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INVESTMENT MANAGEMENT

AI Index Portfolio:

AI Exposure Index & Portfolio Construction

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Introduction

Since the release of ChatGPT in November 2022, there has been much debate, modeling, and forecasting of how large language models (LLMs) could impact the labor market. Such models, recognized for their ability to complete sequences and to generate coherent and contextually relevant text, have swiftly found applications in various economic sectors. Fields like customer support, content creation, and select financial analysis tasks have seen rapid integration of these models (Haleem et al., 2022; OpenAI, 2022; Chang et al., 2023). These advancements echo the arguments of Arntz, Gregory, & Zierahn (2016) and Chui, Manyika, & Miremadi (2016), who posit that while Artificial Intelligence may not eradicate many occupations outright, it is poised to significantly alter the nature of most jobs. Such transformations are contingent on numerous factors, including the nature of the work, the technical feasibility for automation, and the interplay of benefits, costs, and labor dynamics.

LLMs have quickly garnered attention, and emergent concerns regarding job displacement have surfaced. Preliminary data indicates a notable correlation between the incorporation of LLMs and changes in sectors characterized by routine textual, coding, translation, and other repetitive tasks (Chen et al., 2021; Carlini et al., 2021; Felten, 2023; Yilmaz et al., 2023; Jiao et al., 2023; Webb, 2020). As businesses stand to benefit from reduced operational costs and enhanced efficiency, there is a discernible tension between technological progression and job security for certain cohorts of workers.

The address this transformative phase, this study introduces the "AI Exposure Index". This index is designed to gauge the susceptibility of individual professions, companies, and entire industries to LLM influences. It is very critical that corporate decision-makers harness such tools to astutely navigate this evolving landscape and foster a vision where technology complements, rather than supplants, human expertise.

A prevalent assumption is that generative AI, with its potential to automate a plethora of tasks, will invariably lead to widespread job displacement, subsequently creating a 'layoff generation' (Arif et al., 2023). However, these dystopian forecasts often fail to account for the intricate dynamics at the intersection of AI and labor markets. Understanding the relationship between AI and employment is not a straightforward equation, but rather a complex interplay that unfolds within a multitude of economic, social, and institutional contexts. In this paper, our primary focus centers on the substitutive role of ChatGPT in professional contexts. We assign scores to individual tasks across various jobs. While Eloundou et al. (2023) have categorized tasks, our analysis further incorporates real-world legal and ethical considerations, as well as the interplay between automation and large language models. By harnessing the ChatGPT API for extensive categorization, we ensure that our findings are readily replicable, thereby enhancing the robustness and applicability of our results.

We believe our AI Exposure Index can represent companies' strategies regarding large language model (LLM) integration and their susceptibility to the AI era's influences. A primary objective of this research is to construct an investment portfolio centered around the AI Exposure Index. By evaluating the AI Exposure Index across various companies and industries, we aim to identify investment opportunities that align with emerging trends and insights from our analysis.

The construction of the investment portfolio involves a comprehensive assessment of companies' AI adoption levels, workforce dynamics, and market potential. By integrating these factors, we strive to develop a robust and forward-looking investment strategy that leverages the transformative potential of AI while mitigating associated risks. This approach ensures investors are well positioned to capitalize on the ongoing advancements in AI technology and its impact on the global job market.

Data and Methodology

This study proposes a systematic approach to quantify an organization's exposure to artificial intelligence(AI), by developing the AI Exposure Index. Our methodology is built on four key steps, designed to offer a comprehensive assessment of the potential impact of AI on different professions, companies, and industries.

STEP 1: Task Data Collection

We begin by utilizing the O*NET database (version 27.3), which contains detailed information about the tasks involved in various occupations (Tolan et al., 2021). This dataset serves as the foundation for our task-based analysis, allowing us to assess how different tasks within occupations are affected by AI technologies. Using the ChatGPT API, we evaluate the likelihood that each occupation's tasks can be automated or augmented by AI, generating an AI Exposure Index for each profession.

STEP 2: Company and Workforce Data Integration

Next, we integrate employee data from Revelio Labs, which aggregates information from LinkedIn's employment database. This dataset provides detailed insights into the workforce composition of individual companies, including the tasks performed by their employees. By mapping this information to the AI Exposure Index derived in Step 1, we can assess each company's overall exposure to AI based on its workforce's task structure.

