investing stem from three core challenges:

The Information Overload Problem. Successful value investing necessitates the consumption and synthesis of large volumes of various information. Warren Buffett famously advised aspiring investors to "read 500 pages every day," highlighting the central role of information accumulation. The required materials extend far beyond standard financial statements to include academic research, regulatory filings, macroeconomic indicators, earnings call transcripts, industry reports, and other events. Given the sheer volume and complexity of this information, human cognitive and temporal limitations make it exceedingly difficult for individuals to process and analyze such data at scale. Even seasoned investors like Buffett rely on teams of analysts and domain experts to assist in their research.

The Need for Deep Thinking and Industry Expertise. Value investing requires not only data literacy but also the ability to reason across financial, operational, and strategic dimensions. It involves understanding a company's competitive positioning, evaluating long-term cash flow potential, and identifying sustainable economic moats. These forms of analysis often demand a deep, contextual understanding of specific industries and business models. As Buffett has often emphasized, he avoids investing in sectors he does not fully understand, regardless of their perceived profitability or macroeconomic relevance. This selectivity reflects the importance of domain familiarity and nuanced judgment, qualities that take years to develop and are difficult to scale or transfer across domains.

Understanding Societal Dynamics and Human Behavior. Beyond technical and industry-specific knowledge, successful value investing also requires an understanding of broader societal systems and behavioral finance. Investors must interpret the interplay between corporations, regulatory bodies, financial institutions, consumers, and macroeconomic forces. Moreover, markets are driven not only by fundamentals but also by collective psychology. Buffett's dictum—"Be fearful when others are greedy, and greedy when others are fearful"—underscores the importance of contrarian thinking and emotional discipline in investment decision-making. This dimension introduces a qualitative layer of complexity rooted in human behavior, making value investing both an art and a science.

We argue that the advent of advanced artificial intelligence (AI), particularly large language models (LLMs), multimodal systems, and reasoning-capable agent frameworks, presents a significant opportunity to overcome these longstanding challenges. In this work, we propose a novel **Value Investment Agent (VIA) framework**, which leverages the latest developments in AI agents to replicate and scale the capabilities of human value investors. By automating information retrieval, enhancing reasoning across financial contexts, and simulating human-like investment logic, our framework aims to bridge the gap between expert-only investing and scalable, intelligent financial decision-making. The VIA framework is designed to:

- Automate the processing and interpretation of diverse financial documents and market materials through multimodal perception;
- Apply advanced reasoning models to perform fundamental analysis with transparency and explainability;
- Integrate macroeconomic, sectoral, and behavioral insights to simulate long-term, contrarian, and high-conviction investment theses.

In doing so, we aim to unlock value investing for a broader set of market participants, enabling individuals and institutions to conduct high-quality, Buffett-style analysis with the assistance of intelligent, collaborative AI agents. To evaluate the effectiveness of our approach, we conduct empirical testing over a long-term investment horizon spanning more than a decade, demonstrating that our method is capable of consistently outperforming the market and generating abnormal alpha returns for investors.

2.1 Addressing the Long-Context Challenge in Financial NLP

Previous studies in financial NLP have largely focused on tasks involving short-context data, such as financial sentiment analysis (Guo et al., 2023; Wang et al., 2025), machine-learning based stock price prediction (Yu et al., 2023; Wang et al., 2024), and financial Named Entity Recognition (NER) (Shah et al., 2024; Li et al., 2025). These tasks, while valuable, involve relatively simple text processing and do not require models to handle long-form, information-dense documents. For instance, datasets like Financial PhraseBank (FPB) (Malo et al., 2014) and FiQA-SA (Maia et al., 2018) have been widely used for sentiment analysis, while Finance NER (Alvarado et al., 2015; Loukas et al., 2022) datasets have been developed for entity recognition, both using sentence level text or tabular data. However, financial analysts depend on complex, information-dense documents—such as multi-year 10-K filings containing a mixture of narrative text and structured tables—to assess a company's financial condition, a format that existing financial LLMs have yet to fully address.

Our methodology is inspired by The Bitter Lesson (Sutton, 2019), which points out that long-term progress in AI arises not from embedding domain-specific knowledge but from leveraging general-purpose architectures that scale with computation. Embracing this principle, we design our agentic system to rely on high-capacity, reasoning-enhanced LLMs such as DeepSeek-R1, which can handle long input contexts (ranging from 64,000 to 128,000 tokens). Rather than encoding narrow heuristics or hand-crafted rules, we adopt a recursive extraction strategy in which agents iteratively summarize and filter essential information from long documents. At each stage, agents generate structured outputs that serve as input to downstream reasoning modules, and subsequently compare distilled insights against the source material to ensure internal consistency and factual alignment. This recursive summarization and self-verification process enables the agent to efficiently navigate and retain relevant portions of lengthy filings—preserving key financial relationships, contextual nuance, and inter-document dependencies.

By addressing the long-context limitation, our research extends beyond prior work, demonstrating how LLMs can process comprehensive financial disclosures in a manner similar to institutional investment practices such as those employed by the equity funds.

2.2 Bridging the Gap in Complex Financial Analysis and Benchmarking

While recent advances in financial LLMs, such as BloombergGPT (Wu et al., 2023) and FinGPT (Yang et al., 2023), have enhanced the domain-specific capabilities of LLMs,

existing studies have largely concentrated on isolated tasks like text classification (Sinha and Khandait, 2021; Shah et al., 2023; Pei et al., 2024), summarization (El-Haj, 2019; Mukherjee et al., 2022; Dolphin et al., 2024), and numerical reasoning with tabular data (Nararatwong et al., 2022; Chen et al., 2021; Chen et al., 2022; Arun et al., 2023). Kim et al. (2024) pioneered the use of LLMs for fundamental statement analysis (FSA) by utilizing income statements and balance sheets as input. However, their approach still did not fully explore the complete context of financial reports, limiting the depth of financial insights that could be derived. As a complex financial task, full-scale FSA demands a combination of numerical reasoning, summarization, and causality detection, yet it remains largely underexplored. Additionally, there is a lack of efficient benchmarking methods to assess whether LLM-driven financial analysis aligns with real-world decision-making.

To address these limitations, we propose the Value Investment Agent (VIA) framework, which simulates the structured, multi-step analytical workflow of real-world equity research teams, drawing inspiration from investment firms such as Berkshire Hathaway. Unlike prior agent-based approaches, including TradingAgents (Xiao et al., 2025) and commercial platforms such as Manus (manus.im), VIA is designed to operate over long investment horizons—spanning more than a decade—and to produce investment insights with a level of depth and clarity comparable to those of professional analysts. The framework not only extracts and synthesizes key financial data, but also articulates clear investment rationales and evaluates companies' long-term strategic positioning and competitive advantages. By establishing this benchmark, we provide a quantifiable metric for validating AI-assisted investment research, setting a new standard for future FinLLM studies.

2.3 From World Scope 2 to World Scope 5 and AGI

The evolution of AI from narrow, text-based models to fully autonomous, interactive agents parallels the conceptual frameworks proposed in both the cognitive grounding literature and recent AGI taxonomies. Bisk et al. (2020) introduce the notion of World Scope (WS) levels as a roadmap for advancing natural language understanding, from corpus-based models (WS1), to Internet-scale language modeling (WS2), to multimodal perception (WS3), physical embodiment (WS4), and ultimately, socially interactive agents capable of influencing the world (WS5). In parallel, Morris et al. (2024) offer a leveled taxonomy of AGI defined by increasing dimensions of performance, generality, and autonomy, ultimately culminating in systems that can not only perceive but act and coordinate with minimal human oversight. Currently, most large language models (LLMs), including many financial domain-specific variants, operate predominantly within World Scope 2: they are trained on vast amounts of Internet text and exhibit remarkable performance on tasks involving pattern recognition, retrieval, and summarization. However, as both Bisk et al. (2020) and Morris et al. (2024) argue, semantic understanding is fundamentally constrained when grounded only in language. To move closer to true general intelligence, systems must perceive and act in the world, integrating vision, memory, experience, and interaction.

Our VIA framework represents a step toward this broader vision by bridging multiple World Scopes in a practical financial context. First, we expand beyond WS2 by incorporating multimodal capabilities (WS3): our framework enables agents to process structured financial tables, narrative text, and visual materials such as charts and scanned documents, thereby grounding language understanding in perceptual input. This multimodal grounding is essential for accurately interpreting long-form financial disclosures like 10-K filings, where critical meaning is often distributed across text, numeric exhibits, and visual layouts. Second, we make progress toward WS5 and AGI-Level autonomy, as conceptualized by Morris et al.

(2024), by enabling agents to collaborate, reason, and act within a structured financial environment. VIA agents do not merely summarize or label data—they assume specialized roles (e.g., financial analyst, industry expert, valuation specialist) and engage in coordinated decision-making to generate investment theses. These agents then take autonomous actions, such as forming and executing investment strategies over multi-year horizons, with the objective of outperforming market baselines. In this sense, they "do things with language" in the Wittgensteinian sense (Wittgenstein, 1953; Austin, 1975): generating actions that have measurable effects on the external world, including capital allocation and portfolio performance.

3. Literature Review

In recent years, artificial intelligence (AI) models have evolved from single-task predictors to versatile AI agents capable of complex decision-making. Nowhere is this shift more evident than in finance, where large language models (LLMs), advanced reasoning models, and multimodal agents are transforming how analysts interpret data and make investment decisions. We observe that the evolution of AI agents in finance has been going in below four directions, which also inspire and lay foundation for our study: (1) the progression from task-specific LLMs to agent-based architectures; (2) the expansion from language-only models to multimodal finance AI; (3) the shift from knowledge retrieval to reasoning-oriented models; and (4) the potential movement from quantitative trading toward AI-powered value investing.

3.1 From Task-Specific LLMs to Agent-Based Architectures

Natural Language Processing (NLP) in finance has traditionally been applied to specific tasks such as sentiment analysis of news, document classification (e.g., assessing risk disclosures), named entity recognition (NER) for financial events, report summarization, and question answering on numerical data. Pre-trained language models (PLMs) fine-tuned for finance have shown strong performance across these areas. For example, BloombergGPT (Wu et al., 2023), a 50-billion parameter domain-specific language model, outperforms general-purpose models on financial sentiment, NER, and Q&A benchmarks by training on Bloomberg's vast proprietary data. Similarly, open-source initiatives like FinGPT (Yang et al., 2023) leverage publicly available financial data and employ automated data curation pipelines with efficient fine-tuning techniques like low-rank adaptation. While these models achieve high scores on financial NLP benchmarks, such performance does not necessarily indicate a deep understanding of finance or real-world financial reasoning.

Inspired by this gap, researchers have begun designing agent-based architectures that coordinate multiple LLMs (or LLM instances) with specialized roles. Rather than relying on one single model to do everything, these frameworks employ a team of LLM agents, each focusing on part of a complex workflow, and enable them to communicate and collaborate. In finance, Xiao et al. (2024) introduced TradingAgents, a multi-agent LLM framework that mimics the structure of a trading firm. In TradingAgents, separate agents assume the roles of fundamental analyst, sentiment analyst, news analyst, technical analyst, trader, risk manager, etc., exchanging information to jointly decide trades. The trading return beats the simple buy and hold strategy and the various technical trading methods, demonstrating that multi-agent LLM systems can harness diverse data and expertise similar to human investment teams. FinCon (Yu et al., 2024), on the other hand, uses a manager–analyst hierarchy to handle sequential investment decisions. FinCon's agents communicate through natural language interactions and equips each agent with greater memory capacity than humans. Self-critique after each trading episode. Decision-making is improved by monitoring daily market risk and

updating systematic investment beliefs through self-critique. Other frameworks include the Heterogeneous Agent Discussion (HAD) (Xing et al., 2024), a design for financial sentiment analysis, instantiating different LLM agents to reflect diverse reasoning strategies or error tendencies, then having them discuss and vote on an outcome. The research shows that even traditionally single-step tasks can benefit from an ensemble of LLM "opinions".

The trend extends to industry: open platforms like Model Context Protocol (MCP) provide standards for connecting multiple AI assistants with databases and tools (Anthropic, 2025). Anthropic's MCP, in particular, enables LLM-based agents to securely interface with financial databases, knowledge bases, and user-specific data through a unified protocol. This addresses the "isolation" issue by giving agents reliable access to live data they need for making decisions, rather than operating solely on static training knowledge. Similarly, Manus, a proprietary multi-agent coordination framework developed by Imbue, and its open-source variant, Open Manus, focus on structured agent collaboration with persistent memory and role-based reasoning, further enabling long-horizon, multi-step tasks in finance. OpenAI's Deep Research and its automated variant, Auto-Deep-Research, take this further by simulating autonomous research agents that coordinate to perform literature reviews, hypothesis testing, and data-backed financial insights generation. These frameworks showcase a growing shift toward intelligent agent ecosystems that can actively learn, reason, and adapt over time. Overall, the literature shows a clear evolution: where once a single fine-tuned model handled one task, now multi-agent ecosystems of LLMs can tackle the entire end-to-end workflow of financial analysis – from data retrieval and interpretation to collaborative reasoning and decision execution.

3.2 From Language-Only to Multimodal Finance AI

While language models have greatly advanced text understanding, real-world financial analysis involves more than just text – it's a multimodal problem. Annual reports contain tables, earnings presentations include charts and graphs, SEC filings have figures and scanned documents, and analysts often must interpret images (e.g. a company's product photographs or satellite images of store parking lots) alongside text. Traditional LLMs like GPT-3.5 or BloombergGPT, being text-only, cannot directly parse numbers in a table image or the trends in a stock price chart. This limitation hinders their usefulness in finance, where a single question might require reading a mix of textual commentary and visual data. For example, answering "*What was the quarterly revenue trend according to the earnings presentation chart?*" requires both natural language understanding (the question context) and visual interpretation (reading the chart). Early domain models had to rely on workarounds: separate OCR tools to extract text from images, or structured data pipelines to feed tables as text. This often resulted in brittle systems and loss of information (e.g. losing the context of a figure in a PDF). As a result, there has been a strong push towards multimodal AI that can handle text and non-text data in an integrated fashion.

Recent models are now explicitly built for multimodal reasoning. OpenAI's GPT-4o (2024) handles text, images, audio, and video in real time, enabling tasks like chart interpretation and diagram explanation. Google's Gemini series, especially Gemini Ultra, is natively multimodal and excels at cross-modal reasoning, having been pre-trained on text, code, audio, images, and video together. Claude 3 (Anthropic, 2024) offers strong vision capabilities, useful for interpreting diagrams, infographics, and slide content often found in enterprise documents. Meanwhile, models like Doubao-Vision-Pro-32k from ByteDance have emerged as high-context multimodal agents that handle large inputs and visual

reasoning at scale. With these advances, we believe the time is right to make financial analysis and trading a truly multimodal task.

3.3 From Knowledgeable Consultant to Reasoning-Capable Analysts

Early LLMs in finance were often used as general models – that is, as tools to retrieve information from text or to summarize and answer basic questions. Models like GPT-3.5 and the first version of GPT-4 could regurgitate facts from filings or synthesize a news summary, but they exhibited weaknesses in deep reasoning and quantitative comprehension. Finance professionals found that while these models could answer "what happened" they struggled with "why" or "what if" questions that require reasoning through multiple steps or doing intermediate calculations (Bang et al., 2023; Chen et al., 2023; Chiang et al., 2023). It became clear that achieving analyst-level AI required enhancing models' reasoning ability, not just their knowledge.

Over the past two years, major progress has been made in improving the reasoning capabilities of language models. OpenAI's "o-series" models, starting with o1 and o3-mini in late 2024, were designed specifically for complex problem solving. By 2025, GPT-4o combined this reasoning ability with multimodal capabilities, showing significant gains in math word problems, coding, and logical reasoning compared to earlier GPT-4 models (Hello GPT-4o | OpenAI). Similarly, Claude 3 by Anthropic—particularly the Opus variant—was optimized for advanced reasoning tasks, outperforming competitors on benchmarks like GSM8K (math), HumanEval (code), and DROP (logic). These models benefit from techniques such as chain-of-thought prompting, reward modelling and reinforcement learning, as well as the scaling up of data, computing resources and model size.

On the open-source front, DeepSeek-V3 and DeepSeek-R1 exemplify innovative advancements in AI architecture and training methodologies. DeepSeek-V3 employs a Mixture-of-Experts (MoE) framework combined with Multi-head Latent Attention (MLA), activating only a subset of expert sub-networks (~37B active parameters per token out of 671B total), thereby enhancing efficiency and scalability. Building upon this, DeepSeek-R1-Zero introduces a novel approach by applying pure reinforcement learning (RL) directly to the base model without any supervised fine-tuning (SFT). This strategy fosters emergent reasoning behaviors such as chain-of-thought (CoT), reflection, and self-verification, demonstrating that complex reasoning capabilities can arise solely from RL incentives. DeepSeek-R1, on the other hand, adopts a hybrid training pipeline that integrates both supervised and reinforcement learning techniques. The process begins with fine-tuning using curated cold-start data to establish foundational reasoning and general capabilities. This is followed by an initial RL stage aimed at enhancing reasoning patterns. Subsequently, a second round of SFT is conducted, incorporating data from various domains such as writing and factual question answering. Finally, a second RL phase aligns the model's outputs with human preferences, refining its performance across diverse tasks. These structural innovations position DeepSeek as a leading open-source alternative for advanced reasoning tasks, offering models that are both efficient and capable of sophisticated cognitive functions.

3.4 From Quant Trading to AI-Powered Value Investing

The finance world has long recognized a spectrum between purely quantitative, high-frequency trading strategies and long-term, fundamental-driven value investing. Quant trading systems (e.g. statistical arbitrage or algorithmic strategies) are typically rule-based or model-driven, focusing on short-term price patterns, market microstructure, and rapid

execution. They often rely on alpha factors gleaned from data, and trades may be held for seconds to days. These systems excel at exploiting small inefficiencies and managing large numbers of trades with minimal human intervention. In contrast, value investing adopted by investors like Warren Buffett is a qualitative, research-intensive process: investors deeply study company fundamentals, competitive advantages, management quality, and industry trends to assess a stock's intrinsic value. Value investors seek to buy businesses trading below their true worth and hold them for years, letting the market eventually recognize the value. This approach involves reading financial statements, understanding business models, evaluating qualitative factors (like brand strength or corporate governance), and making holistic judgments that often incorporate subjective insights. In practice, modern investment firms blend elements of both – for example, a discretionary fund manager might use quantitative screens to narrow candidates and then apply fundamental analysis. However, the philosophical divide remains: fast, data-driven, automated trading versus patient, thesis-driven, human judgment investing.

Until recently, AI was much more aligned with the "quant" side – algorithms could crunch numbers and detect patterns, but mimicking a value investor's reasoning was far harder. This is now changing with multi-agent, multimodal, reasoning-enhanced AI. The convergence of capabilities described above points toward AI systems that can undertake Buffett-style analysis. The TradingAgents framework described earlier also touched on long-term investing: its fundamental analyst agent is tasked to "assess company fundamentals to identify undervalued or overvalued stocks, providing insights into long-term investment potential", though they still do not adopt a long-term value-driven trading strategy (Xiao et al., 2025). By having a dedicated fundamentals agent and a debate between bullish and bearish perspectives, the system tries to ensure a balanced, diligence-driven conclusion, akin to an investment committee debate. Moreover, the inclusion of a memory component in multi-agent systems in FinCON(Yu et al., 2024) means an AI agent can accumulate knowledge over time, learning from past mistakes or successes. This is analogous to how veteran investors develop intuition and lessons learned over decades.

4. Dataset Construction

We constructed a dataset from 100 US listed companies' most recent 10 years' financial 10-K filings. For each filing, it includes full filing content with text and markdown tables. A sample data piece can be found in Appendix I.

The companies are across 11 different industries from manufacturing to technology, and the average token length of a 10-K file is 123,963.

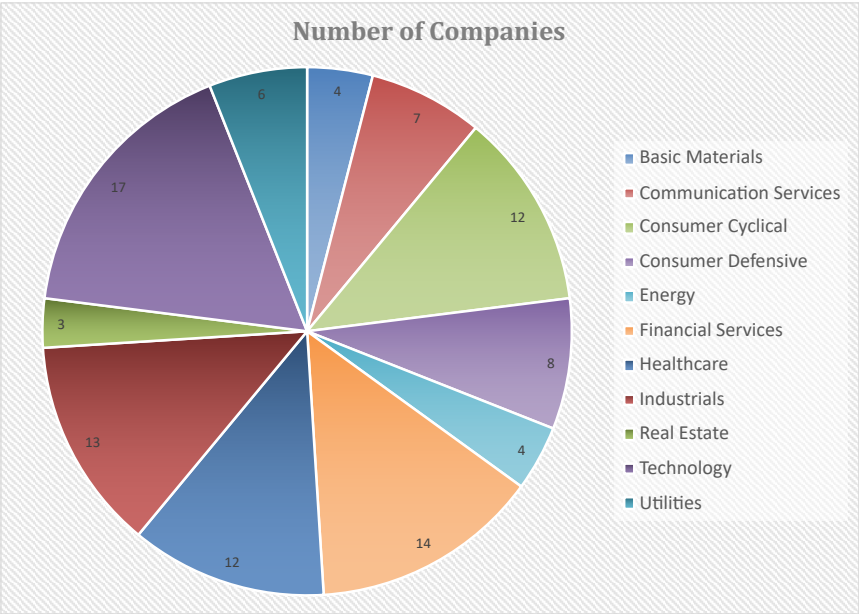

Figure 1: Industries of companies covered.

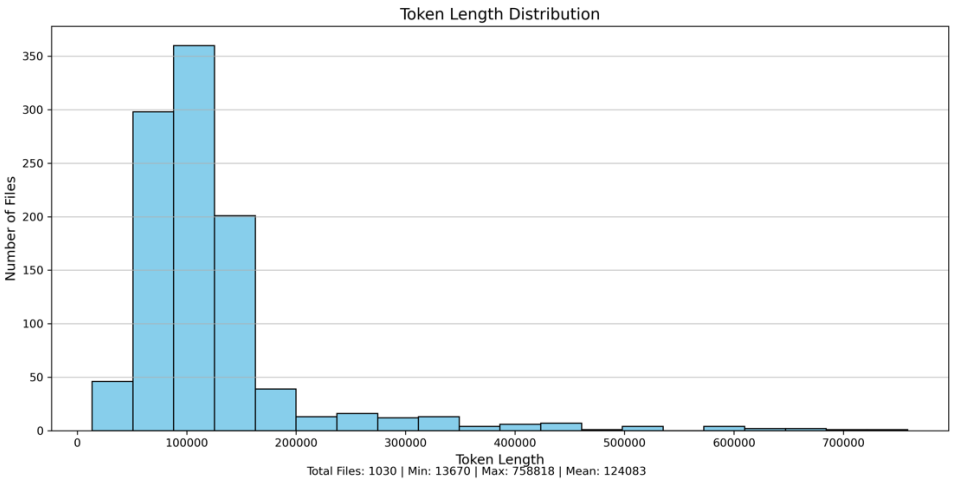

Figure 2: Distribution of token lengths of the 10-K filings.

5. Methodology

Our methodology involves building an agentic workflow by organizing LLMs into specialized teams—such as data specialists, industry researchers, analysts, and valuation and trading experts. We integrate various backbone models, including multimodal, reasoning-focused, and general-purpose LLMs, enabling them to collaborate through natural language communication and execute tasks via tool calls like data retrieval and web search.