STEP 3: Industry and Company-Level Analysis

With the AI Exposure Index calculated for each occupation and company, we extend the analysis to industry-wide assessments. By aggregating company-level exposure scores, we derive the AI exposure for entire industries, providing a macro-level perspective on how AI might influence different sectors. This analysis helps identify industries that are either highly vulnerable to AI-driven disruption or positioned to benefit from AI adoption.

STEP 4: AI Exposure-Based Portfolio Construction

Using the calculated AI Exposure Index, we construct an investment portfolio aimed at leveraging AI-driven opportunities. We first rank companies within each industry by their AI Exposure Index scores, then sort them into top and bottom quantiles. Companies in the top 10% are categorized as "high AI exposure" firms, while those in the bottom 10% are classified as "low AI exposure" firms. These quantile-based rankings are then used to create portfolios that either emphasize or de-emphasize exposure to AI, depending on the investor's strategic objectives.

Backtesting and Portfolio Evaluation

To validate the performance of the constructed portfolios, we conduct a backtest over a five-year period, assuming an annual risk-free rate of 2%. We compare the cumulative returns of the portfolios, with the results presented in Figure 3. Our statistical analysis indicates that the portfolio comprised of companies with the lowest AI exposure has outperformed the portfolio of highly exposed companies, suggesting a cautious approach to investing in high-AI exposure firms.

By following this structured methodology, our AI Exposure Index provides a robust, replicable framework for assessing the impact of AI across professions and industries. Furthermore, the construction of an AI-driven investment portfolio offers a practical application of this metric for investors seeking to navigate the rapidly evolving AI landscape.

Rubric of Exposure

Drawing upon the methodologies of Brynjolfsson (2018), Felten et al. (2018), and Webb (2020), we have developed a standardized framework to measure the extent of AI exposure for tasks associated with various occupations. Our comprehensive task-based classification rubric assesses AI exposure potential by considering not only technical feasibility but also legal, ethical, and social factors. The rubric is divided into three categories: **No Exposure (E0)**, **Weak Exposure (E1)**, and **Strong Exposure (E2)**, each with distinct criteria.

- **No Exposure (E0):** This category encompasses tasks that are not suitable for automation or AI integration due to their reliance on high levels of judgment, human interaction, and adaptability. Such tasks often involve complex human engagements, unpredictable situations, or critical decision-making that can significantly impact lives or livelihoods. Additionally, tasks in this category may be legally mandated to require human involvement.
- **Weak Exposure (E1):** Tasks in this category are partially automatable. They typically involve a combination of structured tasks that are suitable for automation and unstructured tasks that require human judgment or interaction. In these roles, technology can assist or enhance human performance but cannot completely replace human oversight. These tasks may also necessitate regular human intervention, adjustments, or decision-making.
- **Strong Exposure (E2):** This category includes tasks that can be fully automated. These tasks are usually highly structured, repetitive, and do not require human judgment, creativity, or complex interaction. Automation can efficiently handle these tasks at scale without significantly affecting human lives or livelihoods. Importantly, there are no legal restrictions necessitating human involvement in these tasks.

Our rubric expands on the foundation laid by Eloundou et al. (2023) by incorporating ethical, legal, and social considerations, making it a more holistic and comprehensive tool for assessing AI exposure. Furthermore, by differentiating between tasks that can be fully, partially, or not at all automated, the rubric offers a more granular understanding of AI's potential impact on the workforce. This approach equips decision-makers with a robust tool to forecast the transformative effects of AI on various occupations.

AI Exposure in the S&P 500

Using the AI Exposure Index computed for each occupation, we can derive a company's overall AI Exposure based on the composition of its workforce. By leveraging stock occupation data from Revelio Labs, we calculated the AI Exposure for each company within the S&P 500.

These AI Exposure results enable us to conduct additional analyses, such as evaluating changes in job structures within companies (Figure 1) and examining the regional distribution of AI exposure for each company (Figure 2).

Portfolio Construction

To build portfolios, we first rank companies within each industry by their AI Exposure scores. We then identify the top 10% of companies (those with the highest AI Exposure) and the bottom 10% (those with the lowest AI Exposure). Finally, we aggregate the top and bottom tickers across industries, using either equal weighting or market capitalization weighting to construct comprehensive portfolios.

This process allows us to focus on companies with the highest and lowest AI Exposure within each industry, offering valuable insights into which firms are most susceptible to, or most resilient against, AI-driven transformations. By applying the appropriate weighting to these tickers, we can create balanced portfolios that reflect either the companies most exposed to AI or those least affected by it.

The holdings of each portfolio are detailed in Tables 1 and 2.