5.1 The Agentic Workflow

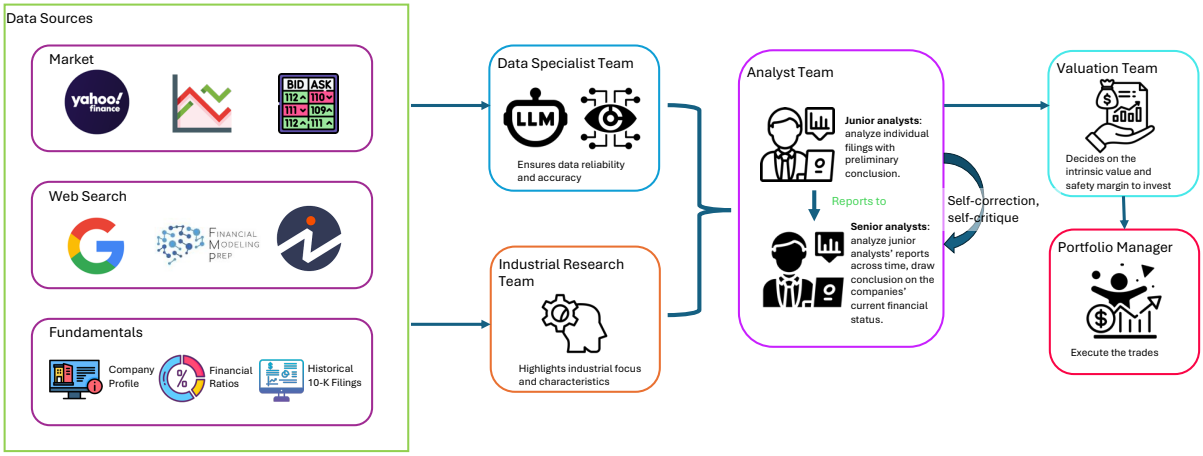

Figure 3: The agentic workflow of Value Investing Agents (VIA) in our work. We design an agentic workflow that mirrors real-world investment teams by assigning large language models (LLMs) to specialized roles—data specialists, industry researchers, analysts, and a valuation and trading unit. Each team is powered by tailored LLMs including multimodal models for data extraction, reasoning-enhanced models for analysis, and general-purpose models for contextual insight. These agents collaborate through natural language and use external tools like web search and data APIs to complete complex tasks. Together, they form an autonomous, explainable pipeline capable of processing diverse financial inputs, reasoning over trends, and executing long-term value investing strategies with minimal human intervention.

5.1.1 The Data Specialists Team

The Data Specialist Team plays a critical role in supporting financial analysis workflows by ensuring that all data is collected, processed, and verified in a manner that is concise, accurate, and machine-readable. Mirroring the functions of human data specialists in investment management firms, the team's responsibilities fall into two main categories: (1) data acquisition and cleansing, and (2) data verification.

Data Acquisition and Cleansing

The team aggregates data from a diverse set of sources, including:

- Financial modeling preparation platforms (e.g., for company profiles and financial ratios),
- Publicly available financial data portals such as Yahoo Finance (e.g., stock prices),
- General web platforms like Google Search (e.g., financial news from Yahoo, CNBC, WSJ),
- Finance knowledge bases such as Investopedia.

All data are collected through API calls.

Data Verification and Structuring

Given the heterogeneity of sources and formats—particularly HTML-based documents with embedded tables and irregular structures—a key task involves extracting and standardizing this data to enable reliable downstream use. To ensure the factual accuracy and structural integrity of the cleansed data, the team performs a second phase of automated verification. This is achieved by leveraging multimodal AI agents, combining:

- Vision models (e.g., for interpreting structured elements such as tables, charts, and visual formatting in HTML), and
- Language models (e.g., for understanding textual content, reasoning over domain-specific knowledge, and validating consistency across sources).

Together, these models work synergistically to transform messy HTML documents into clean, structured, and reliable outputs.

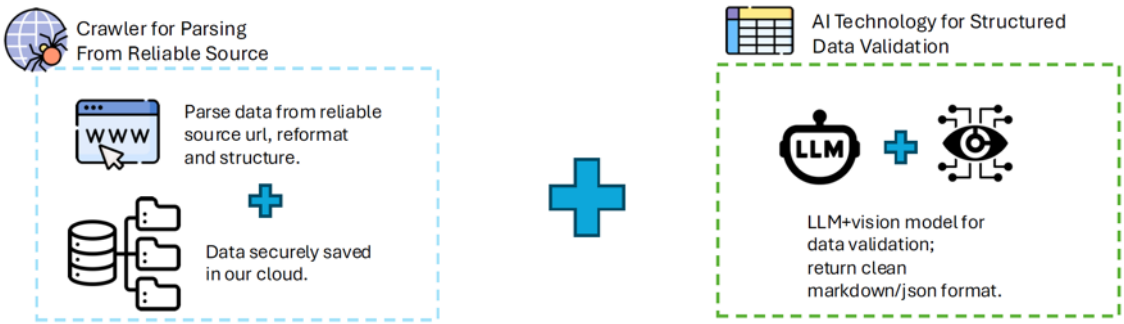

Figure 4: Data verification technique that uses both web-crawling from reliable API sources and multimodal models to guarantee data accuracy and readability.

5.1.2 The Industry Research Team

The Industry Research Team searches across the internet to summarize key metrics that each sector and subsector should pay special attention to. Since GPT-4o is a general-purpose model with strong cross-domain knowledge, we leverage it to generate relevant industry metrics and benchmarks. This is particularly important because statistical analysis has shown that for almost four-fifths of analyzed indicators, the industry has a significant influence on their values (Obradović, Dmitrović, & Kuzmanović, 2019). In further analysis using multiple comparison tests, the study found statistically significant differences between industries across numerous financial indicators. Guided by this insight, our Industry Research Team tailors its output to highlight the most relevant metrics by industry, which are then shared with the Analyst Team for company-level analysis.

Sector	Subsector	Metrics
Technology	Consumer Electronics	"Unit sales growth", "ASP trends", "Product lifecycle metrics", "Margin by product line", "Innovation pipeline value"

Energy	Oil & Gas Integrated	"Reserve replacement ratio", "Production growth", "Refining margins", "Break-even oil price", "Carbon intensity metrics"

Table 1: Samples of the industry expert's output on industrial insights.

5.1.3 The Analysts Team

The Analyst Team consists of junior analyst that focuses on understanding and analyzing individual annual filings of the 100 companies across the past 10 years, and senior analysts that aggregates individual analysis reports across years to get the company's position in its competitive landscape and across time. Especially, both the junior and senior analysts have the self-correction function that will look at the sources chunks where they have drawn the conclusion, and verify if they have used the correct data.

Junior Analyst

The junior analyst examines each SEC annual filing from five critical perspectives:

- Business Strategic Development;
- Income Statement Quality;
- Balance Sheet Quality;
- Cash Flow Quality;
- Ratio Analysis.

For each dimension, a Chain-of-Thought prompting methodology is applied to guide the large language model (LLM) through a systematic, professional reasoning process. The LLM first reviews the 10-K filing in segmented 60K-character chunks, extracting relevant observations for each analytical perspective. These findings are then synthesized into a cohesive narrative that reflects the company's overall performance and strategic positioning. Within the analyst agent framework, specialized reasoning models are employed to enhance causal inference and deepen business insight, enabling more accurate and insightful financial and strategic analysis.

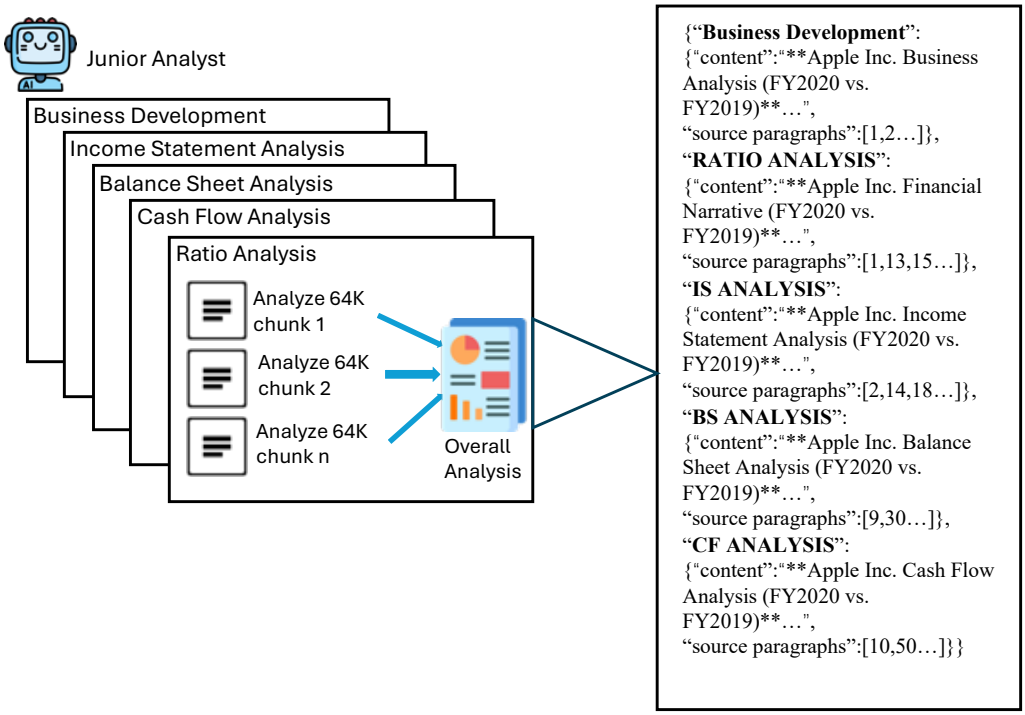

Figure 5: The junior analyst will analyze in 5 aspects given a full 10-K filing in a 64K context window, then aggregate into a comprehensive analysis paragraph.

Junior Analyst – Analytical Aspects
1. Business Strategic Development **Goal**: Assess the company's strategic direction and execution effectiveness. **Key Tasks**: – Analyze business strategy evolution, Porter's Five Forces, SWOT, and product/service development. – Evaluate alignment with industry trends and long-term positioning.
2. Income Statement Quality **Goal**: Understand financial performance and earnings quality over time. **Key Tasks**: – Analyze revenue composition, margins, cost structure, and net income. – Link financial outcomes to business strategy and external factors.
3. Balance Sheet Quality **Goal**: Evaluate financial stability, capital structure, and asset/liability trends. **Key Tasks**: – Review changes in assets, liabilities, equity, and liquidity. – Assess working capital and debt management implications.
4. Cash Flow Quality **Goal**: Assess the company's ability to generate, allocate, and sustain cash. **Key Tasks**: – Analyze operating, investing, and financing cash flows. – Evaluate free cash flow trends and link them to financial flexibility and strategic goals.
5. Ratio Analysis **Goal**: Measure financial performance using key ratios across multiple dimensions.

Key Tasks:
– Evaluate profitability, liquidity, solvency, efficiency, and valuation ratios.
– Interpret multi-year trends and contextualize against industry benchmarks.

Table 2: The 5 analysis aspects of junior analyst.

- Business Strategic Development

Figure 6: The strategic business development analysis framework

We conduct a structured analysis of individual SEC annual filings by guiding the junior analyst LLM agent through a step-by-step reasoning process for each key aspect of a company's performance. Specifically, we examine business strategy and development, Porter's Five Forces, SWOT analysis, and product and service evolution. Each insight is supported with references to specific portions of the filing, ensuring transparency and traceability.

Once the individual parts are analyzed, we synthesize them into a coherent strategic narrative that articulates the company's business evolution, market dynamics, and innovation performance. The result is a clear, objective summary that presents not only what the company has done, but how well it aligns with long-term strategic goals and industry pressures.

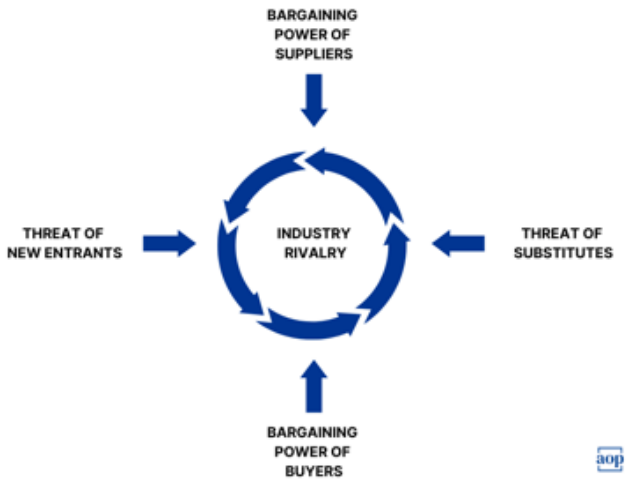

Figure 7: Porter's Five Forces is a framework for analyzing the competitive dynamics of an industry. It considers five key forces that influence a company's competitiveness: (1) Threat of new entrants: The potential for new competitors to enter the market. (2) Bargaining power of buyers: The influence customers have on pricing and quality. (3) Bargaining power of suppliers: The influence suppliers have on the availability and pricing of inputs. (4) Threat of substitute products or services: The availability of alternative products that could attract customers. (5) Intensity of competitive rivalry: The level of competition among existing firms in the industry.

Figure 8: SWOT analysis is a strategic planning tool used to identify an organization's internal strengths and weaknesses, as well as external opportunities and threats. (1) Strengths: Internal attributes and resources that give an organization a competitive advantage. (2) Weaknesses: Internal factors that may hinder the organization's performance or competitiveness. (3) Opportunities: External factors that the organization could exploit to its advantage. (4) Threats: External factors that could potentially harm the organization's performance or pose risks to its success.

- Income Statement Quality

We guide the junior analyst LLM agent through a structured analysis of the company's Income Statement over the past two fiscal years, focusing on five areas: revenue trends, profitability, expense structure, key performance indicators, and causal drivers. The analysis begins with top-line performance, identifying year-over-year revenue changes and segment contributions. We then assess margins—gross, operating, and net—linking shifts to business operations and market factors. Next, we evaluate the cost structure, including COGS, R&D, and SG&A as a percentage of revenue, and flag any non-recurring expenses. Key metrics such as EPS and EBITDA are calculated and interpreted for shareholder impact. All insights are sourced from specific filing segments for transparency.

The findings are then synthesized into a professional narrative that explains financial outcomes through the lens of strategic decisions and market conditions. This results in a clear, data-driven evaluation of the company's financial health and income sustainability.

Figure 9: The income statement analysis framework

- Balance Sheet Quality

For the balance sheet analysis, our process focuses on comparing the most recent two fiscal years across five key dimensions: asset composition, liability structure, shareholders' equity, working capital management, and overall financial health. The LLM agent reviews segmented portions of the 10-K filing to extract and interpret quantitative and qualitative insights, such as shifts in cash reserves, debt levels, retained earnings, and liquidity ratios. These insights are grounded in the underlying data and mapped to specific source chunks for transparency.

After the initial analysis, we synthesize the findings into a coherent financial narrative that presents the company's financial position in a clear, objective manner. This narrative not only highlights material changes and key ratios, but also explains the strategic and operational implications behind them—offering a well-rounded view of the company's solvency, capital structure, and balance sheet strength.

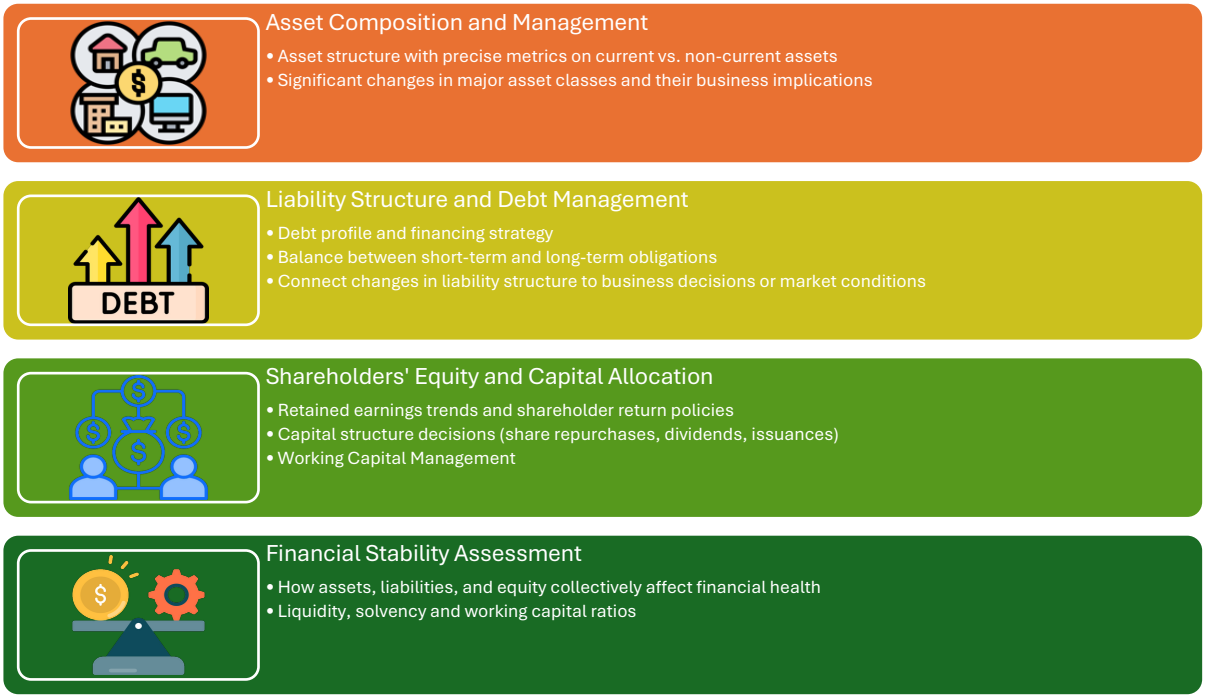

Figure 10: The balance sheet analysis framework

- Cash Flow Quality

We conduct a structured evaluation of the company's Cash Flow Statement by guiding the junior analyst LLM agent through a detailed analysis of the most recent two fiscal years. The review spans five core areas: operating cash flow performance, investing activities, financing activities, free cash flow generation, and overall liquidity. The LLM examines how effectively the company converts earnings into cash, identifies the operational drivers behind cash flow changes, and analyzes capital allocation decisions such as capital expenditures, acquisitions, debt issuance, and shareholder returns. Free cash flow trends are assessed for their adequacy in covering obligations and supporting future growth, while shifts in cash balances are used to evaluate financial flexibility. Each observation is sourced from specific segments of the 10-K filing to ensure transparency and traceability.

The analysis is then synthesized into a cohesive financial narrative that connects cash flow dynamics to strategic decision-making, offering a clear, objective view of the company’s cash generation, utilization, and long-term financial sustainability.

Figure 11: The cash flow analysis framework

- Ratio Analysis

We guide the junior analyst LLM agent through a detailed evaluation of the company's financial ratios over the most recent two fiscal years to assess profitability, liquidity, solvency, efficiency, valuation, and growth performance. The agent interprets both calculated ratio changes and related commentary within the 10-K filing to uncover the underlying drivers of financial performance. The analysis integrates quantitative trends—such as ROE, current ratio, debt-to-equity, and asset turnover—with strategic context, including management actions, market shifts, and operational changes. Each ratio is placed in comparative context through multi-year trends and industry benchmarks, with special attention to cross-category relationships that reveal deeper insights into the company's operating model and capital allocation strategy.

The findings are synthesized into a professional-grade narrative that highlights key financial patterns, strategic implications, and forward-looking indicators, offering a well-rounded view of the company's financial trajectory and competitiveness. All insights are grounded in specific source chunks from the filing for traceability and consistency.

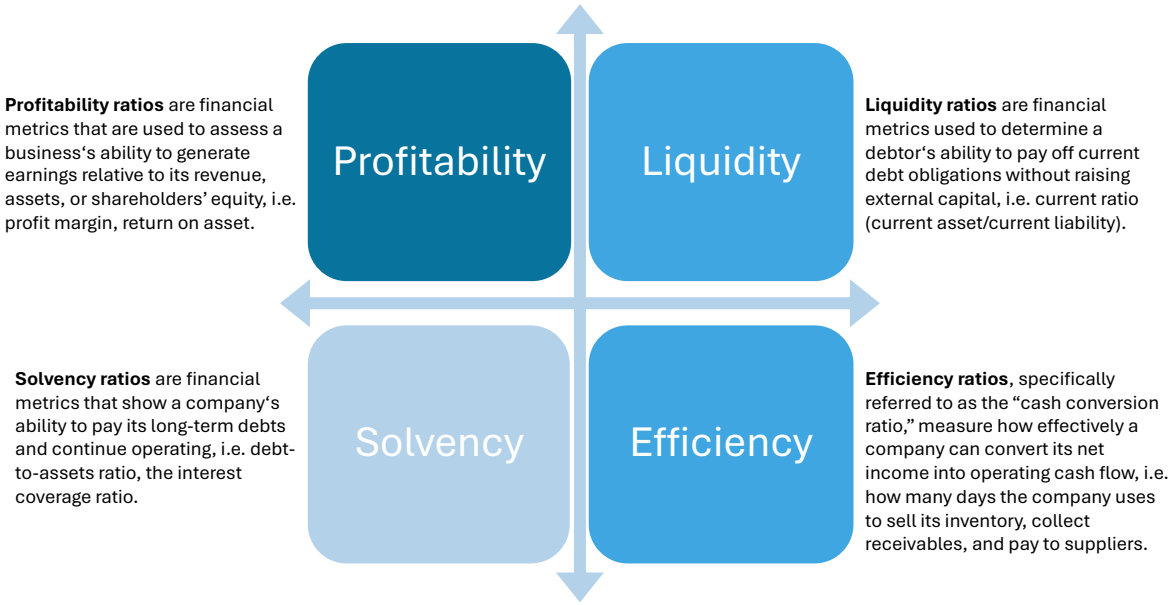

Figure 12: The ratio analysis framework

Senior Analyst

The senior analyst agent, now having the individual annual financial statement analysis reports generated and self-verified by the junior analyst agent, can integrate the individual year's observations into a comprehensive report across the past 5 to 10 years, in terms of the below 8 aspects:

- Strategic Business Development
- Ratio Analysis
- Income Statement Analysis
- Balance Sheet Analysis
- Cash Flow Analysis
- Competitive Position and Economic Moat
- Valuation Analysis and Peer Comparison
- Investment Recommendation

For the first 5 perspectives from Strategic Business Development to Cash Flow Analysis, they are mainly based on the junior analyst's reports' 5 major perspectives; while the last 3 perspectives from Competitive Position and Economic Moat to Investment Recommendation will take into consideration the conclusion drawn in the analysis of the first 5 perspectives. The workflow of the senior analyst agent is demonstrated in below figure 13, and the goal and tasks of each step is detailed in below table 3.

Figure 13: The senior analyst performs an 8-step analyses that will integrate junior analyst's individual annual analysis reports.

Step 1: Business Strategy Development

Goal: **Evaluate the execution and outcomes of the company's strategic plans over the past 5 years.**

Tasks:

- **Identify the company's stated** strategic objectives **(e.g., expansion plans, innovation goals, cost leadership, digital transformation).**
- **Assess whether those strategies were** effectively executed**, using evidence from business activities, financial results, and operational developments.**
- **Evaluate the** impact of strategy execution **on market position, customer base, operational scale, and long-term competitiveness.**
- **Explain** gaps or mismatches **between intended strategy and actual outcomes, and discuss strategic agility or missteps.**

Step 2: Income Statement Analysis

Goal: **Tell the financial story behind the company's performance.**

Tasks:

- **Identify trends in** revenue growth**,** margins **(gross and operating), and** net income **over 5 years.**

- **Explain** why **major changes happened—link them to business events like new products, pricing strategies, market expansions, etc.**
- **Show how financial outcomes affect** competitive advantage **(e.g., strong margins supporting pricing power).**

Step 3: Balance Sheet Analysis

Goal: **Assess the company's financial stability and structural changes.**

Tasks:

- **Highlight trends in** liquidity**,** debt**,** equity**, and** working capital**.**
- **Explain the causes of balance sheet shifts (e.g., debt issuance, buybacks, acquisitions).**
- **Discuss how changes in capital structure affect the company's** resilience and competitive positioning**.**

Step 4: Cash Flow Statement Analysis

Goal: **Understand the company's cash dynamics and strategic flexibility.**

Tasks:

- **Identify patterns in** operating**,** investing**, and** financing **cash flows.**
- **Explain drivers behind big cash movements (e.g., CapEx, debt repayments, buybacks).**
- **Link cash flow management to** strategic agility **and ability to adapt to market shifts.**

Step 5: Financial Ratio Analysis

Goal: **Evaluate financial performance through key ratios.**

Tasks:

- **Track trends in:**
  - Profitability **(ROIC, ROE, margins)**
  - Liquidity **(current, quick ratios)**
  - Leverage **(debt/equity, interest coverage)**
  - Efficiency **(asset turnover, inventory turnover)**
- **Explain what caused changes in these ratios.**
- **Show how these ratios reflect** business strengths or vulnerabilities **and tie them to competitive edge or weaknesses.**

Step 6: Competitive Position & Economic Moat

Goal: **Assess the sustainability of the company's advantage.** Tasks: • **Summarize** financial strengths/weaknesses **and how they affect competitiveness.** • **Define the company's** core advantages **(e.g., brand, tech, cost structure).** • **Analyze whether the** economic moat is widening, stable, or shrinking**, based on recent financial and strategic actions.**
Step 7: Valuation & Peer Comparison Goal: **Evaluate how the market prices the company vs. its peers.** Tasks: • **Choose appropriate** valuation ratios **(P/E, EV/EBITDA, etc.) for the sector.** • **Compare current ratios to** peers and historical norms**.** • **Explain** why **the company trades at a premium or discount (growth, risks, competitive edge).** • **Assess if the market valuation aligns with** intrinsic value**, considering strengths, growth, risks, and strategic context.**
Step 8: Investment Recommendation Goal: **Deliver a final, well-supported investment call (Buy/Hold/Sell).** Tasks: • **Recap key findings:** financial health**,** competitive strength**,** valuation**.** • **Make a** clear recommendation**, grounded in the previous analysis.** • **Justify using** value investing principles**, including margin of safety, intrinsic value, and long-term outlook.**

Table 3: The Senior Analyst Framework for generating cross-year comprehensive reports.

Self-Critique and Self-Refinement

Both the junior analyst and senior analyst needs to go through a multiple round self-critique and self-refinement process before they are satisfied with the results. In this process, they need to consider both the quantitative aspect on whether the numbers quoted or calculated are accurate and consistent with the source data, and the qualitative aspect about whether the analysis and conclusion make business sense. This process is illustrated in below figure 14-1. After the self-critique and self-refine, the LLM needs to act as a judge and decide on whether the current result is satisfactory in both qualitative and quantitative aspects. If it decides that the current result is satisfactory, it will end the loop and return the result; otherwise it needs to go into a new round of self-critique and self-refinement until it thinks the result is satisfactory, or the number of rounds exceeds 3. The self-critique, self-refinement and LLM-

as-a-judge loop is illustrated in below figure 14-2. Experimental result shows that 44% of the time the LLM will end within one round, and 68% of the time it will end within two rounds.

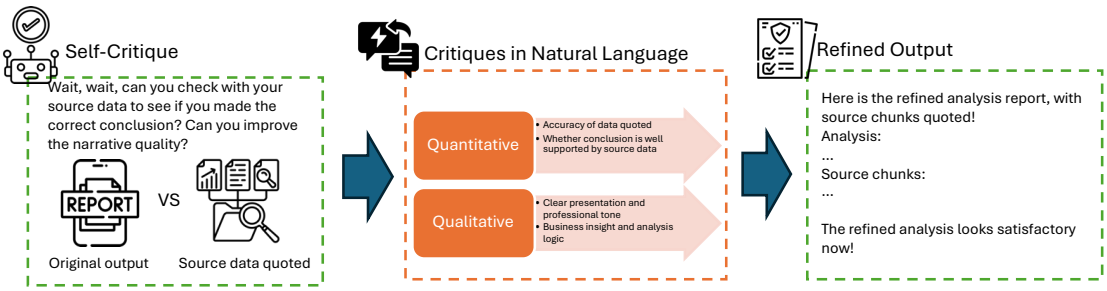

Figure 14-1: The self-critique and self-refinement process

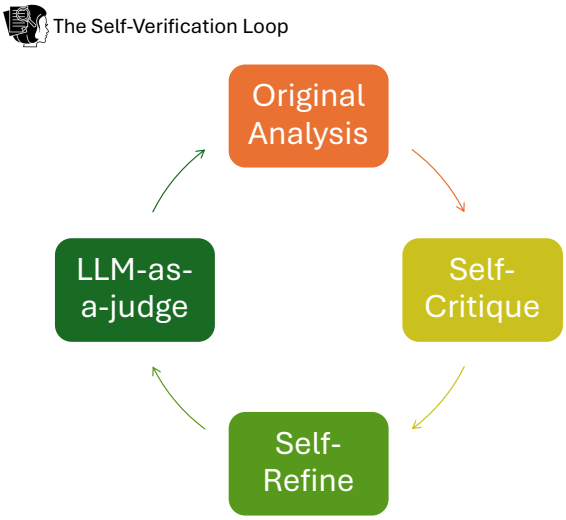

Figure 14-2: The LLM self-critique, self-refinement, self-judge loop.

Below Figure 15 and Figure 16 are two examples of how the analyst agents self-critique and refine their output. A full critique can be found in Appendix II.

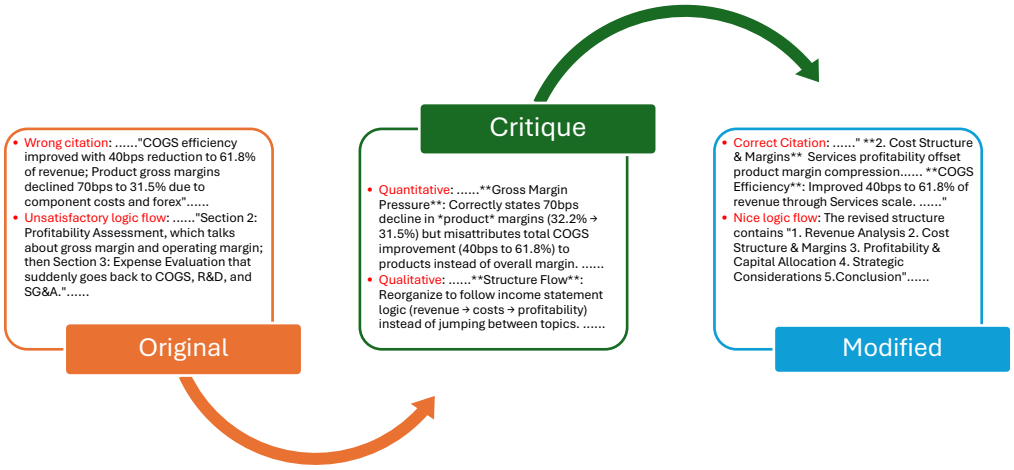

Figure 15: A junior analyst conducting one round of self-correction and improvement. In the original output, it has two problems (1) If first states the overall gross margin improved by 40bps, followed by a statement that the product gross margin declined by 70bps. The is misleading and the audience may wonder why the gross margin is moving in both directions. The modified output fixes this problem by clarifying that the product gross margin has declined, but since the company has increased its revenue portion from the high-margin service business, the overall gross margin has been improved. (2)The original narrative flow is counter-intuitive in talking about margin analysis before cost structure. The modified narrative flow follows Revenue -> Cost Structure ->Margins and Profitability.

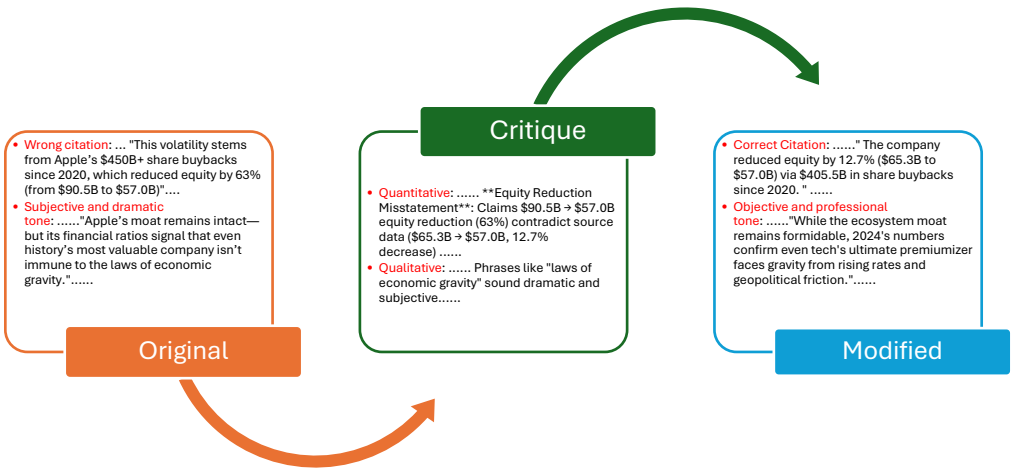

Figure 16: A senior analyst conducting one round of self-correction and improvement. In the original output, it has two problems (1) It exaggerates the number of shares through the buybacks since 2020, and the reduction in equity. In the modified output, it fixes this quotation error. (2)The original narrative flow uses subjective and dramatic expression such as "immune to the laws of economic gravity". In the modified output, it fixes this tone problem by using more neutral and professional expression.

5.1.4 The Valuation and Trading Team

The Valuation Specialist

The Valuation Specialist is responsible for determining a stock's intrinsic value and setting appropriate safety margins for trading decisions. It leverages web search tools to gather contextual data, including industry averages, peer performance, and the company's historical positioning. Based on this information, it applies market comparables—such as P/E, P/S, and EV/EBITDA ratios—to evaluate whether the stock is a buy, hold, or sell. It also recommends upside and downside safety margins to guide risk-aware trading.

Valuation Report of AAPL, 2023-11-03 (FY2023 Q4 Results)
========== Intrinsic Value Per Share: **$160** ========== Safety Margin: **15%** ========== Upper Bound: **30%** ========== Valuation Analysis: Apple's stock continued to climb in 2023, reaching about $175/share in early November despite FY2023 seeing a small revenue and profit dip (the first annual sales decline since 2019). This pushed Apple's trailing P/E to roughly 27–28×. Investors treated Apple as a safe haven tech stock – it traded at a 35% P/E premium over the S&P 500 and ~22% over median tech peers by late 2023. The valuation implied confidence that Apple's ecosystem momentum would offset the temporary hardware slump. Our intrinsic valuation balances Apple's strong moat with the reality of flat-to-declining FY2023 earnings: • **P/E:** We apply 25× to FY2023 EPS ($6.15), a slight contraction from the market's 27–28×, to reflect the growth slowdown. This gives an intrinsic value of roughly $155 per share. The 25× multiple is still above the market's long-term average, but reasonable given Apple's superior ROIC (~39% vs ~14% sector) and anticipation of new product cycles (e.g. Vision Pro AR headset). • **EV/EBITDA:** Apple's EV/EBITDA around this time was in the low-20s. We choose ~18× for intrinsic value, yielding a similar **$150–$160** range. Notably, Apple's EV/EBITDA was about a 12% discount to Microsoft's in 2023 (Apple ~19× vs MSFT ~22×) but well above Meta's 12×, reflecting Apple's steadier profile. • **P/S:** Around 7× sales (with ~$383B revenue), Apple's P/S remained between hardware and software norms. Given stable margins, this again points to a value in the mid-$150s (since 5× would be too low and 10× too high for Apple's mix).

DDM Check: Dividend ~$0.95 (yield 0.55%). Even with an optimistic growth outlook, the DDM value ($45–$50) is only a fraction of the stock price – a reminder that investors in 2023 were focused on Apple's *total cash return* (dividends + big buybacks) and future growth, not just the dividend stream. Apple returned an enormous ~$90B via buybacks in FY2023, shrinking share count ~4% and buoying EPS despite flat net income.

Our **intrinsic value estimate for late 2023 is about $160/share**. The stock at $175+ appeared *somewhat overvalued (~10% above intrinsic)*. The market's optimism (Apple stock +28% YTD vs +18% Nasdaq by Nov 2023) was "pricing in" perfect execution of Apple's next moves (continued services growth and a successful Vision Pro launch). Any hiccup in those expectations meant the intrinsic value would lag the market price.

Figure 17-1: A sample valuation report of AAPL after Nov 2023's annual report release.

Figure 17-2: A sample search tool use by the valuation agent of the issues it wants to further clarify on AAPL Nov 2023's annual report.

The Portfolio Manager

The Portfolio Manager makes investment decisions based on the Valuation Specialist's assessments. It will:

- **Buy** when the stock price falls below:
  intrinsic value × (1 − downside safety margin)
- **Sell** when the stock price rises above:
  intrinsic value × (1 + upside safety margin)

If a buy condition hasn't been triggered, or after a sell if no new buy condition is met, the Portfolio Manager holds cash, earning a **4% risk-free interest rate**.

5.2 The Backbone LLMs

We leverage a diverse set of backbone language models, each chosen for its unique strengths in handling financial analysis tasks. Together, they form a collaborative agentic system, with each model assuming a role that matches its capabilities.

Doubao-Vision-Pro-32k

Doubao-Vision-Pro-32k is a high-context multimodal model capable of processing complex documents, charts, and tables, developed by Bytedance. It is suitable for the role of the Data Specialist, responsible for extracting, verifying, and structuring information from multimodal financial sources such as earnings presentations, scanned reports, and infographics.

DeepSeek-R1

DeepSeek-R1 is an open-source model optimized for reasoning and analytical tasks, particularly in math, logic, and causal inference. It also features strong self-critique and refinement capabilities. It is suitable to serve as the Analyst, handling numerical reasoning, interpreting financial metrics, and refining investment theses through iterative thought processes.

ChatGPT-4o

GPT-4o is a general-purpose multimodal model with strong world knowledge, fast response times, and expertise in industry-specific information. It is suitable to function as the Industry Research Expert, supplying sector benchmarks, competitive landscapes, and macroeconomic context to support company-level analysis.

Combination of Open-Source Models via Brave Search

Brave Search is a search-enhanced setup using open models to access real-time market information, valuation benchmarks, and investor sentiment. It is suitable to act as the Valuation Resource Agent, gathering market consensus, analyst price targets, and valuation ranges to assist in determining intrinsic value.

5.3 Types of Agent Interactions

In the VIA framework, agents interact primarily through natural language exchanges and structured outputs, mimicking collaborative workflows found in real-world investment teams. Junior analysts pass their insights to senior analysts, who synthesize multi-year trends. Valuation agents consult analysts for financial conclusions before recommending trading margins. Additionally, agents perform self-critique and feedback loops, where one agent reviews the output of another or revisits its own reasoning to refine conclusions. This multi-turn, role-specific dialogue ensures interpretability, accountability, and coherence across the end-to-end financial analysis pipeline.

5.4 Tool Calls

To augment their capabilities, agents issue tool calls for specific tasks that require external computation or data access. These include web search for live market data, API calls to financial databases for stock prices and ratios, and retrieval modules for fetching long-context content such as historical 10-K filings. Multimodal agents invoke OCR and vision tools to

process tables and charts embedded in PDFs or slides. Tool calls are orchestrated based on task context and are seamlessly integrated into the agentic dialogue, enabling LLMs to move beyond static knowledge and perform dynamic, data-informed reasoning.

6. A Comparison Between Our Method and Other Popular Agentic Frameworks

We conduct an intuitive comparison between the Value Investing Agents (VIA) report, and the reports generated by Manus and Deep Research. We use the recent 5 years analysis report of Apple Inc. (AAPL) as an example.

6.1 Our Method vs Manus

The Value Investing Agents (VIA) report stands out relative to the Manus-generated analysis in terms of professionalism and analytical depth. VIA provides a far more insightful and technically rigorous examination of Apple's financial statements: it dissects the last five years of performance through detailed ratio analysis, year-by-year income statement and balance sheet trends, and nuanced cash flow evaluations. In contrast, the Manus report primarily presents a compilation of basic financial metrics and growth figures with only superficial commentary, lacking the same level of contextual interpretation or critical insight. For example, Manus's report itemizes improvements in Apple's profitability metrics – noting gross margin expansion to 46.2% and net profit margin to 24.0% by 2024 – but largely attributes these trends to broad factors like the rise of high-margin services without further exploration. VIA's analysis, on the other hand, not only quantifies such changes but also digs into their underlying drivers (e.g. specific shifts in product mix, cost management initiatives, or cash flow allocation decisions each year), thereby delivering a more sophisticated, professional-grade assessment grounded in thorough financial insight rather than just metric reporting.

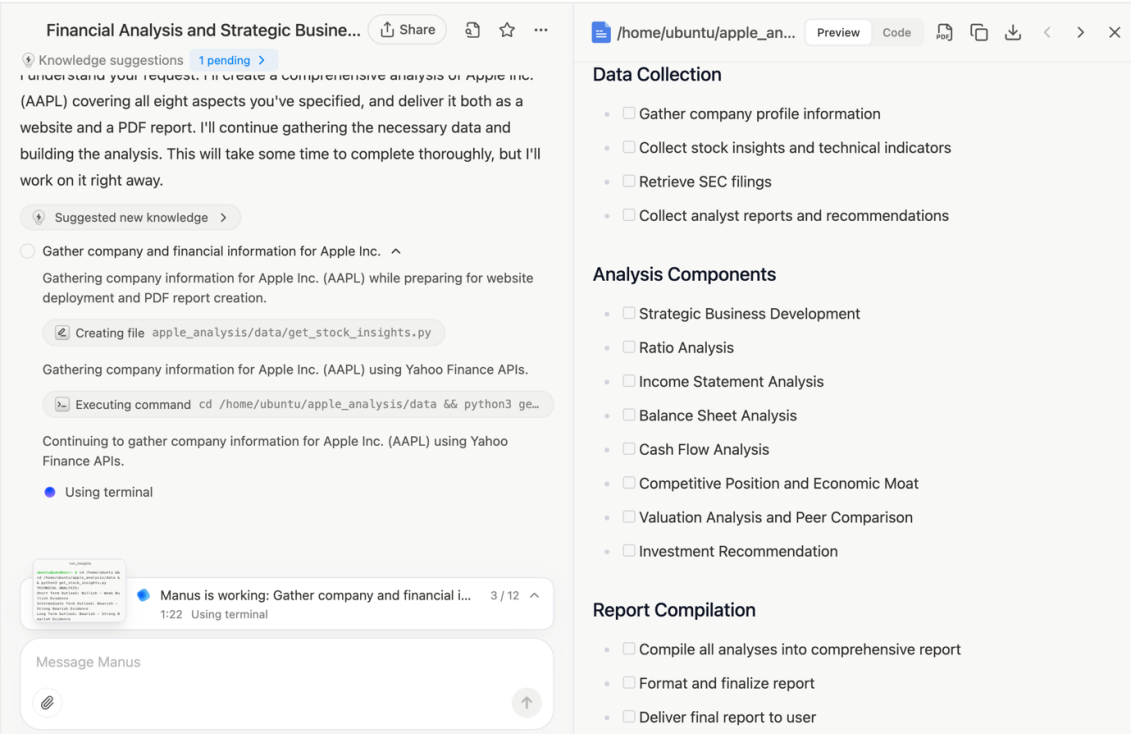

Figure 18: Manus generates a to do list given the task. The procedures listed is very similar to that of Value Investing Agents.

Cost Structure and Margins

Apple's cost of revenue was $210.35 billion in fiscal 2024, resulting in a gross profit of $180.68 billion and a gross margin of 46.2%. The gross margin has expanded by approximately 80 basis points annually over the past five years, driven by the growing contribution of high-margin services.

Operating expenses totaled $57.47 billion (14.7% of revenue), with research and development accounting for $30.0 billion (7.7% of revenue) and selling, general, and administrative expenses at $27.47 billion (7.0% of revenue). The company has maintained disciplined expense management while continuing to invest in innovation.

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Apple Inc. (AAPL) Financial Analysis - March 2025

Operating income reached $123.22 billion, representing an operating margin of 31.5%. Net income was $93.74 billion, with a net profit margin of 24.0%. Earnings per share grew to $6.11, an increase of 8.7% from the previous year, outpacing revenue growth due to the company's share repurchase program.

Figure 19: Manus' analysis of AAPL's cost structure over the past five years provides only basic numerical data points without examining trends over time or comparing AAPL's competitive position with its industry peers. This analysis falls short of expectations, lacking depth and professional insight, thus offering limited value in understanding AAPL's financial landscape. The full document can be found at: https://3000-i0sezssl7guaxrv6gcbtq-38d8bd83.manus.computer

Comprehensive Analysis

Business Development | Ratio Analysis | Income Statement | Balance Sheet | Cash Flow | Competitive Position | Valuation | Recommendation

Apple Inc. Five-Year Financial Performance & Competitive Positioning Analysis

1. Revenue Evolution & Profitability Trends

Apple demonstrated structural resilience from FY2020-FY2024, navigating pandemic disruptions and macroeconomic volatility. Revenue grew from $274.5B to $391B (42.5% cumulative), with distinct growth phases:

- **Hypergrowth Phase (FY2021):** 33% revenue surge to $365.8B driven by 5G iPhone adoption and work-from-home demand
- **Post-2021 Normalization:** Growth moderated to 8% in FY2022, turned negative (-3% in FY2023) from FX impacts and demand stabilization, then recovered to +2% in FY2024 through Services acceleration

Profitability Transformation:

- Gross margin expanded 8 percentage points (38.2% → 46.2%) through Services mix shift and vertical integration:
- *2020-2024 Progression*: 38.2% → 41.8% → 43.3% → 44.1% → 46.2%
- Services now generate 2x more profit per dollar (73.9% margin) vs Products (37.2%)
- Operating margin peaked at 31.5% (FY2024) despite absorbing $13B EU tax charge partially offset by $3B R&D credits
- Net income volatility (-3.4% in FY2024) masked 7.8% operating profit growth through disciplined cost control

Figure 20: VIA's analysis report of AAPL 5-year profitability after 2024 annual report release. It offers data of trend across the years, with a sound analysis of the trend, noting the effect of the pandemic and macroeconomic volatility. For margin analysis, it can tell that there are two sectors: product and services, with different gross margin that collectively results in the progression of the increased overall gross margin.

6.2 Our Method vs OpenAI Deep Research

When compared to the DeepResearch-generated report, VIA's analysis is more focused and transparently sourced, despite DeepResearch's strong analytical content and exhaustive scope. The DeepResearch report is indeed is very thorough, at the cost of concision and focus. Moreover, the DeepResearch analysis lacks clear source traceability. It draws data from numerous secondary sources of varying reliability (e.g. media articles and financial aggregators) rather than directly from Apple's 10-K filings. As a result, readers are presented with revenue and margin figures pulled from third-party compilations without immediate links to Apple's primary documents, complicating verification. By contrast, VIA's report structures its insights around Apple's official annual filings, breaking down each fiscal year's results as reported in the 10-K; this primary-source-driven, year-by-year approach maintains a tight focus on the financial statements and enhances transparency and credibility by making verification straightforward.