Empirical Analysis: Backtesting AI Exposure Portfolios

To assess the performance of the portfolios constructed using the AI Exposure Index, we conducted a five-year backtest, assuming an annual risk-free rate of 2%. The portfolios consisted of companies grouped by their AI Exposure, specifically focusing on the top 10% and bottom 110% quantile firms in terms of exposure to AI. The backtest results provided key insights into the comparative performance of these portfolios, as outlined in Figure 3 and Table 2.

The **portfolio of companies with the lowest AI exposure** (the bottom 10%) demonstrated a significant cumulative return over the test period, outperforming the portfolio of companies with the highest AI exposure. This finding suggests that, during the past five years, firms that were less susceptible to automation and AI-driven disruption were able to generate more stable and favorable returns. The bottom 10% portfolio's annual return of approximately 25.65%, along with a relatively high Sharpe ratio of 0.99, indicates strong performance with manageable risk.

In contrast, the **portfolio of companies with the highest AI exposure** (the top 10%) showed lower overall returns, with an annual return of around 14.89% and a Sharpe ratio of 0.70. These results suggest that while these companies are on the cutting edge of AI integration, they may face heightened risks associated with technological disruptions and workforce restructuring, which can create volatility. The relatively lower performance could be attributed to challenges in adapting to AI technologies, regulatory concerns, or transitional costs in AI adoption.

Furthermore, the analysis of **equal-weighted portfolios** compared to **market-cap-weighted portfolios** provided additional insights. The equal-weighted portfolio for the bottom 10% yielded an annual return of approximately 20.58% from January 1st, 2019, through December 31st, 2023, while the market-cap-weighted bottom 10% portfolio showed slightly higher returns at 25.65% over the same period.

These results imply that, over the past five years (2019-2023), companies with lower AI exposure offered more predictable growth and profitability, providing a relatively safer investment option. Conversely, companies with high AI exposure, while innovative and potentially poised for future growth, faced short-term challenges that could impact their market performance.

The findings from this backtest underscore the importance of balancing AI exposure in portfolio construction. Investors who focus on companies with low AI exposure may benefit from reduced volatility and steady returns, while those who invest in high AI-exposure companies may need to account for the higher risks associated with rapid technological transformation.

Integrating the AI Exposure Index into Large-Cap Growth Portfolio Construction

To leverage the AI Exposure Index for enhancing a large-cap growth portfolio, the integration should be rooted in using the AI Exposure Index to evaluate the potential growth and risk profiles of the companies involved. The AI Exposure Index, as developed in this research paper, quantifies how companies across various industries are exposed to AI-driven automation based on workforce composition and task structure. In the context of large-cap growth portfolios—which focus on investing in established companies with high potential for above-average growth—this AI Exposure Index can serve as a critical tool for identifying which companies are best positioned to thrive in an AI-dominated future.

A procedure for integrating the AI Exposure Index would involve assessing the AI-readiness of companies currently in the portfolio by analyzing their exposure scores. Companies with higher AI exposure, which indicates they are more susceptible to automation and technological transformation, can be seen as having a competitive advantage in industries where AI can enhance efficiency and reduce costs. By focusing on the top 10% quantile of companies with the highest AI exposure, the portfolio could be adjusted to emphasize firms likely to lead in innovation and benefit from AI integration, ensuring alignment with the large-cap growth objective of capturing companies with strong forward-looking growth potential. Additionally, a secondary layer of assessment could be applied by evaluating companies' ability to manage the risks associated with AI integration, such as potential workforce disruptions or regulatory challenges, thereby selecting firms that are both AI-forward and resilient to related risks.

On the other hand, companies with low AI exposure, which rely on tasks less vulnerable to AI automation, might still be valuable in balancing the portfolio's risk. This balance helps mitigate the volatility that could arise from AI-related risks, such as rapid technological changes or market disruptions. Therefore, while AI exposure enhances growth prospects, maintaining some exposure to low-AI firms ensures the portfolio is not overly exposed to industry-specific shocks. Through regular rebalancing based on the AI Exposure Index, the portfolio can continuously adjust to emerging AI trends, keeping it agile in the face of ongoing technological disruption. This dual approach — focusing on high-AI-exposure firms for growth and low-AI-exposure firms for stability — would allow for the creation of a more dynamic, future-proof large-cap growth portfolio.