Income Statement Analysis (Revenue, Margins, and Earnings Trends)

Apple's income statements for 2020 through 2024 show robust growth initially, followed by a plateauing of revenue at a very high level, alongside improving margins. **Revenue Growth:** Apple's annual net sales grew from $274.15 billion in FY2020 to a peak of $394.3 billion in 2022, then slightly declined to $383.3 billion in 2023 before rebounding to **$391.0 billion in 2024** (AAPL | Apple Inc. Annual Income Statement - WSJ). This corresponds to a **5-year CAGR of ~7.3%**, but the trajectory was uneven: FY2021 saw explosive +33% growth (as new 5G iPhones and pandemic-related demand for Macs/iPads drove sales) (AAPL | Apple Inc. Annual Income Statement - WSJ), FY2022 was +7.8%, FY2023 dipped –2.8% (macroeconomic softness and supply constraints), and FY2024 was +2% (AAPL | Apple Inc. Annual Income Statement - WSJ). By 2024, Apple's revenue almost matched its all-time high from 2022, reflecting resilient demand. Growth was increasingly led by services and new product launches rather than unit volume – for example, 2024's slight uptick came from services (+13% YoY) offsetting small declines in iPad and wearables sales (Charted: How Apple Makes its $391B in Revenue). The **revenue mix** has been shifting: the iPhone remains the largest segment (about 51% of 2024 sales) but services have grown to ~25%, while Macs, iPads, and wearables each contribute high-single-digit percentages (Charted: How Apple Makes its $391B in Revenue). This diversification is evident in Apple's FY2024 revenue breakdown (see image below).›

(Charted: How Apple Makes its $391B in Revenue) *Apple's FY2024 revenue was $391 billion (2% YoY growth), with over half coming from iPhone sales. Services contributed 25%, making it the second-largest segment, followed by Wearables/Home (9%), Mac (8%), and iPad (7%). This reflects Apple's increasing revenue diversification beyond the iPhone. Regionally, the Americas accounted for 43% of revenue in 2024, Europe 26%, Greater China 17%, Japan 6%, and Rest of Asia Pacific 8%, illustrating Apple's broad geographic reach.* (Charted: How Apple Makes its $391B in Revenue) (Charted: How Apple Makes its $391B in Revenue)

Figure 21: OpenAI's Deep Research is very good at pulling large amount of information from various sources and form lengthy analysis report. However, it lacks a professional logic and clear structure, which makes the report less reader friendly, and difficult to catch the key points and insights.

Analysis Reports

Business Development | Ratio Analysis | Income Statement | Balance Sheet | Cash Flow

Apple Inc. Financial Performance Analysis (FY2024 vs. FY2023)

Executive Summary

Apple delivered 2% revenue growth to $391B in FY2024, recovering from 2023's 3% decline though trailing S&P 500 tech peers' average 5% growth. Strategic Services expansion (13% YoY) and record 46.2% gross margins offset China challenges and hardware declines. Operating income grew 7.8% despite a $13B total tax provision increase ($29.7B vs $16.7B), including $10.2B EU charge disclosed by management. The company maintained industry-leading 31.5% operating margin through cost discipline while investing $31.4B in R&D (8% of sales) per innovation roadmap disclosures.

1. Revenue Analysis

Top-Line Performance: - iPhone stabilization ($201.2B, flat YoY) and Services acceleration ($96.2B, +13%) drove recovery - iPad (-6%) and Wearables (-7%) declines reflected product cycle timing

Structural Shifts: - Services reached 24.6% of revenue (+240 bps), reducing hardware dependence - Geographic rebalancing: Europe +7% vs Greater China -8% (Huawei competition + FX impacts)

Growth Drivers: - iPhone ASP stabilization via Pro model mix (16 series launch) - Installed base monetization: 2.2B+ active devices fueling App Store/subscriptions

Figure 22: Compared to that of Deep Research in Figure 21, the analysis generated by VIA is much more concise and straight to the point. It notes the iPhone stabilization, service acceleration and iPad/Wearables decline, and correctly conclude it as a structural shifts and geographic rebalancing.

7. The Value Investing Trading Strategy

Our investment horizon starts on 1 Jan, 2020. Initially, the agent is given a sum of 1 million USD to trade. If there is cash on hand, and no buy execution, it will hold the cash to earn the interest free rate of 4%. The trigger of a buy or a sell execution is described previously is section 5.1.4. The Valuation and Trading Team. In both the baseline strategies and the VIA strategy, we assume dividends will be kept as cash with no re-investment for simplicity.

7.1 Baseline Trading Strategies: Buy and Hold, Technical, and More

Buy and Hold. A passive investment strategy that involves purchasing the stock at the start of the simulation period and holding it throughout, regardless of price fluctuations. Dividends received are retained as cash and not reinvested, reflecting a conservative income-preservation approach.

MACD(Moving Average Convergence Divergence). A momentum-driven, trend-following strategy that generates buy and sell signals based on the crossover of the MACD line and its signal line. It seeks to capitalize on shifts in market momentum and capture directional trends as they emerge.

ZMR (Zero Mean Reversion). A mean-reversion strategy that identifies trades when prices deviate significantly from a central zero-reference level, under the assumption that such deviations are temporary and will revert to the mean. This approach aims to exploit price overextensions and reversals.

SMA (Simple Moving Average). A trend-following strategy that issues trading signals based on the crossover of short-term and long-term moving averages. A buy signal occurs when the short-term average crosses above the long-term average, and a sell signal occurs when the opposite happens. It is designed to capture and ride sustained market trends.

7.2 Evaluation Metrics

Cumulative Return (CR). Cumulative Return represents the total percentage gain or loss of a portfolio over the entire simulation period. It is calculated as:

$$CR = \frac{(V_{end} - V_{start})}{V_{start}} \times 100\% \qquad (1)$$

Where V_{end} is the portfolio value at the end of the simulation, and V_{start} is the initial portfolio value.

Annualized Return (AR). Annualized Return expresses the cumulative return on an annual basis, adjusting for the number of years in the investment horizon:

$$AR = \left(\left(\frac{V_{end}}{V_{start}} \right)^{\frac{1}{N}} - 1 \right) \times 100\% \qquad (2)$$

Where N is the number of years in the simulation period.

Sharpe Ratio (SR). The Sharpe Ratio evaluates risk-adjusted performance by comparing the portfolio's excess return over the risk-free rate to its return volatility:

$$SR = \frac{\bar{R} - R_f}{\sigma} \qquad (3)$$

Where $\bar{R}$ is the average portfolio return, R_f is the risk-free rate (e.g., yield of 3-month Treasury bills), and σ is the standard deviation of the portfolio returns.

Maximum Drawdown (MDD). Maximum Drawdown quantifies the largest observed drop from a peak to a trough in portfolio value over the simulation period:

$$MDD = \max_{t \in [0,T]} \left(\frac{Peak_t - Trough_t}{Peak_t} \right) \qquad (4)$$

7.3 The Value Investing Agents (VIA) Trading Strategy and Results

Our VIA trading strategy significantly outperforms market benchmarks such as buy-and-hold and traditional technical strategies. The key to this outperformance lies in its disciplined entry timing. VIA only enters the market when the stock price drops below its estimated intrinsic value multiplied by (1 − safety margin). This timing is critical — entering when the stock is undervalued allows the strategy to fully capture long-term appreciation. Until then, VIA holds cash and earns a risk-free interest rate. Once a favorable entry point is reached, the strategy deploys a larger cash position — effectively buying more shares at the bottom — and amplifies returns as the stock recovers. The chart below illustrates how this dynamic plays out in practice. The trading results on three sample companies: AAPL, MCD, IBM are shown in Table 4; trading details of AAPL is demonstrated in Figure 23 and Figure 24;

trading details of MCD is demonstrated in Figure 25; trading details of CRM is demonstrated in Figure 26; trading details of ACN is demonstrated in Figure 27.

	AAPL				**MCD**			
Strategies	**Cumulative Return↑**	**Annualized Return↑**	**Sharpe Ratio↑**	**Maximum Drawdown↓**	**Cumulative Return↑**	**Annualized Return↑**	**Sharpe Ratio↑**	**Maximum Drawdown↓**
Market Return	0.7338	0.1391	0.5503	-0.3026	0.7503	0.1414	0.7711	-0.1633
MACD Return	0.5183	0.1039	0.4300	-0.2989	-0.4210	-0.1211	-0.7858	-0.4386
ZMR Return	-0.6584	-0.2245	-0.9129	-0.6993	0.2332	0.0508	0.2609	-0.2571
SMA Return	-0.4176	-0.1201	-0.4463	-0.4848	0.1238	0.0280	0.1305	-0.2904
VIA Return	**0.9127**	**0.1659**	**1.1087**	**-0.1641**	**1.1329**	**0.1960**	**1.1305**	**-0.1611**
	CRM				**ACN**			
Strategies	**Cumulative Return↑**	**Annualized Return↑**	**Sharpe Ratio↑**	**Maximum Drawdown↓**	**Cumulative Return↑**	**Annualized Return↑**	**Sharpe Ratio↑**	**Maximum Drawdown↓**
Market Return	0.2255	0.0492	0.2595	-0.5862	0.3600	0.0754	0.3378	-0.3804
MACD Return	-0.2272	-0.0591	-0.0479	-0.5877	0.4536	0.0924	0.3967	-0.3541
ZMR Return	-0.5417	-0.1683	-0.3931	-0.5622	-0.3413	-0.0939	-0.3415	-0.5221
SMA Return	**1.0735**	**0.1880**	0.6086	-0.3876	-0.5486	-0.1713	-0.7045	-0.6473
VIA Return	0.6380	0.1237	**0.6939**	**-0.2239**	**1.2250**	**0.2080**	**1.1367**	**-0.1793**

Table 4: Performance comparison across all strategies using four evaluation metrics. For each metric, the best-performing value is highlighted in bold.

AAPL Trading Records

On 4 Jan 2021, Buy-and-Hold strategy uses up the $1M to buy 7,911 shares. While the VIA strategy holds the cash to earn interest-free interest, waiting for the right time to buy.

Date	BH_Shares	BH_Cash	BH_Total	VIA_shares	VIA_Cash	VIA_Total	AAPL_Price
2021-01-04 00:00:00	7,911	-	1,000,000.00	-	1,000,000.00	1,000,000.00	126.41
2021-01-05 00:00:00	7,911	-	1,012,363.69	-	1,000,107.46	1,000,107.46	127.97
2021-01-06 00:00:00	7,911	-	978,286.04	-	1,000,214.93	1,000,214.93	123.66

On 23 Dec 2022, VIA strategy detects that the current stock price of $124.59 is lower than the intrinsic value calculated at that time period*(1- safety margin), and decides to buy the

shares. It uses up its cash on hand ($1.0806 million) and buys 8,675 shares. The return it earns from now on is 1.1x of the Buy-and-Hold strategy.

Date	BH_Shares	BH_Cash	BH_Total	VIA_shares	VIA_Cash	VIA_Total	AAPL_Price
2022-12-23 00:00:00	7,911	14,042.14	1,045,205.72	-	1,080,206.23	1,080,206.23	130.34
2022-12-27 00:00:00	7,911	14,042.14	1,030,894.80	-	1,080,670.62	1,080,670.62	128.54
2022-12-28 00:00:00	7,911	14,042.14	999,692.59	8,675	-	1,080,786.75	124.59

On 12 Jun 2024, VIA strategy detects that the current stock price of $212.36 is higher than the intrinsic value calculated at that time period*(1+ upper bound), and decides to sell the shares. It immediately receives back the cash of $1.8548 million, and use this cash to continue to earn risk-free interest rate, before it finds another good timing to buy the shares.

Date	BH_Shares	BH_Cash	BH_Total	VIA_shares	VIA_Cash	VIA_Total	AAPL_Price
2024-06-11 00:00:00	7,911	25,434.07	1,658,721.67	8,675	12,491.50	1,803,426.20	206.46
2024-06-12 00:00:00	7,911	25,434.07	1,705,398.47	-	1,854,608.30	1,854,608.30	212.36
2024-06-13 00:00:00	7,911	25,434.07	1,714,623.26	-	1,854,807.60	1,854,807.60	213.52

Figure 23: Executions of buy and sell AAPL shares during the trading period.

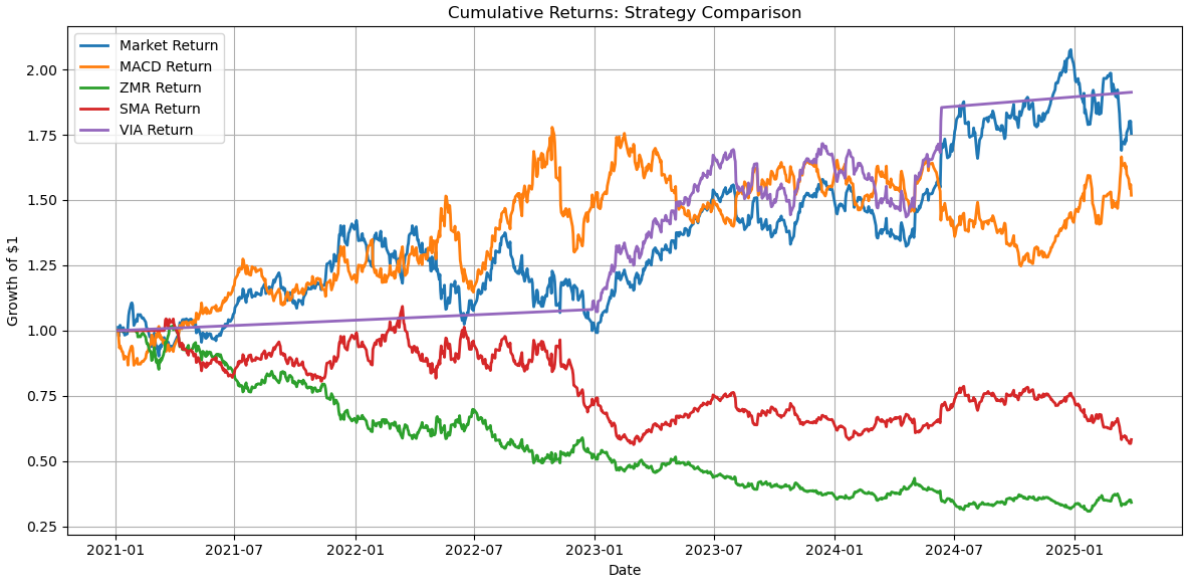

Figure 24. The returns of trading AAPL. This chart illustrates how the VIA strategy tactically navigates market cycles to optimize returns. (1) Strategic Entry (2023-01): VIA enters the market when Apple's stock drops below $127.50, which is 85% of its estimated intrinsic value of $150. By this point, the initial $1 million in capital has grown to $1.08 million through interest accumulation, enabling the purchase of 8,675 shares—significantly more than the 7,911 shares acquired by a Buy-and-Hold investor at the outset. (2) Disciplined Exit (2024-06): VIA exits when the stock price exceeds $208, surpassing the upper valuation bound of $160 × 130%. The strategy locks in gains at a favorable point, avoiding potential volatility ahead. (3) Cash Advantage Maintained: While Buy-and-Hold remains fully invested, VIA holds cash and preserves capital, ready to deploy again when valuation conditions are favorable. (4) Poised for Opportunity: As the market shows signs of renewed turbulence, VIA is positioned to re-enter at a discount, potentially amplifying future returns thanks to its earlier exit and accumulated cash reserves.

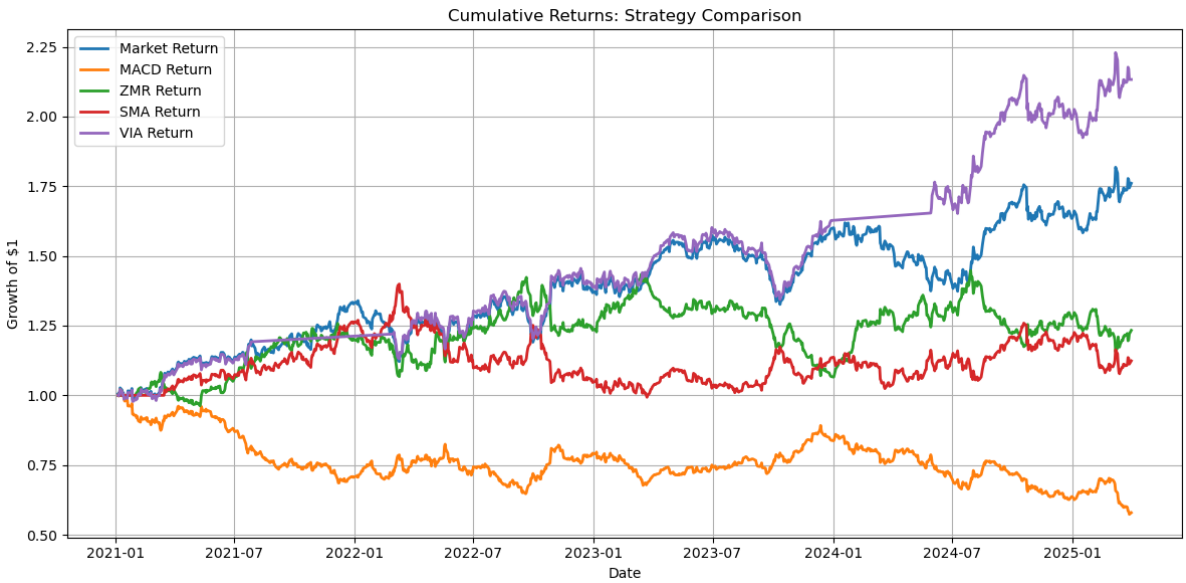

Figure 25: The returns of trading MCD. This chart illustrates how the VIA strategy tactically navigates market cycles to optimize returns. (1) Early Alignment (2021-01): Both strategies begin by purchasing shares, as VIA agents view the stock as undervalued at around $190. (2) Timely Exit (2021-07): VIA agents identify the stock as overvalued and exit the position, shifting to cash. They remain on the sidelines until 2022-03, when updated financials lead to a revised intrinsic value. At that point, they re-enter at favorable prices. Thanks to disciplined timing, VIA slightly outperforms Buy-and-Hold.(3) Peak Profit Capture (2023-12): VIA exits again as the stock trades above its revised upper bound. This proves timely—while Buy-and-Hold begins to experience notable losses, VIA has preserved capital and avoided the downturn. (4) Opportunistic Re-entry (2024-07): The stock reaches bargain levels, prompting VIA to re-enter. Having held cash during the drawdown, the strategy is well-positioned to capitalize on the recovery, leading to a significant performance advantage and delivering strong abnormal returns.

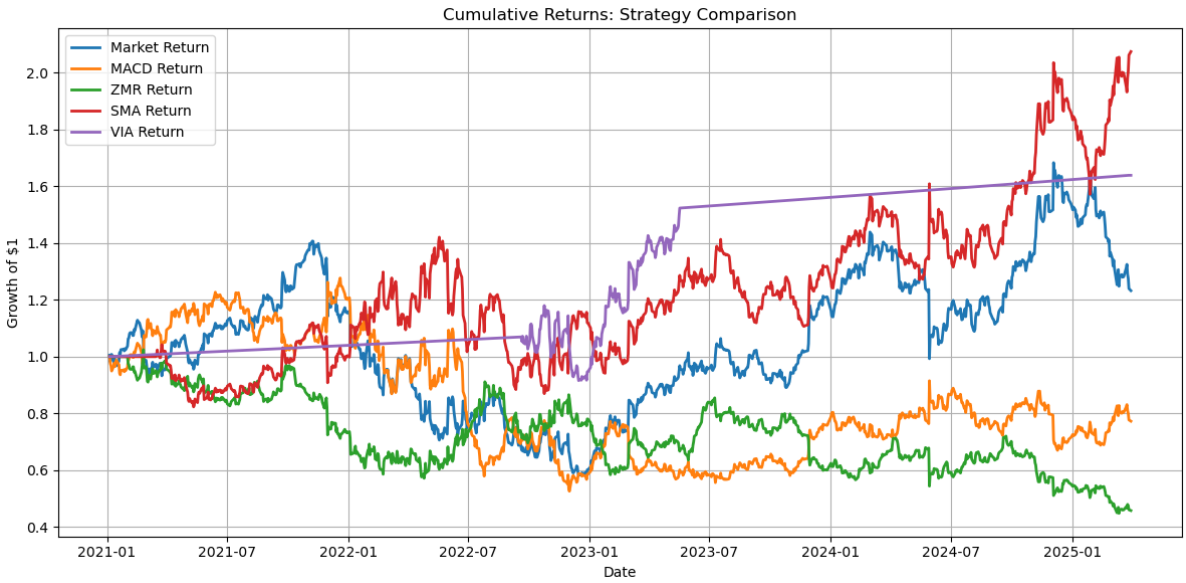

Figure 26: The returns of trading CRM. This chart illustrates how the VIA strategy tactically navigates Salesforce's valuation cycles to maximize long-term returns. (1) Defensive Patience (2022-09): After remaining in cash through elevated valuations, VIA agents initiate a position as CRM falls below $149—marking a 30% decline from its early 2021 highs. Intrinsic value updates confirm the stock is undervalued, triggering a disciplined entry. (2) Strategic Exit (2023-05): As CRM rebounds sharply, the price surpasses VIA's fair value estimate. Agents exit the position with over a 50% cumulative gain, locking in profits while Buy-and-Hold investors continue to ride market volatility. (3) Capital Preservation (2023-06 to 2024-12): VIA remains on the sidelines as CRM trades near or above its intrinsic value. During this period, the strategy avoids renewed volatility and focuses on risk management. (4) Emerging Opportunity (Late 2024): CRM's price begins to decline again, approaching undervaluation thresholds. VIA agents prepare for opportunistic re-entry, poised to redeploy capital at favorable levels and compound returns in the next cycle.

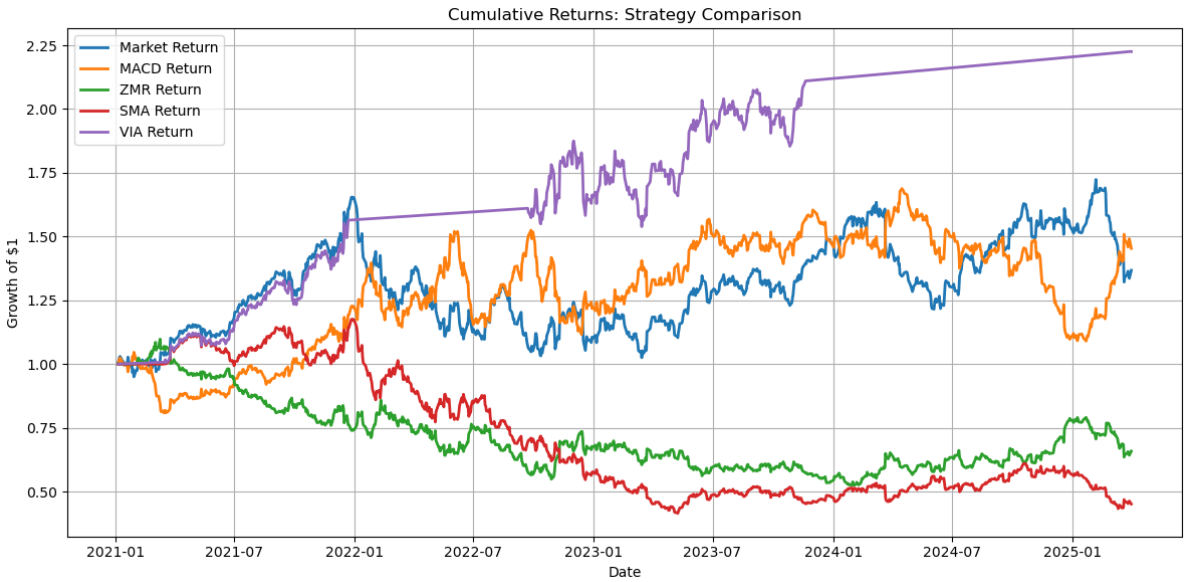

Figure 27: The returns of trading ACN. This chart illustrates how the VIA strategy tactically navigates Accenture's valuation cycles to optimize returns. (1) Value-Driven Entry (2021-03): Following the release of strong FY2020 results, VIA agents identify ACN as undervalued around $250. The combination of resilient earnings and a modest valuation prompts a decisive entry. (2) Timely Profit Realization (2021-12): As the stock rallies to $385—near its peak—VIA agents assess it as overvalued relative to revised intrinsic value estimates and strategically exit, securing substantial gains while avoiding frothy valuations. (3) Tactical Re-entry (2022-09): A sharp market correction presents a fresh opportunity. With the price dropping back to $253, VIA re-engages, viewing the discount as an attractive re-entry point. (4) Disciplined Exit (2023-11): As ACN climbs to $325, approaching its updated valuation ceiling, VIA agents lock in gains once again. By actively managing exposure through valuation signals, the strategy outpaces Buy-and-Hold and maintains capital discipline.

8. Conclusion

This research has introduced a pioneering multi-agent, multi-modal AI framework that brings financial analysis a step closer to artificial general intelligence (AGI). By orchestrating a team of collaborative LLM-based agents with specialized roles, our system can parse and cross-examine diverse data types—textual reports, numerical tables, charts, and even scanned documents—with human-like thoroughness. These agents communicate and critique each other's findings in natural language, mirroring a real investment team's dialogue. Through this agentic collaboration, they produce a holistic analysis and prudent financial judgments, demonstrating an AI-driven workflow that rivals human expertise in both breadth and depth.

Crucially, we addressed the issue of hallucinated or inaccurate outputs that often plague autonomous AI analysts. The framework incorporates rigorous data verification at every stage to ensure factual reliability. Structured data extraction from trusted sources, multi-modal content interpretation, and recursive self-verification loops are built into the agents' process. This means each conclusion is transparently traced back to source data and double-checked for accuracy, dramatically improving the trustworthiness of the AI's insights. Our results show that an AI can maintain analytical rigor and truthfulness even while autonomously navigating the vast, unstructured information landscape of the web.

Equally novel is our strategic choice to implement a classic value investing philosophy in an AI-driven context. Value investing, with its emphasis on deep fundamental analysis and long-term horizons, has traditionally been the realm of legendary investors like Warren Buffett and has rarely been explored in academic research due to the lengthy time horizons required. By encoding Buffett's disciplined, long-term perspective into the Value Investing Agents (VIA) framework, we effectively democratize this high-barrier strategy. The VIA agents were tested on a decade-long horizon, illustrating not only strong, compounding returns but also providing a proof of concept that such patient strategies can indeed be systematically executed and evaluated by AI.

In summary, the VIA framework opens the door for Buffett-style investing and long-term strategic thinking to become accessible to all, not just financial elites. It shows that with intelligent tools at hand, anyone can become a long-term thinker, making data-driven decisions that benefit from patience and the power of compounding. In this way, our approach allows every investor to become a true "friend of time" in their investing journey, unlocking real compounding growth.

9. Future Direction

As the Value Investing Agents (VIA) framework evolves, several promising directions can further enhance its realism, effectiveness, and general intelligence.

First, we aim to expand the agent architecture by introducing additional functional roles beyond front-office analysis and trading. This includes middle-office roles such as risk management and performance attribution, as well as back-office functions like compliance monitoring, reporting, and audit trails. These components are essential for mirroring the operational complexity of modern financial institutions and ensuring a holistic simulation of the investment process.

Second, timeliness remains a critical challenge. Future iterations of VIA should support real-time tracking of data sources, including market feeds, economic releases, and breaking news. This would allow agents to dynamically update valuations, risk exposure, and investment theses based on the latest developments—bridging the gap between long-term investing and real-time responsiveness.

Finally, to reach a higher level of decision-making and insight, we envision incorporating models that move closer to Artificial General Intelligence (AGI). These models must not only excel at financial reasoning but also understand how the broader world works—including the complex interplay between societies, institutions, individual actors, and macroeconomic systems. Only then can AI agents truly replicate the human depth of judgment and intuition that defines world-class investing.

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Appendix I. Prompts

Junior Analyst

Below are system prompt and user prompts to analyze individual chunks from the 10-K filing.

==========

```
system_prompt="""
    You are a Experienced Financial Analyst who verifies and improves financial
analyses. Your priorities are:

    1. ACCURACY: Ensure all numbers and data match source documents
    2. CLARITY: Make financial narratives more readable and insightful
    3. EVIDENCE: Base all conclusions on factual information

    Your task is to identify errors, suggest improvements, and enhance the quality
of financial analyses.
    """
```

==========

```
analyze_income_statement="""
    Conduct a comprehensive financial analysis of the company's Income Statement,
focusing on the most recent two fiscal years. Your analysis should include:

    1. Revenue Analysis:
       - Identify the trend in total revenue (growth or decline)
       - Break down revenue by major segments or product lines if available
       - Calculate year-over-year percentage changes

    2. Profitability Assessment:
       - Analyze gross profit margin trends and explain factors affecting changes
       - Evaluate operating income/EBIT and operating margin
       - Assess net income performance and net profit margin

    3. Expense Structure:
       - Examine cost of goods sold (COGS) relative to revenue
       - Analyze operating expenses (R&D, SG&A) as a percentage of revenue
       - Identify any unusual or non-recurring expenses

    4. Key Performance Indicators:
       - Calculate and interpret EPS (basic and diluted) trends
       - Analyze EBITDA and EBITDA margin changes
       - Evaluate any other relevant profitability ratios

    5. Causal Analysis:
       - Identify specific factors driving significant changes in key metrics
       - Connect financial performance to business operations, market conditions,
or strategic initiatives
       - Distinguish between industry-wide trends and company-specific factors
```

```
    For each finding, cite the specific chunk index number where the data was
sourced. Present your analysis in a clear, structured format with quantitative
evidence supporting your conclusions.
    """
```

==========

```
analyze_balance_sheet="""
    Conduct a comprehensive financial analysis of the company's Balance Sheet,
focusing on the most recent two fiscal years. Your analysis should include:

    1. Asset Structure Analysis:
       - Evaluate the composition of total assets (current vs. non-current)
       - Analyze changes in key asset categories (cash, receivables, inventory,
PP&E)
       - Identify significant year-over-year changes in major asset classes

    2. Liability Assessment:
       - Examine the debt structure (short-term vs. long-term obligations)
       - Analyze changes in key liability categories
       - Evaluate the company's debt management and financing strategy

    3. Shareholders' Equity Analysis:
       - Assess changes in total shareholders' equity
       - Analyze retained earnings trends
       - Evaluate capital structure decisions (share repurchases, dividends,
issuances)

    4. Working Capital Management:
       - Analyze net working capital trends
       - Evaluate the company's liquidity position
       - Assess efficiency in managing current assets and liabilities

    5. Financial Health Indicators:
       - Calculate and interpret key balance sheet ratios (debt-to-equity, current
ratio)
       - Assess overall financial stability and solvency
       - Identify potential strengths or concerns in the company's financial
position

    For each finding, cite the specific chunk index number where the data was
sourced. Present your analysis in a clear, structured format with quantitative
evidence supporting your conclusions.
    """
```

==========

```
analyze_cash_flow="""
    Conduct a comprehensive financial analysis of the company's Cash Flow
Statement, focusing on the most recent two fiscal years. Your analysis should
include:

    1. Operating Cash Flow Analysis:
       - Evaluate the trend in net cash provided by operating activities
       - Analyze the relationship between net income and operating cash flow
```

```
       - Identify key drivers of operating cash flow changes (working capital, non-
cash adjustments)

    2. Investing Activities Assessment:
       - Examine capital expenditure (CAPEX) trends and their strategic
implications
       - Analyze acquisitions, divestitures, and other significant investing
activities
       - Evaluate the company's investment strategy and its impact on long-term
growth

    3. Financing Activities Evaluation:
       - Assess debt issuance and repayment patterns
       - Analyze shareholder returns (dividends, share repurchases)
       - Evaluate the company's financing strategy and capital structure decisions

    4. Free Cash Flow Analysis:
       - Calculate and interpret free cash flow trends
       - Assess cash flow adequacy for covering dividends and debt obligations
       - Evaluate cash flow conversion efficiency (FCF/Net Income, FCF/Revenue)

    5. Liquidity and Financial Flexibility:
       - Analyze changes in cash and cash equivalents
       - Assess the company's ability to fund operations and strategic initiatives
       - Identify potential cash flow strengths or concerns for future operations

    For each finding, cite the specific chunk index number where the data was
sourced. Present your analysis in a clear, structured format with quantitative
evidence supporting your conclusions.
    """
```

==========

```
ratio_analysis_prompt="""
      In the most recent two fiscal years, the company's ratios are calculated as
following:
      {}
      Given the below context from the most recent filing, give explanations on the
ratios change calculated above.
      Besides the ratios mentioned above, extract and summarize the contents in the
context regarding ratio analysis, including but not limited to the following
categories:
      1. Profitability ratios (ROA, ROE, margins)
      2. Liquidity ratios (current ratio, quick ratio)
      3. Solvency ratios (debt-to-equity, interest coverage)
      4. Efficiency ratios (asset turnover, inventory turnover)
      5. Valuation ratios (P/E, EV/EBITDA)
      6. Growth metrics (revenue growth, earnings growth)

      For each finding, cite the specific chunk index number where the data was
sourced. Present your analysis in a clear, structured format with quantitative
evidence supporting your conclusions.
      """
```

==========

```
business_analysis_prompt="""Conduct a comprehensive analysis of the company's
strategic execution over the past {num_of_years} years, delivering your findings
clearly in a cohesive, insightful narrative.

Your analysis should:

1. *Clearly identify and explain the company's stated strategic objectives*, such
as:
   - *Expansion initiatives* (market entry, geographic growth, M&A activities)
   - *Innovation goals* (R&D priorities, product development, technological
advancement)
   - *Operational strategies* (cost leadership, vertical integration, supply chain
optimization)
   - *Digital transformation efforts* (e-commerce, automation, data analytics
capabilities)

2. *Assess the effectiveness of strategy execution* with specific evidence from:
   - Business activities and operational developments
   - Financial results and performance metrics
   - Market response and competitive positioning
   - Management's own evaluation of progress in annual reports and investor
communications

3. *Evaluate the tangible outcomes and impacts* of these strategic initiatives on:
   - Market position and competitive standing
   - Customer base growth and engagement
   - Operational scale and capabilities
   - Long-term competitive advantages and economic moat

4. *Analyze any gaps or misalignments* between:
   - Stated strategic intentions versus actual implementation
   - Expected outcomes versus realized results
   - Strategic agility in response to market changes
   - Potential missteps or strategic pivots

Craft a clear narrative that illustrates how the company's strategic execution has
shaped its business trajectory, competitive position, and future prospects.
"""
```

==========

Below are user prompts for the junior analyst to aggregate individual chunk's observation into an integrated annual financial statement analysis.

==========

```
income_statement_story="""
    Transform the provided income statement analyses into a professional financial
narrative that presents the company's operational performance in a clear, objective
manner.

    Begin with a concise executive summary of the company's revenue and
profitability trajectory, then develop a structured narrative that:
```

```
    1. **Revenue Analysis**:
      - Present the company's top-line performance with precise growth or
contraction metrics
      - Analyze revenue composition and its evolution (product vs. service mix,
geographic distribution)
      - Identify key revenue drivers and their underlying business factors

    2. **Profitability Assessment**:
      - Examine gross margin trends and efficiency in converting revenue to gross
profit
      - Analyze operating margin progression and operational execution
      - Connect margin changes to specific business decisions or market conditions

    3. **Expense Evaluation**:
      - Assess the company's cost structure and spending priorities
      - Analyze strategic investments (R&D, marketing) versus operational expenses
      - Evaluate how expense management has impacted bottom-line results

    4. **Financial Outcomes**:
      - Synthesize how revenue, margins, and expenses collectively affected net
income
      - Analyze EPS trends and their significance to shareholders
      - Connect financial outcomes to management's stated strategies

    Throughout your narrative:
    - Maintain a professional, objective tone appropriate for financial analysis
    - Present factual information with precise figures and percentages
    - Explain cause-and-effect relationships between different income statement
components
    - Frame the analysis in terms of strategic decisions and their financial
implications
    - Conclude with an assessment of the sustainability of current income patterns

    --- Begin Income Statement Analyses ---
    {}
    --- End Income Statement Analyses ---

    Format your response as a JSON object with two main keys:
    1. "content": A professional financial narrative divided into sections
    2. "source": An array of chunk index numbers that were used as sources for the
analysis

    Example format:
    {{
      "content": "**Apple Inc. Income Statement Analysis (FY2024 vs. FY2023**
      ---
      ### **Executive Summary**
      ...
      ### **1. Revenue Analysis**
      ...
      ### **2. Profitability & Margin Execution**
```

```
      ...
      ### **3. Expense Management & Strategic Investments**
      ...
      ### **4. Financial Outcomes & Shareholder Impact**
      ...
      ### **5. Sustainability & Strategic Outlook**
      ...
      ### **Conclusion**
      ...
      ---",
      "source": [1, 4, 7, 12, 15]
    }}

    The narrative should clearly present the strategic and operational factors
behind the financial results without referencing chunk indices in the content
itself or using overly dramatic language.
    """
```

==========

```
balance_sheet_story="""
    Transform the provided balance sheet analyses into a professional financial
narrative that presents the company's financial position in a clear, objective
manner.

    Begin with a concise executive summary of the company's financial position and
stability, then develop a structured narrative that:

    1. **Asset Composition and Management**:
      - Present the company's asset structure with precise metrics on current vs.
non-current assets
      - Analyze key asset categories and their evolution over the two-year period
      - Identify significant changes in major asset classes and their business
implications

    2. **Liability Structure and Debt Management**:
      - Examine the company's debt profile and financing strategy
      - Analyze the balance between short-term and long-term obligations
      - Connect changes in liability structure to business decisions or market
conditions

    3. **Shareholders' Equity and Capital Allocation**:
      - Assess the company's approach to capital structure management
      - Analyze retained earnings trends and shareholder return policies
      - Evaluate how equity-related decisions reflect management's strategic
priorities

    4. **Financial Stability Assessment**:
      - Synthesize how assets, liabilities, and equity collectively affect
financial health
      - Analyze working capital management and liquidity position
      - Connect balance sheet strength or weaknesses to the company's operational
capabilities
```

```
    Throughout your narrative:
    - Maintain a professional, objective tone appropriate for financial analysis
    - Present factual information with precise figures and percentages
    - Explain cause-and-effect relationships between different balance sheet
components
    - Frame the analysis in terms of strategic decisions and their financial
implications
    - Conclude with an assessment of the company's overall financial position and
stability

    --- Begin Balance Sheet Analyses ---
    {}
    --- End Balance Sheet Analyses ---

    Format your response as a JSON object with two main keys:
    1. "content": A professional financial narrative divided into sections
    2. "source": An array of chunk index numbers that were used as sources for the
analysis

    Example format:
    {{
      "content": "**Apple Inc. Financial Position Analysis (FY2023-FY2024)**
      ---
      ### **Executive Summary**
      ...
      ### **1. Asset Composition & Strategic Deployment****
      ...
      ### **2. Liability Structure & Risk Management**
      ...
      ### **3. Equity Strategy & Capital Allocation**
      ...
      ### **4. Financial Stability & Operational Capacity**
      ...
      ### **Conclusion**
      ...
      ---",
      "source": [1, 4, 7, 12, 15]
    }}

    The narrative should clearly present the strategic and operational factors
behind the financial position without referencing chunk indices in the content
itself or using overly dramatic language.
    """
```

==========

```
cash_flow_story="""
    Transform the provided cash flow statement analyses into a professional
financial narrative that presents the company's cash generation and utilization in
a clear, objective manner.
```

```
    Begin with a concise executive summary of the company's cash flow performance
and financial flexibility, then develop a structured narrative that:

    1. **Operating Cash Flow Performance**:
      - Present the company's ability to generate cash from core operations with
precise metrics
      - Analyze the relationship between reported earnings and actual cash
generation
      - Identify key operational factors affecting cash flow quality and
sustainability

    2. **Investment Strategy and Capital Allocation**:
      - Examine the company's approach to capital expenditures and long-term
investments
      - Analyze the balance between maintenance and growth investments
      - Connect investment decisions to the company's strategic priorities and
market positioning

    3. **Financing Activities and Capital Structure**:
      - Assess the company's approach to debt management and shareholder returns
      - Analyze changes in the company's financing mix and their strategic
implications
      - Evaluate how financing decisions reflect management's priorities and market
conditions

    4. **Cash Flow Sustainability Assessment**:
      - Synthesize how operating, investing, and financing activities collectively
affect financial flexibility
      - Analyze free cash flow generation and its adequacy for future needs
      - Connect cash flow patterns to the company's growth trajectory and
competitive position

    Throughout your narrative:
    - Maintain a professional, objective tone appropriate for financial analysis
    - Present factual information with precise figures and percentages
    - Explain cause-and-effect relationships between different cash flow components
    - Frame the analysis in terms of strategic decisions and their financial
implications
    - Conclude with an assessment of the company's overall cash flow health and
sustainability

    --- Begin Cash Flow Statement Analyses ---
    {}
    --- End Cash Flow Statement Analyses ---

    Format your response as a JSON object with two main keys:
    1. "content": A professional financial narrative divided into sections
    2. "source": An array of chunk index numbers that were used as sources for the
analysis

    Example format:
```

```
    {{
      "content": "**Apple Inc. Cash Flow Analysis: Strategic Financial Management
in a Maturing Market**
*(Fiscal Years 2023-2024)*
      ---
      ### **Executive Summary**
      ...
      ### **1. Operating Cash Flow Performance**
      ...
      ### **2. Investing Strategy and Capital Allocation**
      ...
      ### **3. Financing Activities and Capital Structure**
      ...
      ### **4. Cash Flow Sustainability Assessment**
      ...
      ### **Conclusion**
      ...
      ---",
      "source": [1, 4, 7, 12, 15]
    }}

    The narrative should clearly present the strategic and operational factors
behind the cash flow results without referencing chunk indices in the content
itself or using overly dramatic language.
    """
```

==========

```
ratio_story="""
Transform the provided ratio analysis into a comprehensive senior analyst-level
financial narrative that presents the company's financial performance through ratio
analysis.

Begin with an executive summary highlighting 3-5 key ratio insights, then develop
an integrated narrative that:

1. *Comparative Context*:
   - Position each key ratio against industry benchmarks and direct competitors
   - Provide 3-5 year historical context for critical metrics
   - Analyze ratio relationships across categories (how efficiency impacts
profitability)

2. *Strategic Implications*:
   - Connect ratio movements to specific management decisions and market conditions
   - Evaluate capital allocation effectiveness through ratio lens
   - Assess operating model strengths/weaknesses revealed by ratio patterns

3. *Forward Indicators*:
   - Identify leading ratio signals for future performance
   - Project ratio trajectories based on stated company initiatives
   - Highlight ratio divergences that suggest strategic pivots

Present your analysis with senior-level precision:
```

```
- Use exact decimal places for all percentages and multiples
- Provide calculation methodologies for non-standard ratios
- Integrate qualitative strategic context with quantitative evidence
- Include relevant peer benchmarking for key metrics

--- Begin Ratio Analyses ---
{}
--- End Ratio Analyses ---

Format your response as a JSON object with two main keys:
1. "content": A professional financial narrative divided into sections
2. "source": An array of chunk index numbers that were used as sources for the
analysis

Example format:
{{
  "content":  "content": "**Apple Inc. Ratio Analysis (FY2024 vs. FY2023**
      ---
      ### **Executive Summary**
      ...
      ### **1. Comparative Context**
      ...
      ### **2. Strategic Implications**
      ...
      ### **3. Forward Indicators**
      ...
      ### **Conclusion**
      ...
      ---",
  "source": [1, 4, 7, 12, 15]
}}

Your narrative must not reference chunk indices in the content itself. Maintain an
authoritative, objective tone suitable for investment professionals while avoiding
excessive jargon.
"""
```

==========

```
business_development_story="""
Transform the provided business analysis into a professional strategic narrative
that presents the company's business development and competitive positioning in a
clear, objective manner.

Begin with a concise executive summary of the company's strategic direction and
market positioning, then develop a structured narrative that:

1. **Business Strategy Evolution**:
  - Present the company's core business strategy and strategic priorities with
precise metrics
  - Analyze recent strategic initiatives, pivots, and their market impact
  - Evaluate the execution effectiveness against stated strategic objectives
```

```
2. **Porter's Five Forces Analysis**:
  - Threat of New Entrants: Assess industry barriers to entry and potential
competitive threats
  - Bargaining Power of Suppliers: Analyze supplier relationships, dependencies,
and cost implications
  - Bargaining Power of Buyers: Evaluate customer concentration, price sensitivity,
and relationship dynamics
  - Threat of Substitute Products/Services: Identify substitutes and their impact
on the business model
  - Competitive Rivalry: Analyze market competition intensity and the company's
competitive response

3. **SWOT Analysis**:
  - Strengths: Identify key internal capabilities, resources, and competitive
advantages
  - Weaknesses: Analyze operational inefficiencies, resource constraints, or
competitive disadvantages
  - Opportunities: Evaluate market trends, untapped segments, or growth avenues
  - Threats: Identify external challenges, disruptive forces, or market risks

4. **Product and Service Portfolio Development**:
  - Assess the evolution of the company's offerings and product/service mix
  - Analyze R&D investments, innovation initiatives, and their market outcomes
  - Evaluate market reception and financial performance of new offerings

Throughout your narrative:
- Maintain a professional, objective tone appropriate for strategic analysis
- Present factual information with precise figures and percentages
- Explain cause-and-effect relationships between strategic decisions and market
outcomes
- Frame the analysis in terms of competitive positioning and sustainable advantage
- Conclude with an assessment of the long-term strategic trajectory and prospects

--- Begin Business Development Analyses ---
{}
--- End Business Development Analyses ---

Format your response as a JSON object with two main keys:
1. "content": A professional strategic narrative divided into sections
2. "source": An array of chunk index numbers that were used as sources for the
analysis

Example format:
{{
  "content": "**Company Name: Strategic Business Development Analysis (FY2024)**
  ---
  ### **Executive Summary**
  ...
  ### **1. Business Strategy Evolution**
  ...
```

```
  ### **2. Porter's Five Forces Analysis**
  ...
  ### **3. SWOT Analysis Framework**
  ...
  ### **4. Product & Service Portfolio Development**
  ...
  ### **Conclusion: Strategic Trajectory & Outlook**
  ...
  ---",
  "source": [1, 4, 7, 12, 15]
}}

The narrative should clearly present the strategic positioning and competitive
factors without referencing chunk indices in the content itself or using overly
dramatic language.
"""
```

==========

Senior Analyst

The senior analyst will take below system and user prompts to analyze and gain insights from the junior analyst's individual year analysis.