Table 1: Holding list for Top 10% Portfolio on 2024-01

Month	Ticker	Weight	Month	Ticker	Weight	Month	Ticker	Weight
2023-12	COP	0.034254	**2023-12**	EBAY	0.005627	**2023-12**	WRB	0.0.004533
2023-12	CTRA	0.004771	**2023-12**	ETSY	0.002412	**2023-12**	ACN	0.05471
2023-12	OKE	0.010167	**2023-12**	WBA	0.005596	**2023-12**	DXC	0.001039
2023-12	ALB	0.004214	**2023-12**	KHC	0.011273	**2023-12**	INTU	0.043481
2023-12	CTVA	0.008393	**2023-12**	MO	0.017732	**2023-12**	HPE	0.005486
2023-12	FMC	0.001955	**2023-12**	STZ	0.010985	**2023-12**	NTAP	0.004514
2023-12	FTV	0.006431	**2023-12**	CL	0.016312	**2023-12**	AMAT	0.033469
2023-12	GD	0.017682	**2023-12**	Cl	0.021778	**2023-12**	AVGO	0.129876
2023-12	LMT	0.02722	**2023-12**	CNC	0.009853	**2023-12**	VZ	0.039392
2023-12	NOC	0.017457	**2023-12**	RMD	0.006289	**2023-12**	IPG	0.003107
2023-12	ROK	0.008843	**2023-12**	ABBV	0.069328	**2023-12**	OMC	0.004256
2023-12	BR	0.006022	**2023-12**	AMGN	0.03831	**2023-12**	EIX	0.006815
2023-12	RHI	0.002314	**2023-12**	IQV	0.010495	**2023-12**	NEE	0.030973
2023-12	CHRW	0.002505	**2023-12**	BAC	0.066224	**2023-12**	SRE	0.011688
2023-12	EXPD	0.004596	**2023-12**	C	0.024469	**2023-12**	ARE	0.005513
2023-12	APTV	0.006307	**2023-12**	BK	0.009949	**2023-12**	DLR	0.01013
2023-12	GRMN	0.006112	**2023-12**	BLK	0.029962	**2023-12**	EQIX	0.018793
2023-12	HAS	0.001761	**2023-12**	FIS	0.008846	**2023-12**	CBRE	0.007052
2023-12	BKNG	0.030759	**2023-12**	STT	0.005941			
2023-12	EXPE	0.005142	**2023-12**	ACGL	0.006888			

Table 2: Holding list for Bottom 10% Portfolio on 2024-01

Month	Ticker	Weight	Month	Ticker	Weight	Month	Ticker	Weight
2023-12	BKR	0.006646	**2023-12**	SBUX	0.021117	**2023-12**	FLT	0.003964
2023-12	HAL	0.006251	**2023-12**	ROST	0.009051	**2023-12**	PYPL	0.013123
2023-12	VLO	0.008417	**2023-12**	TSCO	0.004508	**2023-12**	AFL	0.009366
2023-12	NUE	0.008312	**2023-12**	DG	0.005797	**2023-12**	ALL	0.007116
2023-12	SHW	0.015509	**2023-12**	KDP	0.009051	**2023-12**	GL	0.002225
2023-12	STLD	0.003712	**2023-12**	MDLZ	0.019148	**2023-12**	ANSS	0.006124
2023-12	IEX	0.00319	**2023-12**	MNST	0.011644	**2023-12**	CDNS	0.014395
2023-12	PWR	0.006091	**2023-12**	EL	0.010185	**2023-12**	SNPS	0.015203
2023-12	SNA	0.002962	**2023-12**	DGX	0.003012	**2023-12**	AAPL	0.15
2023-12	TT	0.010782	**2023-12**	STE	0.00422	**2023-12**	APH	0.011522
2023-12	URI	0.007485	**2023-12**	SYK	0.0221	**2023-12**	AMD	0.04627
2023-12	ROL	0.004106	**2023-12**	UHS	0.002021	**2023-12**	QCOM	0.031355
2023-12	RSG	0.01008	**2023-12**	MTD	0.005061	**2023-12**	TMUS	0.03602
2023-12	FDX	0.01228	**2023-12**	WAT	0.003782	**2023-12**	DIS	0.032173
2023-12	UPS	0.026054	**2023-12**	WST	0.005014	**2023-12**	LYV	0.004188
2023-12	TSLA	0.15	**2023-12**	HBAN	0.003578	**2023-12**	ATO	0.003396
2023-12	TPR	0.00164	**2023-12**	RF	0.003502	**2023-12**	D	0.00764
2023-12	VFC	0.00142	**2023-12**	BRK.B	0.15	**2023-12**	PEG	0.00592
2023-12	DRI	0.003811	**2023-12**	FDS	0.00353	**2023-12**	CPT	0.002059
2023-12	HST	0.002668	**2023-12**	VICI	0.006407			