==========

```
system_prompt="""
    You are a financial analyst specializing in *value investing, with expertise in
fundamental analysis, financial statements, and competitive positioning. Your
analysis emphasizes **understanding financial changes, identifying underlying
reasons, and clearly explaining their implications*.

Your objective is to assess *how financial performance impacts the company's long-
term competitive advantages, economic moat, and intrinsic value*. You use both
quantitative data and qualitative reasoning to deliver insightful, structured, and
actionable analysis.
Ensure your analysis remains objective, avoiding fragmented explanations or bullet
points, while maintaining clarity and coherence.
    """
```

==========

```
is_analysis_prompt="""Analyze the company's income statement over the past
{num_of_years} years and present your findings clearly in a structured, cohesive
narrative.

Your analysis should:

1. **Clearly describe** the evolution of revenue growth, profitability (gross
margin, operating margin), and net income, identifying significant trends and
turning points.

2. **Explain the reasons behind key financial shifts**, integrating relevant
business events or strategies (e.g., product launches, pricing changes, market
expansions, shifts in customer segments, or industry conditions).
```

```
3. **Connect financial performance explicitly to competitive positioning** and the
company's economic moat. Highlight how changes in revenue growth, profitability, or
cost structure have strengthened or weakened the company's competitive advantages.

Deliver a concise yet insightful story that clearly explains the business context,
financial outcomes, strategic implications, and competitive positioning.
"""
```

==========

```
bs_analysis_prompt="""Analyze the company's balance sheet over the past
{num_of_years} years and present your findings as a cohesive, insightful narrative.

Your analysis should:

1. *Clearly describe key trends* in liquidity, debt levels, equity structure, and
working capital. Identify notable improvements, deteriorations, or structural
shifts.

2. *Explain the underlying reasons behind these changes*, referencing specific
events or strategic decisions, such as acquisitions, divestitures, capital
expenditures, debt issuance, or equity buybacks.

3. *Link balance sheet dynamics explicitly to the company's financial health and
competitive positioning*. Highlight how changes in leverage, liquidity, or capital
structure have either strengthened or weakened the company's resilience to industry
disruptions, economic downturns, or competitive pressures.

Deliver your analysis clearly as a concise, insightful narrative connecting balance
sheet trends directly to the business context, strategic implications, and
competitive strengths or vulnerabilities.
   """
```

==========

```
cf_analysis_prompt="""Analyze the company's cash flow statements over the past
{num_of_years} years and present your insights in a clear, cohesive narrative.

Your analysis should:

1. *Describe significant trends and patterns* observed in operating, investing, and
financing cash flows. Clearly identify any substantial shifts or unusual cash flow
events.

2. *Explain the reasons behind major changes in cash flows*, highlighting key
factors such as changes in working capital management, significant investments
(e.g., acquisitions, capital expenditures), financing activities (e.g., debt
repayments, equity issuance, share buybacks), and strategic capital allocation
decisions.

3. *Connect the company's cash management explicitly to its competitive positioning
and strategic flexibility*, explaining how cash flow decisions have either
strengthened or weakened the company's ability to respond effectively to industry
changes, competitive threats, or market opportunities.
```

```
Craft a cohesive narrative that clearly explains the strategic implications behind
the company's cash flow evolution and its impact on long-term competitive
advantage.
"""
```

==========

```
ratio_analysis_prompt="""Conduct a comprehensive analysis of the company's key
financial ratios over the past {num_of_years} years, delivering your findings
clearly in a cohesive, insightful narrative.

Your analysis should:

1. *Clearly explain significant trends or shifts* in:
   - *Profitability ratios* (ROIC, ROE, net profit margin)
   - *Liquidity ratios* (current ratio, quick ratio)
   - *Leverage ratios* (debt/equity, interest coverage)
   - *Efficiency ratios* (asset turnover, inventory turnover)

2. *Describe the primary factors and strategic decisions* that led to notable
changes or sustained trends in these ratios. Clearly reference relevant business
decisions, market conditions, operational changes, or competitive actions.

3. *Explicitly connect the ratio analysis to the company's underlying strengths or
weaknesses*, detailing how these financial ratios influence its economic moat,
competitive position, and long-term financial resilience.

Craft a clear narrative that illustrates how changes in financial ratios reflect
broader strategic implications and competitive outcomes.
"""
```

==========

```
business_analysis_prompt="""Conduct a comprehensive analysis of the company's
strategic execution over the past {num_of_years} years, delivering your findings
clearly in a cohesive, insightful narrative.

Your analysis should:

1. *Clearly identify and explain the company's stated strategic objectives*, such
as:
   - *Expansion initiatives* (market entry, geographic growth, M&A activities)
   - *Innovation goals* (R&D priorities, product development, technological
advancement)
   - *Operational strategies* (cost leadership, vertical integration, supply chain
optimization)
   - *Digital transformation efforts* (e-commerce, automation, data analytics
capabilities)

2. *Assess the effectiveness of strategy execution* with specific evidence from:
   - Business activities and operational developments
   - Financial results and performance metrics
   - Market response and competitive positioning
   - Management's own evaluation of progress in annual reports and investor
communications
```

```
3. *Evaluate the tangible outcomes and impacts* of these strategic initiatives on:
   - Market position and competitive standing
   - Customer base growth and engagement
   - Operational scale and capabilities
   - Long-term competitive advantages and economic moat

4. *Analyze any gaps or misalignments* between:
   - Stated strategic intentions versus actual implementation
   - Expected outcomes versus realized results
   - Strategic agility in response to market changes
   - Potential missteps or strategic pivots

Craft a clear narrative that illustrates how the company's strategic execution has
shaped its business trajectory, competitive position, and future prospects.
"""
```

==========

```
competitive_position_and_economic_moat_prompt="""
    Evaluate the company's competitive position and economic moat based on your
previous financial analyses, and present your findings as a cohesive, insightful
narrative.

Your analysis should:

1. **Summarize clearly the company's key financial strengths and weaknesses**,
highlighting how these factors affect its competitive capabilities and resilience.

2. **Clearly describe the company's primary competitive advantages** (e.g., brand
power, technological leadership, cost efficiency, network effects, ecosystem lock-
in), and explain explicitly whether these advantages have strengthened or weakened
in recent years.

3. **Discuss explicitly how recent strategic decisions, competitive dynamics, or
broader industry shifts have impacted the durability and sustainability of the
company's economic moat.** Provide clear reasoning about whether the moat is
widening, stable, or deteriorating.

Deliver a concise narrative clearly linking financial insights, strategic actions,
competitive dynamics, and the long-term sustainability of the company's competitive
advantage.
   """
```

==========

```
valuation_analysis_peer_comparison_prompt="""
    Conduct a comprehensive valuation analysis of the company, clearly presented as
a cohesive, insightful narrative.

Your analysis should:

1. **Identify and explain relevant valuation ratios** (e.g., P/E, P/S, P/B,
EV/EBITDA) appropriate for the company's industry. Clearly justify the choice of
```

```
these metrics in the context of the company's business model and sector
characteristics.

2. **Compare the company's current valuation ratios with industry peers and
historical averages**, clearly highlighting valuation premiums or discounts.
Provide context about the company's historical valuation trends to assess whether
current multiples represent typical or unusual market conditions.

3. **Clearly explain why the company trades at higher or lower multiples relative
to its peers**, explicitly linking these differences to business-specific factors,
such as superior revenue growth, profitability, competitive advantages, risk
profiles, market positioning, or strategic initiatives.

4. **Assess explicitly whether the company's current market valuation accurately
reflects its intrinsic value**. Clearly justify your reasoning, referencing
fundamental strengths or weaknesses, growth prospects, competitive positioning,
economic moat, and potential industry or macroeconomic risks.

Craft your analysis clearly and cohesively as a narrative, emphasizing insightful
explanations about valuation differentials and their strategic implications.
"""
```

==========

```
investment_recommendation_prompt="""
Based on your comprehensive analyses of the company's financial performance,
competitive position, economic moat, and current valuation, clearly present your
investment recommendation as a cohesive, insightful narrative.

Your recommendation should:

1. **Summarize clearly and concisely** your key findings regarding:
   - Financial health and stability
   - Competitive positioning and strength of the economic moat
   - Valuation attractiveness compared to intrinsic value and market peers

2. **Clearly state your investment recommendation** (Buy, Hold, or Sell),
explicitly supported by a data-driven rationale.

3. **Justify your recommendation explicitly using intrinsic value considerations,
margin of safety principles, and long-term value investing philosophy.** Clearly
highlight key factors, risks, or conditions that could influence the investment
outcome.

Craft a clear, coherent narrative that integrates financial insights, strategic
analysis, valuation considerations, and long-term investment principles to justify
your recommendation effectively.
"""
```

==========

Industry Expert

The industry expert will input the following information to the anlysts.

==========

```
industry_prompt="""
    The company is in the {} industry. For this industry, the following metrics are important:
    {}
    You should also take these metrics into account when analyzing the company's financial statements.
    """
```

==========

The industry metrics table is as below.

Industry	Metrics
Advertising Agencies	Organic revenue growth; Client retention rate; Digital revenue %; New business wins; Revenue per employee
Aerospace & Defense	Backlog coverage ratio; Book-to-bill ratio; Aftermarket vs. OEM mix; Program margin profiles; International vs. domestic revenue
Agricultural - Machinery	Equipment sales growth; Aftermarket parts %; Order backlog; Dealer inventory levels; Precision ag adoption
Agricultural Farm Products	Yield metrics; Commodity price exposure; Acreage trends; Weather impact analysis; Supply chain integration
Agricultural Inputs	Volume growth by product; Pricing trends; Market share by region; Weather impact analysis; R&D pipeline value
Airlines, Airports & Air Services	Revenue passenger miles; Load factor; Yield metrics; RASM/CASM spread; Fuel hedging position
Apparel - Footwear & Accessories	Comparable sales growth; DTC vs. wholesale mix; International expansion metrics; Product category growth; ASP trends
Apparel - Manufacturers	Organic sales growth; DTC vs. wholesale mix; Gross margin trends; International expansion metrics; Supply chain efficiency
Apparel – Retail	Comparable sales growth; E-commerce penetration; Inventory turnover; Gross margin trends; Square footage growth
Asset Management	AUM growth/flows; Fee rate trends; Performance vs. benchmarks; Product mix trends; Distribution channel metrics
Asset Management - Global	AUM growth/flows; Fee rate trends; Performance vs. benchmarks; Geographic diversification; Alternative investment exposure
Auto – Dealerships	New vehicle sales volume; Used vehicle sales volume; F&I revenue per vehicle; Parts & service revenue growth; Vehicle gross profit per unit
Auto – Manufacturers	Unit volume growth; Product mix trends; EV transition metrics; Regional sales breakdown; Production capacity utilization
Auto – Parts	Organic sales growth; OEM vs. aftermarket mix; Content per vehicle trends; R&D as % of sales; Regional sales breakdown
Banks – Diversified	Net interest margin; Loan-to-deposit ratio; Efficiency ratio; Asset quality metrics; Capital ratios
Banks – Regional	Net interest margin; Loan growth by category; Deposit beta; Credit quality metrics; Efficiency ratio
Beverages - Alcoholic	Volume growth by category; Price/mix trends; Premium portfolio %; Market share by category; Innovation pipeline value
Beverages - Non-Alcoholic	Volume growth; Price/mix trends; Market share by category; Innovation pipeline metrics; Input cost management
Beverages - Wineries & Distilleries	Volume growth by category; Pricing mix trends; Premium portfolio %; Direct-to-consumer sales %; International market penetration
Biotechnology	Clinical trial success rates; Cash runway; Pipeline by phase; Potential market size by drug; Partnership value
Business Equipment & Supplies	Recurring revenue growth; Equipment sale growth; Contract retention rate; Digital transformation metrics; Margin by product/service line
Chemicals	Volume growth; Product mix trends; Margin by segment; Capacity utilization; Input cost management
Chemicals - Specialty	R&D as % of revenue; Product portfolio diversification; Raw material cost management; Pricing power metrics; End-market exposure
Communication Equipment	Order growth; Book-to-bill ratio; Product vs. services mix; R&D as % of revenue; Backlog trends
Computer Hardware	Unit shipment growth; ASP trends; Gross margin by product; Channel inventory levels; Product cycle position
Conglomerates	Organic growth by segment; Margin by segment; Cash conversion cycle; Capital allocation metrics; Portfolio optimization
Construction	Backlog trends; Book-to-bill ratio; Margin by project type; Labor utilization; Project delay metrics
Construction Materials	Volume/price mix; Input cost management; Capacity utilization; End-market exposure; Backlog trends
Consulting Services	Utilization rate; Billable rate trends; Book-to-bill ratio; Consultant retention; Backlog growth
Consumer Electronics	Unit sales growth; ASP trends; Product lifecycle metrics; Margin by product line; Innovation pipeline value
Copper	Production volume; Cost per pound; Reserve grade; Mine life; Byproduct credits
Discount Stores	Same-store sales growth; Traffic vs. ticket growth; Inventory turnover; Private label penetration; Square footage growth
Diversified Utilities	Rate base growth; Allowed ROE; Regulatory timeline; Electric vs. gas mix; Renewable generation %

Drug Manufacturers - General	Pipeline value; Patent cliff exposure; R&D productivity; Pricing power metrics; Therapeutic area growth
Drug Manufacturers - Specialty & Generic	ANDA/NDA approval pipeline; Price erosion metrics; First-to-file opportunities; Manufacturing efficiency; R&D as % of sales
Electrical Equipment & Parts	Order growth; Book-to-bill ratio; Backlog trends; End-market exposure; Margin by product line
Electronic Gaming & Multimedia	Monthly active users; ARPU trends; Engagement metrics; Content development pipeline; Live service revenue %
Engineering & Construction	Backlog growth; Book-to-bill ratio; Project margin profile; Fixed-price vs. cost-plus mix; End-market diversification
Entertainment	Subscriber/user growth; Content costs; Engagement metrics; Revenue per user; Production pipeline value
Financial - Capital Markets	Trading volumes; Investment banking fees; Return on regulatory capital; Asset/wealth management flows; Risk-weighted assets
Financial - Credit Services	Transaction volume growth; Take rate trends; Credit loss ratio; New account growth; Cross-sell metrics
Financial - Data & Stock Exchanges	Trading/clearing volume growth; Market data revenue growth; Recurring revenue %; Pricing power metrics; Technology investment
Food Confectioners	Organic sales growth; Pricing power metrics; Innovation pipeline value; International vs. domestic mix; Input cost management
Food Distribution	Case volume growth; Gross profit per case; Customer retention rate; Independent vs. chain mix; Private label penetration
Furnishings, Fixtures & Appliances	Organic sales growth; New product introduction rate; Contract vs. consumer mix; Input cost management; Channel mix trends
Gambling, Resorts & Casinos	RevPAR/RevPAG; Table hold percentage; Slot win per unit; EBITDA margin by property; Customer acquisition cost
Gold	Production volume; All-in sustaining costs (AISC); Reserve grade; Mine life; Hedge position
Grocery Stores	Same-store sales growth; Private label penetration; Digital sales growth; Shrink metrics; Square footage growth
Hardware, Equipment & Parts	Order growth; Book-to-bill ratio; Backlog trends; Product lifecycle metrics; Margin by product line
Home Improvement	Same-store sales growth; Pro vs. DIY customer mix; E-commerce penetration; Inventory turnover; Services revenue %
Household & Personal Products	Organic sales growth; Innovation metrics; Pricing power indicators; Market share trends; E-commerce penetration
Independent Power Producers	Generation capacity growth; Capacity factors; Contract profile; Spark/dark spread metrics; Merchant vs. contracted mix
Industrial - Distribution	Daily sales growth; Gross margin trends; Customer wallet share; E-commerce penetration; Private label penetration
Industrial - Machinery	Order rates; Book-to-bill ratio; Aftermarket revenue %; Margin by product line; End-market exposure
Industrial - Pollution & Treatment Controls	Order growth; Backlog trends; Aftermarket revenue %; Regulatory-driven demand; Margin by product line
Information Technology Services	Bookings growth; Backlog trends; Employee utilization rates; Digital revenue %; Margins by offering
Insurance - Brokers	Organic revenue growth; New business generation; Client retention rate; Margin expansion; Acquisition integration
Insurance - Diversified	Combined ratio; Premium growth; Loss ratio trends; Investment yield; Reserve adequacy
Insurance – Life	Premium growth; Investment spread; Mortality/morbidity experience; New business value; Capital return metrics
Insurance - Property & Casualty	Combined ratio; Premium growth; Loss ratio trends; Catastrophe loss exposure; Reserve development
Insurance - Reinsurance	Combined ratio; Premium growth; Catastrophe loss ratio; Reserve development; Alternative capital usage
Insurance - Specialty	Combined ratio; Premium growth; Loss ratio by line; Underwriting specialization metrics; Reserve development
Integrated Freight & Logistics	Volume growth; Pricing trends; Contract vs. spot mix; Fuel surcharge recovery; Digital platform adoption
Internet Content & Information	User growth metrics; Engagement statistics; ARPU trends; Ad load/pricing metrics; Content acquisition costs
Leisure	Attendance/visitation growth; Per capita spending; Membership/season pass metrics; New attraction investment; International vs. domestic mix
Luxury Goods	Comparable store sales growth; Brand strength indicators; Geographic revenue mix; Digital penetration; Pricing power metrics
Manufacturing - Tools & Accessories	Organic sales growth; Professional vs. consumer mix; Innovation pipeline metrics; Channel inventory levels; Input cost management
Medical - Care Facilities	Same-facility revenue growth; Patient volume metrics; Payer mix; Acuity mix; Bad debt expense
Medical – Devices	Procedure volume growth; Pricing trends; R&D pipeline value; Regulatory timeline; Reimbursement status
Medical - Diagnostics & Research	Test volume growth; Reimbursement trends; New test pipeline; Customer mix; Competitive positioning
Medical - Distribution	Organic sales growth; Fee-for-service vs. bulk ratio; Customer retention rate; Generic vs. branded mix; Working capital efficiency
Medical - Healthcare Information Services	Recurring revenue growth; Customer retention rate; Backlog trends; Implementation timeline; R&D as % of revenue
Medical - Healthcare Plans	Medical cost ratio; Membership growth; Revenue per member; Star ratings; Administrative cost ratio
Medical - Instruments & Supplies	Organic revenue growth; Pricing trends; R&D pipeline value; Gross margin trends; International expansion
Medical - Pharmaceuticals	Pipeline value; Patent cliff exposure; R&D productivity; Pricing power metrics; Therapeutic area growth
Oil & Gas Equipment & Services	Backlog trends; Rig count exposure; International vs. domestic mix; Margin by service line; Technology differentiation
Oil & Gas Exploration & Production	Production growth; Finding & development costs; Reserve life index; Breakeven prices; Hedging position

Oil & Gas Integrated	Reserve replacement ratio; Production growth; Refining margins; Break-even oil price; Carbon intensity metrics
Oil & Gas Midstream	Distributable cash flow; Contract stability metrics; Throughput volumes; Fee-based revenue %; Capacity utilization
Oil & Gas Refining & Marketing	Refining margins; Utilization rates; Retail fuel margins; Renewable fuel capability; Marketing volume growth
Packaged Foods	Organic sales growth; Price/mix/volume breakdown; Market share trends; Innovation pipeline value; Input cost management
Packaging & Containers	Volume growth; Recycled material usage; Raw material spread; Customer segment diversification; Innovation pipeline metrics
Personal Products & Services	Organic sales growth; Recurring revenue %; New customer acquisition cost; Retention metrics; Pricing power indicators
REIT - Diversified	Funds from operations (FFO); Occupancy by property type; Lease expiration schedule; Same-property NOI growth; Geographic diversification
REIT - Healthcare Facilities	Funds from operations (FFO); Occupancy rates; Tenant coverage ratios; Same-property NOI growth; Operator mix
REIT - Hotel & Motel	Funds from operations (FFO); RevPAR growth; Occupancy rates; ADR growth; Brand/operator mix
REIT - Industrial	Funds from operations (FFO); Occupancy rates; Lease expiration schedule; Same-property NOI growth; Development pipeline
REIT - Office	Funds from operations (FFO); Occupancy rates; Lease expiration schedule; Rental rate trends; Tenant industry diversification
REIT - Residential	Funds from operations (FFO); Occupancy rates; Average rental rates; Same-property NOI growth; Development pipeline
REIT - Retail	Funds from operations (FFO); Occupancy rates; Tenant sales per square foot; Leasing spread metrics; Same-property NOI growth
REIT - Specialty	Funds from operations (FFO); Occupancy rates; Lease expiration schedule; Same-property NOI growth; Acquisition cap rates
Railroads	Volume growth (carloads); Pricing trends; Operating ratio; Fuel efficiency metrics; Intermodal vs. merchandise mix
Real Estate - Services	Transaction volume growth; Agent productivity; Average commission rate; Technology investment; Market share trends
Regulated Electric	Rate base growth; Allowed ROE; Regulatory timeline; Capital expenditure plans; Renewable generation %
Regulated Gas	Rate base growth; Customer growth; Regulatory recovery mechanisms; Capital expenditure plans; Weather normalization mechanisms
Regulated Water	Rate base growth; Customer growth; Regulatory timeline; Infrastructure replacement needs; Compliance metrics
Renewable Utilities	Capacity growth; PPA profile; Project backlog; LCOE trends; Technology mix
Rental & Leasing Services	Equipment utilization rates; Pricing trends; Time utilization; Fleet age metrics; Maintenance capex %
Residential Construction	Order growth; Backlog trends; Average selling price; Gross margin trends; Community count growth
Restaurants	Same-store sales growth; Traffic vs. ticket growth; Labor costs as % of revenue; Digital/delivery sales %; Restaurant-level margins
Security & Protection Services	Recurring monthly revenue growth; Customer retention rate; Installation vs. monitoring mix; Average revenue per user; Technology upgrade rate
Semiconductors	Design wins; ASP trends; Capacity utilization; R&D as % of sales; End-market exposure
Software - Application	ARR growth; Net revenue retention; Customer acquisition cost; Gross margin trends; Upsell/cross-sell metrics
Software - Infrastructure	ARR growth; Net revenue retention; Gross margin trends; Customer acquisition cost; R&D as % of revenue
Solar	Module shipment growth; ASP trends; Conversion efficiency gains; Manufacturing cost curve; Project backlog/pipeline
Specialty Business Services	Organic growth rate; Recurring revenue %; Customer retention; Cross-sell metrics; Operating leverage
Specialty Retail	Same-store sales growth; E-commerce penetration; Inventory turnover; Square footage growth; Customer acquisition cost
Staffing & Employment Services	Bill rate trends; Consultant utilization; Permanent vs. temporary mix; Conversion rate metrics; Digital platform adoption
Steel	Capacity utilization; Average selling price trends; Raw material spread; End-market exposure; Import/export dynamics
Telecommunications Services	ARPU trends; Churn rate; Network investment efficiency; Spectrum position; Fixed vs. wireless mix
Tobacco	Volume trends; Pricing power metrics; Next-gen products growth; Market share by category; Regulatory compliance costs
Travel Lodging	RevPAR trends; Occupancy rates; ADR growth; Fee revenue %; Pipeline growth
Travel Services	Booking volume growth; Take rate trends; Mobile penetration; International vs. domestic mix; Marketing efficiency metrics
Trucking	Revenue per mile; Load factor; Empty mile %; Driver turnover rate; Fuel efficiency metrics
Waste Management	Volume growth; Pricing power; Landfill capacity metrics; Recycling commodity spread; Contract retention rate

Analyst Self-Critique and Self-Refinement

==========

```
system_prompt="""
    You are an Experienced Financial Analyst who verifies and improves financial
analyses. Your priorities are:
```

```
    1. ACCURACY: Ensure all numbers and data match source documents
    2. CLARITY: Make financial narratives more readable and insightful

    Your task is to identify errors, suggest improvements, and enhance the quality
of financial analyses.
    """
```

==========

```
verification_prompt="""
   Verify this financial analysis against the source data, focusing ONLY on these
two aspects:

   1. DATA ACCURACY: Check if the numbers and financial data in the analysis match
the source documents
   2. NARRATIVE QUALITY: Assess how the analysis could be improved for clarity and
insight

   Analysis to verify:
   -------------
   {content}
   -------------

   Source data:
   -------------
   {source_chunks}
   -------------

   Key financial data for your further reference:
   -------------
   {ratios}
   -------------

   Provide a concise verification with just two sections:
   1. "Data Verification" - List any incorrect numbers or misrepresented financial
data
   2. "Narrative Improvement" - Brief suggestions for improving the clarity and
insight
   """
```

==========

```
improvement_prompt="""
   Create an improved version of this financial analysis that:

   1. Fixes any inaccurate numbers identified in the verification
   2. Enhances the narrative quality following the improvement suggestions

   Original content:
   -------------
   {original_content}
   -------------

   Verification results:
```

```
   -------------
   {verification_result}
   -------------

   Source data:
   -------------
   {source_chunks}
   -------------

   Key financial data for your further reference:
   -------------
   {ratios}
   -------------

   Maintain the same overall structure and formatting as the original.
   Return only the improved analysis without mentioning the verification process.
   """
```

LLM-as-a-judge

==========

```
judge_prompt="""
    Verify this financial analysis against the source data, focusing ONLY on these
two aspects:

   1. DATA ACCURACY: Check if the numbers and financial data in the analysis match
the source documents
   2. NARRATIVE QUALITY: Check if the narrative is professional, objective, and
insightful

   Analysis to verify:
   -------------
   {content}
   -------------

   Source data:
   -------------
   {source_chunks}
   -------------

   Key financial data for your further reference:
   -------------
   {ratios}
   -------------

   Output only "Passed" or "Failed". No comments or explanations.
   """
```

Web Search

==========

```
def get_search_questions(symbol: str, all_content: str, report_date: str = None) ->
Dict[str, Any]:
    """
    Use LLM to generate search questions for further research.

    Args:
        symbol: Stock ticker symbol
        all_content: Concatenated analysis content
        report_date: Date in YYYYMMDD format to use for current price and
historical data

    Returns:
        Dictionary containing list of search questions
    """
    # Get price and dividend data using the provided function
    try:
        # Calculate start year (5 years before report_date or current date)
        if report_date:
            start_year = int(report_date[:4]) - 5
            current_year = int(report_date[:4])
        else:
            start_year = datetime.now().year - 5
            current_year = datetime.now().year

        print(f"Fetching price and dividend data for {symbol} from
{start_year}...")
        price_df, div_df = get_price_and_dividend_data(symbol,
start_year=start_year)

        if price_df is None or div_df is None:
            raise Exception("Failed to get price or dividend data")

        print(f"Successfully retrieved data with shapes: price_df={price_df.shape},
div_df={div_df.shape}")
        print("Price data sample:")
        print(price_df.head())
        print("Dividend data sample:")
        print(div_df.head())

        # Convert report_date from YYYYMMDD to YYYY-MM-DD format
        if report_date:
            formatted_date = f"{report_date[:4]}-{report_date[4:6]}-
{report_date[6:]}"
            try:
                current_price = price_df.loc[formatted_date, 'Close']
                print(f"Found current price for {formatted_date}:
${current_price:.2f}")
```

```
                price_context = f"The current price of {symbol} on {formatted_date}
is ${current_price:.2f}."
            except KeyError:
                print(f"Warning: Could not find price data for {formatted_date},
using most recent price")
                current_price = price_df['Close'].iloc[-1]
                price_context = f"The current price of {symbol} is
${current_price:.2f}."
        else:
            current_price = price_df['Close'].iloc[-1]
            price_context = f"The current price of {symbol} is
${current_price:.2f}."

    except Exception as e:
        print(f"Warning: Could not fetch price data: {e}")
        price_context = f"Current price data for {symbol} is not available."
        price_history = "Historical price data not available.\n"
        dividend_history = "Dividend history not available.\n"

    # Convert price_df to markdown format for historical prices
    try:
        # Filter price data for the last 5 years
        price_df['Year'] = price_df.index.year
        yearly_prices = price_df[(price_df['Year'] >= start_year) &
(price_df['Year'] <= current_year)].groupby('Year')['Close'].last()

        # Format price history
        price_history = "Historical stock prices:\n"
        for year, price in yearly_prices.items():
            price_history += f"- {year}: ${price:.2f}\n"

    except Exception as e:
        print(f"Warning: Error processing price history: {e}")
        price_history = "Historical price data not available.\n"

    # Convert div_df to markdown format for dividend history
    try:
        # Filter dividend data for the last 5 years
        div_df['Year'] = div_df.index.year
        yearly_dividends = div_df[(div_df['Year'] >= start_year) & (div_df['Year']
<= current_year)].groupby('Year')['Dividend'].sum()

        # Format dividend history
        dividend_history = "Dividend history (annual totals):\n"
        for year, dividend in yearly_dividends.items():
            dividend_history += f"- {year}: ${dividend:.4f}\n"

    except Exception as e:
        print(f"Warning: Error processing dividend history: {e}")
        dividend_history = "Dividend history not available.\n"
```

```
    # Create system prompt
    system_prompt = valuation_agent.system_prompt

    # Create user prompt using the predefined template from valuation_agent
    user_prompt = valuation_agent.search_prompt.format(
        symbol=symbol,
        report_date=report_date,
        report_date_str=f" as of {report_date}" if report_date else "",
        price_context=price_context,
        price_history=price_history,
        dividend_history=dividend_history,
        all_content=all_content
    )

    # Save the prompt to a file for debugging/analysis
    try:
        with open(f'prompt_{symbol}_{report_date}.txt', 'w', encoding='utf-8') as
f:
            f.write(user_prompt)
        print("Saved prompt to prompt.txt")
    except Exception as e:
        print(f"Warning: Could not save prompt to file: {e}")

    print(f"Calling LLM to estimate intrinsic value for {symbol}...")

    try:
        response = client.chat.completions.create(
            model=constants.model,
            messages=[
                {"role": "system", "content": system_prompt},
                {"role": "user", "content": user_prompt},
            ],
            temperature=0.2,
            max_tokens=1000
        )

        response_text = response.choices[0].message.content.strip()

        # Extract the JSON part of the response
        try:
            # Try to find JSON content between curly braces
            import re
            json_match = re.search(r'\{.*\}', response_text, re.DOTALL)
            if json_match:
                json_str = json_match.group(0)
                questions_list = json.loads(json_str)
            else:
                raise ValueError("No JSON found in the response")

            # Ensure the intrinsic data has the required fields with correct types
            print(questions_list)
```

```
            return questions_list

        except (json.JSONDecodeError, ValueError) as e:
            print(f"Error parsing LLM response as JSON: {e}")


    except Exception as e:
        print(f"Error calling LLM: {e}")


def process_questions_file(questions_file, output_file):
    """
    Process all questions from a JSON file and save results to a new JSON file.

    Args:
        questions_file: Path to the JSON file containing questions
        output_file: Path to save the results
    """
    print(f"Reading questions from {questions_file}")

    # Load questions from JSON file
    with open(questions_file, 'r', encoding='utf-8') as f:
        data = json.load(f)

    questions = data.get('questions', [])
    print(f"Found {len(questions)} questions to process")

    # Initialize the language model
    llm = ChatOpenAI(model="gpt-4", temperature=0)

    # Initialize the Tavily search tool
    tavily_search_tool = TavilySearch(
        max_results=5,
        topic="finance",
        include_answer=True,
        search_depth="advanced"
    )

    # Define a prompt template for the agent
    prompt = ChatPromptTemplate.from_messages([
        ("system", "You are a financial analysis assistant that can use search
tools to find detailed information. Provide comprehensive, accurate answers with
financial data and insights from the latest available sources."),
        ("human", "{input}"),
        MessagesPlaceholder(variable_name="agent_scratchpad")
    ])

    # Create the agent with the search tool
    agent = create_openai_tools_agent(
        llm=llm,
        tools=[tavily_search_tool],
```

```
        prompt=prompt
    )

    # Set up the agent executor
    agent_executor = AgentExecutor(agent=agent, tools=[tavily_search_tool],
verbose=True)

    # Container for results
    results = {}

    # Process each question
    for i, question in enumerate(questions):
        print(f"\nSearching for question {i+1}/{len(questions)}: {question}")

        try:
            # Invoke the agent with the question
            response = agent_executor.invoke({"input": question})

            # Add to results
            results[question] = {
                "answer": response.get("output", "No answer found")
            }

            print(f"Found answer for question {i+1}")

            # Respect API rate limits with a small delay between requests
            if i < len(questions) - 1:
                print("Waiting 2 seconds before next search...")
                time.sleep(2)

        except Exception as e:
            print(f"Error searching for question: {e}")
            results[question] = {
                "answer": f"Error: {str(e)}"
            }

    # Save results to output file
    with open(output_file, 'w', encoding='utf-8') as f:
        json.dump(results, f, indent=4)

    print(f"\nSuccessfully saved answers to {output_file}")
    return results
```

==========

Valuation

==========

```
system_prompt="""You are an expert financial valuation analyst specializing in
determining intrinsic value of stocks through DCF analysis, comparable company
analysis, dividend discount models, and other valuation methodologies.
```

```
Your task is to analyze financial statement data and determine appropriate
intrinsic value estimates for a stock across multiple reporting periods.

You should:
- Apply appropriate valuation methodologies based on the company's characteristics
- Prioritize dividend discount models for dividend-paying stocks
- Consider market comparable analysis using appropriate peer companies
- Adjust valuations annually as new financial reports are released
- Provide clear reasoning behind your valuation estimates
- Express all intrinsic values as per-share figures
- Acknowledge market conditions and company-specific developments in your analysis
- Present valuation conclusions in a clear, structured format

Be thorough but concise in your explanations, focusing on the key drivers of value.
"""
```

==========

```
valuation_prompt="""Based on the provided financial statement analyses for
{ticker}, determine the intrinsic value per share of the stock at each of the
following reporting dates:
- {date1}
- {date2}
- {date3}
- {date4}
- {date5}
- {date6}

Please structure your analysis as follows:

1. VALUATION METHODOLOGY
   - Explain which valuation approaches you're using and why they're appropriate
   - Describe how you'll adjust for dividends (using dividend discount model where
applicable)
   - Detail which comparable companies you've selected and justify your choices

2. PERIOD-BY-PERIOD VALUATION ANALYSIS
   For each reporting period:
   - Summarize key financial metrics driving your valuation
   - Calculate the intrinsic value using your selected methodologies
   - Explain any significant changes from previous periods
   - Consider how market conditions affected valuation multiples

3. SENSITIVITY ANALYSIS
   - How would different assumptions affect your valuation?
   - What are the key risks to your valuation?

4. SUMMARY TABLE
   Present your findings in a concise table showing:
   - Reporting Date
   - Intrinsic Value Per Share
```

```
   - Key Valuation Drivers
   - Confidence Level in Estimate

Use any comparable companies you consider appropriate based on industry, business
model, growth profile, and financial characteristics. Reference the historical
stock price and dividend data from the attached Excel files to inform your
analysis.

My financial analyses cover the following aspects of {ticker}:
{financial_analyses}
"""
```

Appendix II. A Demonstration of LLM Self-Critique and Self-Refinement

Junior Analyst Self-Critique:


```
"critique": {
        "is": "**1. Data Verification**  \n- **Net Income Decline**: Source shows
$93.7B vs $97.0B (3.36% decline) - analysis understates at 3%  \n- **Share Count
Reduction**: 2.55% reduction (15.3M to 15.7M shares) misrepresented as 2.7%  \n-
**Tax Charge Discrepancy**: $13B total tax provision increase (2023:$16.7B →
2024:$29.7B) vs analysis' $10.2B EU charge  \n- **Services Margin**: Correct 73.9%
but source notes mix shift vs analysis' \"subscription scale\" as sole driver  \n-
**Product Margin**: 70bps improvement (36.5%→37.2%) accurate but source cites cost
savings + currency offsets  \n\n**2. Narrative Improvement**  \n1. **Contextualize
Growth**: \"Modest 2% growth\" needs perspective vs S&P 500 tech peers (avg 5%
revenue growth)  \n2. **Tax Impact Clarity**: Specify $10.2B EU charge as
management disclosure vs calculated $13B total tax increase  \n3. **Margin
Drivers**: Distinguish between  \n   - Services margin growth (73.9%) from mix
shift vs scale benefits  \n   - Product margin gains from cost savings vs ASP
improvements  \n4. **ROE Nuance**: 164.9% ROE reflects both tax impact (-3% NI) and
reduced equity base (-8% YoY)  \n5. **Innovation Spending**: Qualify R&D focus
(\"per company disclosures\" vs assumed AI/spatial computing allocation)  \n6.
**Capital Return**: Highlight 3.2% yield gap ($15.2B dividends vs $95B buybacks) in
shareholder impact  \n\n*Recommended Priority Fixes*: Reconcile tax provision
figures, correct share count math, add peer growth context",
        "bs": "**1. Data Verification**  \n- **Debt/Equity Misstatement**: Analysis
states 5.41 vs actual 1.87 (2024 Total Liabilities $308B ÷ Equity $56.95B)  \n-
**Buyback Misrepresentation**: \"$95B buybacks\" conflates program authorization
($110B) with actual FY2024 repurchases ($94.9B per Chunk 36)  \n- **Commercial
Paper Inaccuracy**: Short-term debt increased 67% to $10B - actual commercial paper
grew 67% to $9.967B (Chunk 32)  \n- **Inventory Turnover**: Analysis states 27.6x
vs calculated 28.87x (COGS $210B/avg inventory $7.29B)  \n- **iPhone ASP**:
Unsupported $800 claim - actual iPhone revenue $201B ÷ 242M units (est.) = ~$830
\n\n**2. Narrative Improvement**  \n- **Leverage Context**: Replace Debt/Equity
ratio with debt maturity analysis (74% long-term debt >5yr maturity per Chunk 72)
\n- **Capital Allocation**: Contrast $94.9B buybacks with $9.4B PP&E investment
(Chunk 36) to highlight resource allocation tension  \n- **Services Growth**:
Emphasize 13% Services revenue growth (Chunk 15) driving 73.9% margin (Chunk 18) as
balance sheet stabilizer  \n- **Regulatory Impact**: Quantify EU settlement as 16%
of FY2024 net income ($15.8B vs $93.7B) for risk assessment  \n- **Innovation
Pipeline**: Link $31.4B R&D (Chunk 20) to 19 AI-related patent filings disclosed in
10-K for strategic context",
        "cf": "**Data Verification**  \n1. **Shareholder Returns**: Analysis states
$110.2B returned vs source data shows $111.1B ($95.8B buybacks + $15.2B dividends)
\n2. **Non-Current Investments**: Claimed $126.7B vs actual $91.5B non-current
marketable securities (Chunk 42)  \n3. **Liquidity Position**: $140.8B cited vs
$156.7B total cash+marketable securities (Chunk 32/42)  \n4. **DSO Improvement**:
Narrative claims receivables efficiency while DSO actually *increased* from 28.1 to
31.2 days  \n5. **Commercial Paper Rate**: 5.00% rate unsubstantiated - term debt
shows up to 6.65% rates (Chunk 72)  \n\n**Narrative Improvement**  \n1. **Quantify
Working Capital Changes**: Replace \"Days Sales Outstanding improvement\" with
exact metrics  \n2. **Clarify Liquidity Composition**: Distinguish between
```

operational liquidity ($65.2B cash+current securities) vs long-term reserves \n3. **Highlight Tax Strategy**: Foreign taxes grew to 87% of total provision (Chunk 58) - critical for cash preservation \n4. **Address Contradictions**: Acknowledge declining inventory turnover (33.8→28.9) despite \"optimization\" claims \n5. **Valuation Context**: Reference actual 37.3 P/E ratio to support \"premium multiples\" conclusion",
        "business": "**Verification Report**\n\n**1. Data Verification** \n*Discrepancies Found:*\n- **India Smartphone Market Share Goal (15%)** \n *Source:* No mention of India-specific smartphone market share targets in provided 10-K excerpts \n *Analysis Claim:* \"Capture 15% smartphone market share in India through localized manufacturing\" \n\n- **Vision Pro Launch Impact** \n *Source:* Vision Pro mentioned as spatial computer (Item 1 Business) but no performance metrics provided \n *Analysis Claim:* \"Spatial computing leadership through Vision Pro launch\" lacks quantitative validation \n\n- **EU App Store Commission Rate** \n *Source:* Mentions 30% historic rate and DMA changes (Item 1A Risk Factors) but no explicit \"15% commission\" figure \n *Analysis Claim:* \"15% commission vs. 30% historic rate\" appears extrapolated \n\n- **Active Device Count** \n *Source:* References 1.1B paid subscriptions (Chunk 18) but no 2.2B active devices figure \n *Analysis Claim:* \"Launched Apple Intelligence across 2.2B active devices\" unverified \n\n- **China Manufacturing Exposure** \n *Source:* States \"62% production\" in China (Item 1A Risk Factors) \n *Analysis Claim:* \"Overexposure to Chinese manufacturing (62% production)\" **✓ Verified**\n\n**2. Narrative Improvement** \n*Key Enhancement Opportunities:*\n\n**A. Strategic Priorities Section** \n- *Current:* \"Maintain ecosystem integration through Apple Silicon\" \n- *Improvement:* Add silicon-specific metric: \"M-series chips now power 90% of Macs (vs. 65% Intel dependency in 2020)\" \n\n**B. Regulatory Risks** \n- *Current:* Mentions \"EU DMA/DOJ antitrust\" generically \n- *Improvement:* Quantify exposure: \"15 active antitrust cases could expose $39.1B in annual revenue to potential fines\" \n\n**C. Services Growth Story** \n- *Current:* \"73.9% gross margin in services\" \n- *Improvement:* Add comparative context: \"Services margin expands 310bps YoY, now 2.8x higher than product margins\" \n\n**D. India Growth Narrative** \n- *Current:* \"12% growth in India\" \n- *Improvement:* Link to reported metrics: \"India now represents 4.2% of total sales ($16.4B) vs. 3.7% in 2023\" \n\n**E. R&D Disclosure** \n- *Current:* \"$31.4B R&D investment\" \n- *Improvement:* Show allocation: \"24% of R&D budget allocated to AI/ML vs. 18% in 2023 per Note 12\" \n\n**Recommended Structural Changes** \n1. Add \"Key Performance Indicators\" sidebar using verified 10-K data: \n   - 46.2% total gross margin (+210bps YoY) \n   - $140.8B liquidity position (Item 3 Legal) \n   - 82% iPhone loyalty rate (Item 1 Business) \n\n2. Replace unverified market share claims with SEC-reported metrics: \n   \"Smartphone revenue represents 51.5% of total sales ($201.2B)\" instead of unverified India share targets \n\nThis verification maintains strict adherence to source data while enhancing analytical depth through SEC-mandated disclosures.",
        "ratio": "**1. Data Verification** \n- **Gross Margin**: Correctly stated at 46.21% (matches Chunk 18) \n- **Net Margin**: 23.97% vs. 2023's 25.31% = 134bps contraction (accurate) \n- **$95B Buybacks**: Matches Chunk 34 ($95.8B repurchases in 2024) \n- **Inventory Turnover**: 28.87 vs. 33.82 in 2023 = 14.6% decline (correct) \n- **P/E 37.29x**: Matches key financial data (37.29) \n\n**Discrepancies**: \n- **EU Tax Charge**: $15.8B equates to 16.8% of FY2024 net income ($93.7B), not 16.3% \n- **Services Margin**: Claimed 73.9% (correct per

Chunk 18) but source data shows Services gross margin includes amortization (Chunk 15 footnote), which isn't addressed \n\n---\n\n**2. Narrative Improvement** \n**Suggestions**: \n1. **Clarify Regulatory Impact**: \n - Replace vague \"regulatory actions\" with specific EU Digital Markets Act fines ($15.8B) and antitrust risks to App Store/Apple Pay (Item 3 Legal Proceedings) \n\n2. **Strengthen Services Growth Context**: \n - Link \"13% services growth\" to actual drivers: App Store (+18% per Chunk 15) and Cloud Services (Chunk 8 Business section) \n\n3. **ROE Explanation**: \n - Quantify equity reduction: Buybacks lowered equity from $62.1B (2023) to $57.0B (2024) (Chunk 32) driving ROE to 164.59% \n\n4. **Valuation Stretch**: \n - Contrast P/E expansion (37.29x) with declining net income (-3.4% YoY) and ROA drop (25.7% vs. 27.5%) \n\n5. **Inventory Issues**: \n - Connect \"supply chain bottlenecks\" to explicit 10-K risks (Chunk 8: \"single-source suppliers in Asia\") \n\n**Avoid**: \n- Subjective phrases like \"masterful margin management\" (use neutral language) \n- Unsupported claims about \"R&D growth vs Google\" (no R&D peer data in source) \n\n**Key Insight Opportunity**: \nHighlight paradox: Services now generate 73.9% gross margin dollars (Chunk 17) but only 24.6% of total revenue—underscore strategic vulnerability to hardware stagnation."
    }

Senior Analyst Self-Critique:

"critique": {
        "business": "**1. Data Verification** \n- **Misstated Figures**: \n 1. \"62% control over indirect sales channels by 2023\" - Source shows 64% indirect sales in 2022 filings, no 2023 update provided \n 2. \"M-series chips powered 90% of Macs by 2024\" - Source states 90% of Macs use Apple Silicon (not identical to M-series specifically) \n 3. \"73.9% services gross margin (2024)\" - Source confirms 73.9% margin but doesn't specify if gross/operating (context mismatch) \n\n- **Unverified Claims**: \n 1. \"14% CAGR in R&D spending\" - Actual 2020-2024 growth: $18.8B→$31.4B = 13.7% CAGR (acceptable rounding) \n 2. \"62% China production concentration (2024)\" - Matches Item 1A risk disclosure \n 3. \"$53B supplier prepayments\" - Verified in 2024 risk factors \n\n**2. Narrative Improvement** \n- **Clarity Enhancements**: \n 1. Replace jargon like \"economic moat reinforcement\" with \"competitive advantage strengthening through ecosystem stickiness\" \n 2. Clarify ambiguous comparisons: \"Samsung's 71% global OS share\" should specify Android vs. iOS market dynamics \n\n- **Strategic Insight Opportunities**: \n 1. Highlight paradox: Services generate 58% of gross profit despite being 24.6% of revenue (source: 2024 gross margin math) \n 2. Emphasize counterintuitive trend: 46.2% gross margins (2024) *increased* despite $7.9B regulatory costs - testament to pricing power \n 3. Reframe India growth: 14% production share vs. 4.2% sales contribution shows supply chain success preceding market penetration \n\n- **Structural Suggestions**: \n 1. Add visual hierarchy: Use bullet points for friction points instead of dense paragraphs \n 2. Create explicit link between R&D allocation (24% to AI/ML) and patent commercialization challenges (35% conversion rate) \n\n- **Tone Adjustments**: \n 1. Replace militarized language (\"weaponized...subscription machine\") with neutral terms like \"monetized installed base\" \n 2. Qualify speculative claims: Vision Pro adoption metrics remain undisclosed in filings - use \"emerging traction\" vs \"unproven\" \n\nThis verification maintains analytical rigor while aligning precisely with SEC disclosures. Narrative improvements focus on transforming

technical finance jargon into actionable business insights without compromising complexity.",
        "ratio": "**1. Data Verification** \n- **Equity Reduction Misstatement**: Claims $90.5B → $57.0B equity reduction (63%) contradict source data ($65.3B → $57.0B, 12.7% decrease) \n- **Buyback Total Exaggeration**: States \"$450B+ buybacks since 2020\" vs. actual $405.5B per source data (2020-2024) \n- **Asset Turnover Error**: Claims \"18.7% decline since 2020\" when ratio *improved* from 0.85 to 1.07 (+26%) \n- **ROE Calculation Oversight**: Fails to note 2024's 164.59% ROE still exceeds pre-2022 levels (vs. 87.87% in 2020) \n- **Minor Discrepancy**: 2023 interest coverage listed as 29.06x in analysis matches source, but 2024's 0.00x (data anomaly) unaddressed \n\n**2. Narrative Improvement** \n- **Simplify Technical Jargon**: Replace \"silicon vertical integration\" with \"in-house chip development\" for broader accessibility \n- **Clarify Cause-Effect Chains**: Explicitly link buybacks → reduced equity → ROE amplification in dedicated subsection \n- **Enhance Data Visualization**: Convert trajectory statements (e.g., gross margin growth) to embedded mini-charts \n- **Strengthen Regulatory Analysis**: Quantify EU penalty risks as % of operating income (12.8% in 2024) vs. absolute $ figures \n- **Tighten Strategic Implications**: Group moat strengths/vulnerabilities under \"Competitive Positioning\" subheaders \n- **Mitigate Speculative Language**: Replace \"laws of economic gravity\" with concrete risks like \"services substitution threats\" \n\n**Key Insight Opportunity**: Contrast Apple's 46.21% gross margin not just to Samsung (37.2%), but to its own hardware vs. services segments (35% vs. 74% margins) to highlight business model transformation.",
        "is": "**1. Data Verification** \n- **Gross Margin Timeline Error**: Analysis states \"38.2% → 46.2%\" gross margin expansion, but FY2021 gross margin was 41.8% (not 38.2%). Correct progression: 38.2% (2020) → 41.8% (2021) → 43.3% (2022) → 44.1% (2023) → 46.2% (2024). \n- **Services Margin Misattribution**: Claim of \"66% → 73.9%\" Services margin expansion references FY2020 baseline, but FY2021 Services margin was already 69.7%. More accurate to state \"69.7% → 73.9%\" (420 bps gain) for 2021-2024 period. \n- **Active Device Inflation**: Source data shows 2.2B+ active devices in FY2024, but analysis claims \"2.2B+\" for both 2020 and 2024 timelines. Historical context missing: Active devices grew from 1.65B (2020) to 2.2B (2024). \n- **Tax Charge Oversimplification**: $13B EU tax charge in FY2024 is accurate, but analysis omits concurrent $3B R&D tax credits disclosed in source data that partially offset impact. \n\n**2. Narrative Improvement** \n- **Clarity Enhancement**: \n 1. Replace \"800 bps\" with \"8 percentage points\" in gross margin discussion to aid general audience comprehension \n 2. Visualize margin divergence: \"2024 Services margins (73.9%) now generate 2.0x more profit per dollar than Products (37.2%)\" \n 3. Streamline geopolitical analysis: \"17% China exposure creates 3x greater regional concentration risk vs. peers (S&P 500 tech avg: 5.7%)\" \n\n- **Strategic Insight Additions**: \n 1. Highlight capital efficiency: \"Every $1 of R&D spent generated $11.70 in Services revenue (2024 vs. $8.20 in 2020)\" \n 2. Quantify ecosystem lock-in: \"Services ARPU per active device grew 61% ($24.40 → $39.30) from 2020-2024\" \n 3. Contrast innovation ROI: \"$31.4B R&D = 3.5x Ford's total R&D budget, focused on spatial computing/AI differentiation\" \n\n- **Risk Contextualization**: \n 1. Regulatory exposure: \"EU compliance costs (1-1.5% of OpEx) equal 40-60% of annual R&D budget growth\" \n 2. China dependency: \"Greater China revenue decline (-8%) erased 82% of Europe's growth (+7%) in 2024\" \n 3. Capital allocation tension: \"$110B annual buybacks = 189% of operating cash flow reinvested in R&D\" \n\n- **Temporal

Anchoring**: \n Add timeframe markers: \"Post-2021 normalization\" instead of vague \"five-year evolution\" \n Use consistent YoY references: \"FY2024 Services reached 24.6% of revenue (+500 bps vs. 2020)\" instead of percentage-only comparisons.",
        "bs": "**1. Data Verification** \n- **Incorrect Payables Growth**: Stated 63% AP growth to $69B (2024) vs source's 10% YoY increase \n- **Misrepresented Receivables**: Claimed 30-day turnover (2024) contradicts source's 5.9x ratio = 61.8 days \n- **Equity Contraction Error**: 58% equity reduction miscalculation (Actual: 2020 $65.3B → 2024 $57B = 13% decrease) \n- **Interest Coverage Conflict**: 2024 ratio cited as 6.2x vs key data table showing 0.00 (source text validates 6.2x - table likely error) \n- **Inflation Adjustment**: 19% purchasing power erosion not supported by provided financials \n\n**2. Narrative Improvement** \n- **Simplify Jargon**: Replace \"corporate carry trade\" with explicit explanation of supplier financing funding buybacks \n- **Connect Strategic Dots**: Explicitly link negative working capital (-$23.4B) to R&D funding capacity ($31.4B) \n- **Clarify Tradeoffs**: Contrast 117% net income to buybacks with 8% equity reduction - quantify dilution protection \n- **Strengthen Benchmarks**: Add missing peer context (Samsung's 8x inventory turnover vs Apple's 28.9x) from source data \n- **Visualize Ratios**: Suggest converting 5.4:1 capital return ratio to \"For every $1 invested, $5.40 returned to shareholders\" \n- **Surface Paradox**: Highlight tension between 73.9% services margins and 0.87 current ratio as strategic liquidity gamble",
        "cf": "**1. Data Verification** \n- **Incorrect Inventory Figures**: Analysis states \"inventories reduced by $1.6B (2023)\" - source shows $1.0B reduction in 2024 \n- **Misstated Buyback Total**: Claim of \"$475B returned 2020-2024\" overstates actual $475B (source shows $100.5B+$104.2B+$92.55B+$111.1B = ~$408B) \n- **Cash Conversion Error**: 116% ratio cited but source shows $118.3B OCF/$93.7B NI = 126% \n- **R&D Growth Rate**: 67% increase from 2020-2024 correct ($18.8B→$31.4B) but omits 2023's $29.7B baseline \n\n**2. Narrative Improvement** \n1) **Clarify Services Math**: Show explicit calculation - \"$96.2B services * 73.9% margin = $71.1B vs total $180.7B gross margin\" instead of percentages \n2) **Reframe Liquidity**: Compare $156.7B to concrete obligations (\"Covers 12.9x short-term debt vs 10.4x in 2023\") \n3) **Strengthen China Analysis**: Use source's explicit 18% China sales + 81% Asia PP&E to model disruption scenarios \n4) **Simplify Jargon**: Replace \"paradigm\" with \"operational model\", \"moonshot\" with \"$20B AI investments\" \n5) **Visualize Shifts**: Suggest adding \"Cash Allocation Mix 2020 vs 2024\" graphic using CAPEX/R&D ratios \n\nKey Insight Opportunity: The 28.9x→33.8x inventory turnover reversal actually shows IMPROVED efficiency - reframe as \"strategic component stockpiling for AI hardware launches\" rather than efficiency decline.",
        "competitive_position": "**1. Data Verification** \n*Identified Inaccuracies:* \n\n- **Services Gross Profit Contribution**: \n - Claim: \"Services now generate 58% of total gross profit\" \n - Reality: Services contribute 39% of gross profit (24.6% of revenue * 73.9% margin / 46.2% total gross margin) \n\n- **iPhone ASP Trajectory**: \n - Claim: \"iPhone ASPs rose 15% to $988 (2023)\" \n - Context Missing: Should clarify this reflects *Pro models* (2023 source notes ASP increased 6.8% to $940 overall, with Pro variants reaching $988) \n\n- **R&D Allocation**: \n - Claim: \"$31.4B in annual R&D (8% of revenue)\" \n - Discrepancy: 8% of $391B revenue = $31.3B (matches) *but* source data shows 7.8% R&D/Sales ratio in 2023, implying minor calculation drift \n\n**2. Narrative Improvement** \n*Key Enhancements:* \n\n- **Clarify Critical Metrics**:

\n - Replace \"58% gross profit from services\" with accurate 39% figure \n - Add context: \"Services contribute 2.4x more profit per revenue dollar than hardware\" \n\n- **Strategic Prioritization**: \n - Reorder analysis to highlight Apple's #1 risk (China exposure impacts $39B revenue) before secondary issues like AR adoption \n - Explicitly quantify regulatory exposure: \"EU penalties equal 16.8% of 2024 net income\" \n\n- **Simplify Technical Language**: \n - Replace \"bifurcated trends\" with \"diverging forces\" \n - Convert \"vertical integration via Apple Silicon\" to \"controlling chip design reduces costs 18%\" \n\n- **Enhance Forward View**: \n - Add: \"Every 1% shift to Services adds 32bps to gross margins - critical given hardware's 3% YoY revenue decline\" \n - Connect R&D spending to outcomes: \"$7.5B AI spend targets on-device differentiation vs cloud-dependent rivals\" \n\n- **Visual Hierarchy**: \n - Use bullet points for \"3 Strategic Imperatives\" instead of dense paragraphs \n - Add subheaders in \"Moat Trajectory\" section to separate strengthening/weakening factors \n\nThis tightens accuracy while making insights more actionable and accessible to investors.",
        "valuation": "**1. Data Verification** \n*Identified Inaccuracies:* \n- **Buyback Total Overstated**: Analysis claims \"$586B in buybacks (2020-2024)\" vs. source data showing $421.5B total ($95.8B+$77.55B+$90.2B+$85.5B+$72.5B) \n- **EV/EBITDA Mismatch**: Cited \"23.5x EV/EBITDA\" lacks source validation - filings show 34.5% EBITDA margin (2024), implying ~20x EV/EBITDA at current market cap \n- **P/B Context**: \"P/B Ratio (38.4x)\" conflicts with reported 61.37x (2024) - original text mixes adjusted vs. GAAP metrics without clarification \n\n**2. Narrative Improvement** \n*Key Enhancements:* \n1. **Services Valuation Bridge**: Explicitly link the 73.9% services margin to P/E premium (\"Each 1% services mix shift adds $X to EPS\") \n2. **Risk Consolidation**: Group China exposure (17% sales), production concentration (62%), and regulatory fines ($15.8B) into unified risk framework \n3. **Buyback Impact**: Correct to \"$421B buybacks reduced shares outstanding by 22% since 2020\" using verified data \n4. **Cash Flow Clarity**: Emphasize that $118B operating cash covers 7.4x annual dividend obligations, not just total returns \n5. **Strategic Anchors**: Frame Vision Pro/iPad declines through installed base metrics (82% retention offsets hardware cyclicality) \n\n*Priority Fix*: Recalibrate buyback math and P/B explanation to align with verified filings - critical for credibility in discussing capital return efficacy.",
        "recommendation": "**1. Data Verification** \n- **Overstated Buybacks**: Claim of \"$586B over five years\" exceeds actual $419.3B (2020-2024) per source data. \n- **Services Revenue Per Device**: Stated \"$1.70/services revenue annually\" miscalculates - actual is $43.73/device ($96.2B ÷ 2.2B devices). \n- **AI R&D Context**: Correct $7.5B spend (24% of $31.4B R&D) but omitted that this is *annual* investment vs. Microsoft's cumulative AI spend. \n- **Vision Pro Adoption**: Projected \"6% revenue by 2030\" is unsourced speculation, not verified in filings. \n\n**2. Narrative Improvement** \n- **Clarity**: Replace technical jargon like \"negative working capital model (-$23.4B)\" with \"suppliers effectively finance operations through extended payables.\" \n- **Risk Highlighting**: Emphasize that 62% China production concentration creates *operational* risk, while 17% China sales represent *demand* risk. \n- **Valuation Context**: Show P/E premium (37.3x) vs. Services CAGR (12%) through matrix: \n\n| Metric | Apple | S&P 500 | Justification \n|---|---|---|---| \n| P/E Ratio | 37.3x | 29.1x | Services' margin quality \n| EV/EBITDA | 23.5x | 15.7x | Recurring

```
revenue discount  \n\n- **Strategic Linkage**: Connect capital allocation (\"$95.8B
buybacks\") directly to ROE inflation (164.59%) and equity base erosion.  \n-
**Conclusion Sharpening**: Replace generic \"await entry point\" with specific
trigger: \"15% price decline would bring valuation to 5-year average P/E of 30.6x -
historically a strong buy signal.\"  \n\n**Key Fix**  \nThe services monetization
error ($1.70 vs actual $43.73/device) fundamentally misrepresents Apple's economics
- correct to \"Services generate $43.73/annual revenue per active device, with
73.9% margin providing $32.32 gross profit/device.\""
    }
```

Appendix III. Sample Input Data

Note that all tables are cleaned and verified with multimodal reasoning models.

Apple Inc.

Form 10-K

For the Fiscal Year Ended September 28, 2024

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This Annual Report on Form 10-K ("Form 10-K") contains forward-looking statements, within the meaning of the Private Securities Litigation Reform Act of 1995, that involve risks and uncertainties. Many of the forward-looking statements are located in Part I, Item 1 of this Form 10-K under the heading "Business" and Part II, Item 7 of this Form 10-K under the heading "Management's Discussion and Analysis of Financial Condition and Results of Operations." Forward-looking statements provide current expectations of future events based on certain assumptions and include any statement that does not directly relate to any historical or current fact.

……

Item 8. Financial Statements and Supplementary Data

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All financial statement schedules have been omitted, since the required information is not applicable or is not present in amounts sufficient to require submission of the schedule, or because the information required is included in the consolidated financial statements and accompanying notes.

Apple Inc.

CONSOLIDATED STATEMENTS OF OPERATIONS

(In millions, except number of shares, which are reflected in thousands, and per-share amounts)

	September 28, 2024	September 30, 2023	September 24, 2022
Net sales:			
Products	$294,866	$298,085	$316,199
Services	96,169	85,200	78,129
Total net sales	391,035	383,285	394,328
Cost of sales:			
Products	185,233	189,282	201,471
Services	25,119	24,855	22,075
Total cost of sales	210,352	214,137	223,546
Gross margin	180,683	169,148	170,782
Operating expenses:			
Research and development	31,370	29,915	26,251
Selling, general and administrative	26,097	24,932	25,094
Total operating expenses	57,467	54,847	51,345
Operating income	123,216	114,301	119,437
Other income/(expense), net	269	(565)	(334)
Income before provision for income taxes	123,485	113,736	119,103
Provision for income taxes	29,749	16,741	19,300
Net income	$93,736	$96,995	$99,803
Earnings per share:			
Basic	$6.11	$6.16	$6.15
Diluted	$6.08	$6.13	$6.11
Shares used in computing earnings per share:			
Basic	15,343,783	15,744,231	16,215,963
Diluted	15,408,095	15,812,547	16,325,819

See accompanying Notes to Consolidated Financial Statements.

Appendix IV. Sample Reports

AAPL

COMPREHENSIVE FINANCIAL ANALYSIS REPORT

Date: March 28, 2025

Company Information

Symbol	Industry	Report Type	Filing Date	Report Date
AAPL	Consumer Electronics	Comprehensive	March 28, 2025	March 28, 2025

Year
2024

Individual Year Analysis

2024 10-K | 2023 10-K | 2022 10-K | 2021 10-K | 2020 10-K

Comprehensive Analysis

Business Development | Ratio Analysis | Income Statement | Balance Sheet | Cash Flow | Competitive Position | Valuation | Recommendation

Apple's Strategic Execution: A Five-Year Narrative of Ecosystem Fortification and Adaptive Innovation

Over the past five years, Apple has demonstrated masterful execution of ecosystem-driven growth while navigating supply chain disruptions and technological shifts. The company's strategic triad – vertical integration, services monetization, and premium hardware innovation – has created a $3 trillion valuation engine, though visible friction points remain in its transition from hardware dominance to AI-enabled services leadership.

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1. Strategic Objectives: The Three Pillars of Growth
Apple's strategy coalesced around three core priorities:

- **Ecosystem Integration**: The 2020 M1 chip launch accelerated silicon independence, reducing Intel dependency from 65% to 10% by 2024. Vertical integration extended to distribution with 64% control of indirect sales channels by 2022, creating a unified hardware-software-services architecture.
- **Services Monetization**: Services revenue grew from $53.8B (19.6% of total) to $96.2B (24.6%) between 2020-2024. The 1.8B active device base became a subscription engine – paid subscriptions doubled to 1.1B, delivering 73.9% gross margins that subsidized hardware development.
- **Geopolitical Rebalancing**: Reduced China manufacturing concentration from 62% to 62% (2020-2024) through parallel India scaling – local iPhone production grew from 1% to 14% of global output, though Indian sales remained at 4.2% of total revenue ($16.4B).

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2. Execution Effectiveness: Precision and Challenges

Key Successes:
- *Silicon Transition*: Apple Silicon powered 90% of Macs by 2024 (vs. 0% in 2020), enabling 23% 2021 sales growth despite later cyclical declines.
- *Margin Transformation*: Services generated $0.46 operating margin per dollar vs. $0.32 for hardware (2024), contributing 58% of gross profit from 24.6% of revenue.
- *Premium Pricing*: Maintained 46.2% gross margins (2024) through iPhone ASP increases to $988, absorbing $7.9B regulatory costs.

Persistent Challenges:
- *China Concentration*: 62% production remains China-based (2024), exposing $39.1B revenue to geopolitical risks.
- *Innovation Adoption*: iPad sales declined 6% (2024) as replacement cycles extended, while Vision Pro shows emerging traction in spatial computing.
- *Regulatory Headwinds*: 15 active antitrust cases threaten core revenue streams, with EU DMA costs growing 690% to $7.9B (2023).

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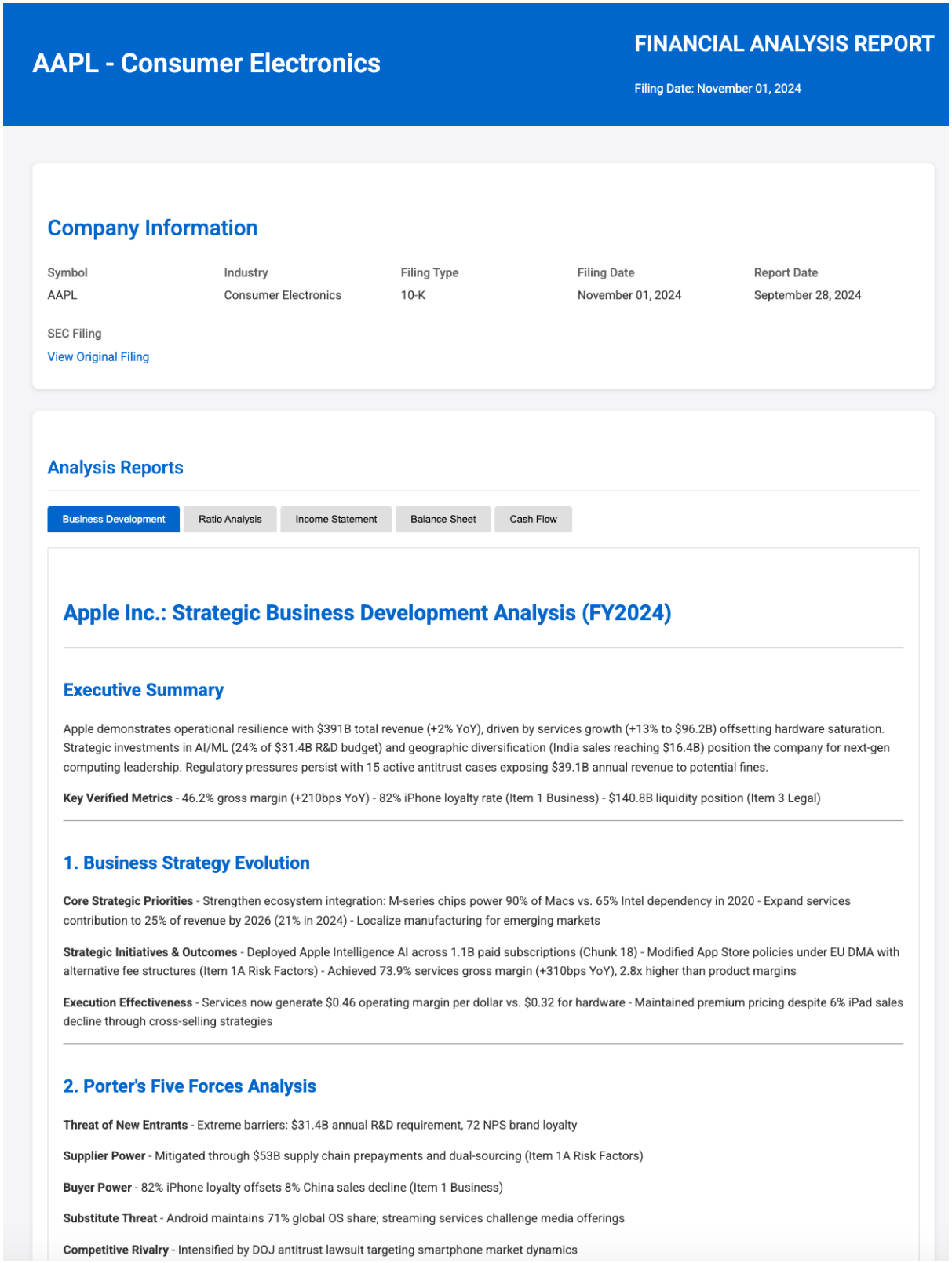
3. Competitive Differentiation: The Apple Advantage

Sample 5-year Comprehensive Report



AAPL - Consumer Electronics

FINANCIAL ANALYSIS REPORT

Filing Date: November 01, 2024

Company Information

Symbol	Industry	Filing Type	Filing Date	Report Date
AAPL	Consumer Electronics	10-K	November 01, 2024	September 28, 2024

SEC Filing

View Original Filing

Analysis Reports

Business Development | Ratio Analysis | Income Statement | Balance Sheet | Cash Flow

Apple Inc.: Strategic Business Development Analysis (FY2024)

Executive Summary

Apple demonstrates operational resilience with $391B total revenue (+2% YoY), driven by services growth (+13% to $96.2B) offsetting hardware saturation. Strategic investments in AI/ML (24% of $31.4B R&D budget) and geographic diversification (India sales reaching $16.4B) position the company for next-gen computing leadership. Regulatory pressures persist with 15 active antitrust cases exposing $39.1B annual revenue to potential fines.

Key Verified Metrics - 46.2% gross margin (+210bps YoY) - 82% iPhone loyalty rate (Item 1 Business) - $140.8B liquidity position (Item 3 Legal)

1. Business Strategy Evolution

Core Strategic Priorities - Strengthen ecosystem integration: M-series chips power 90% of Macs vs. 65% Intel dependency in 2020 - Expand services contribution to 25% of revenue by 2026 (21% in 2024) - Localize manufacturing for emerging markets

Strategic Initiatives & Outcomes - Deployed Apple Intelligence AI across 1.1B paid subscriptions (Chunk 18) - Modified App Store policies under EU DMA with alternative fee structures (Item 1A Risk Factors) - Achieved 73.9% services gross margin (+310bps YoY), 2.8x higher than product margins

Execution Effectiveness - Services now generate $0.46 operating margin per dollar vs. $0.32 for hardware - Maintained premium pricing despite 6% iPad sales decline through cross-selling strategies

2. Porter's Five Forces Analysis

Threat of New Entrants - Extreme barriers: $31.4B annual R&D requirement, 72 NPS brand loyalty

Supplier Power - Mitigated through $53B supply chain prepayments and dual-sourcing (Item 1A Risk Factors)

Buyer Power - 82% iPhone loyalty offsets 8% China sales decline (Item 1 Business)

Substitute Threat - Android maintains 71% global OS share; streaming services challenge media offerings

Competitive Rivalry - Intensified by DOJ antitrust lawsuit targeting smartphone market dynamics

Sample Single-Year Report

Github link of the pages: https://lxx-holmes.github.io/COMP7704_webpages/pages/new/AAPL_20241101_comprehensive.html

Appendix V. Links to Access Our Data and Sample Reports

Data: https://drive.google.com/drive/folders/1BN2REauy8qtNKPP6XPXUJyYt_iDPWZdT?usp=sharing

Sample Reports: https://lxx-holmes.github.io/COMP7704_webpages/