Table 3: Statistic Facts for the portfolios

	Annualized Return	STD	Sharpe Ratio
Top10%(Cap-Weighted)	0.1488669228026518	0.1829098801702583	0.7045377903189176
Bottom10%(Cap-Weighted)	0.2564635170945382	0.23653138748441188	0.9997130596890522
Top10%(Equal)	0.12691095908681915	0.19879793794346795	0.5377870625459976
Bottom10%(Equal)	0.20580104718631342	0.2092373779438371	0.8879916629245164

Figure 1: Job structure inside AAPL

The distribution of AAPL's Employment AI Exposure Index is unevenly organized, exhibiting two distinct peaks: one at a low exposure score around 0.2 and another at a high exposure score around 0.5. This suggests that AAPL relies heavily on both low-skill and high-skill employees.

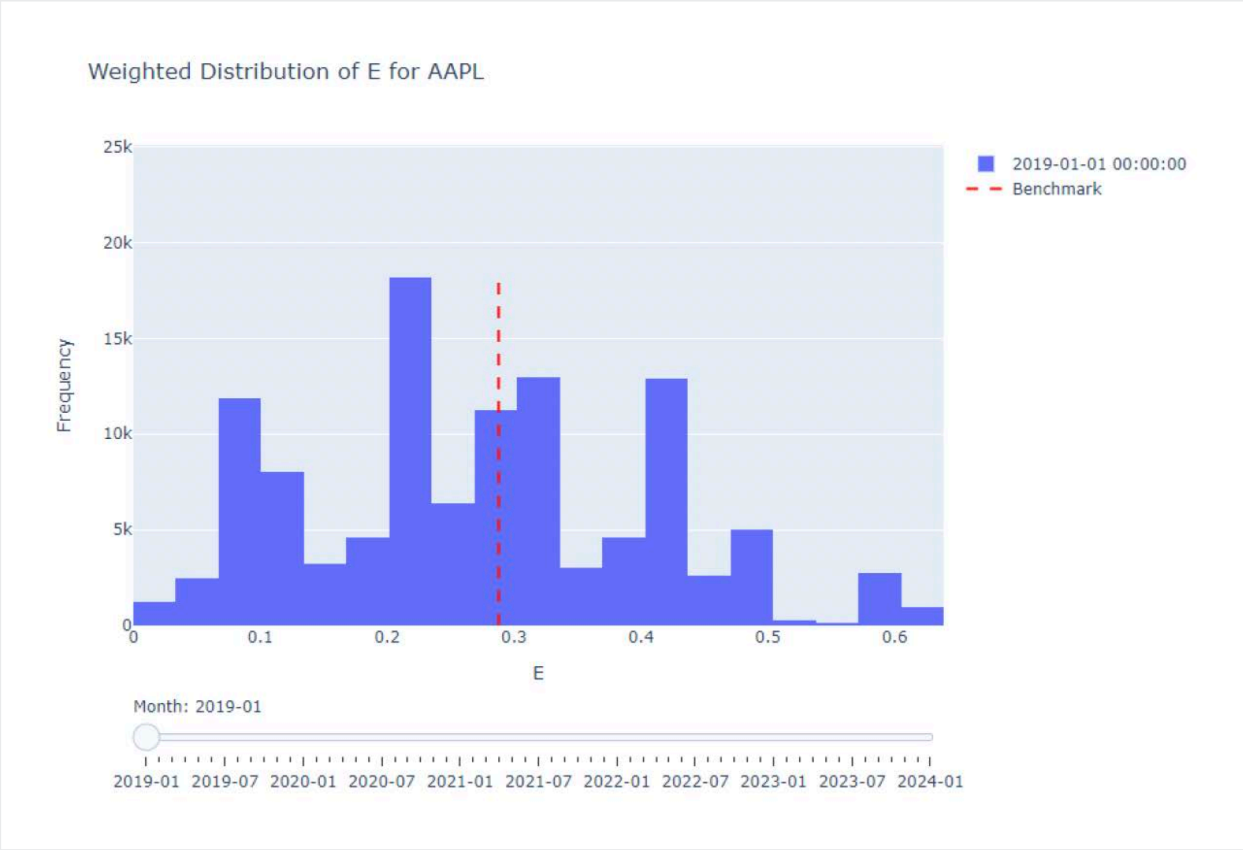


Figure 2: State Level Heat Map for AAPL

The heat map illustrates AAPL's employment distribution or job placements across various states.

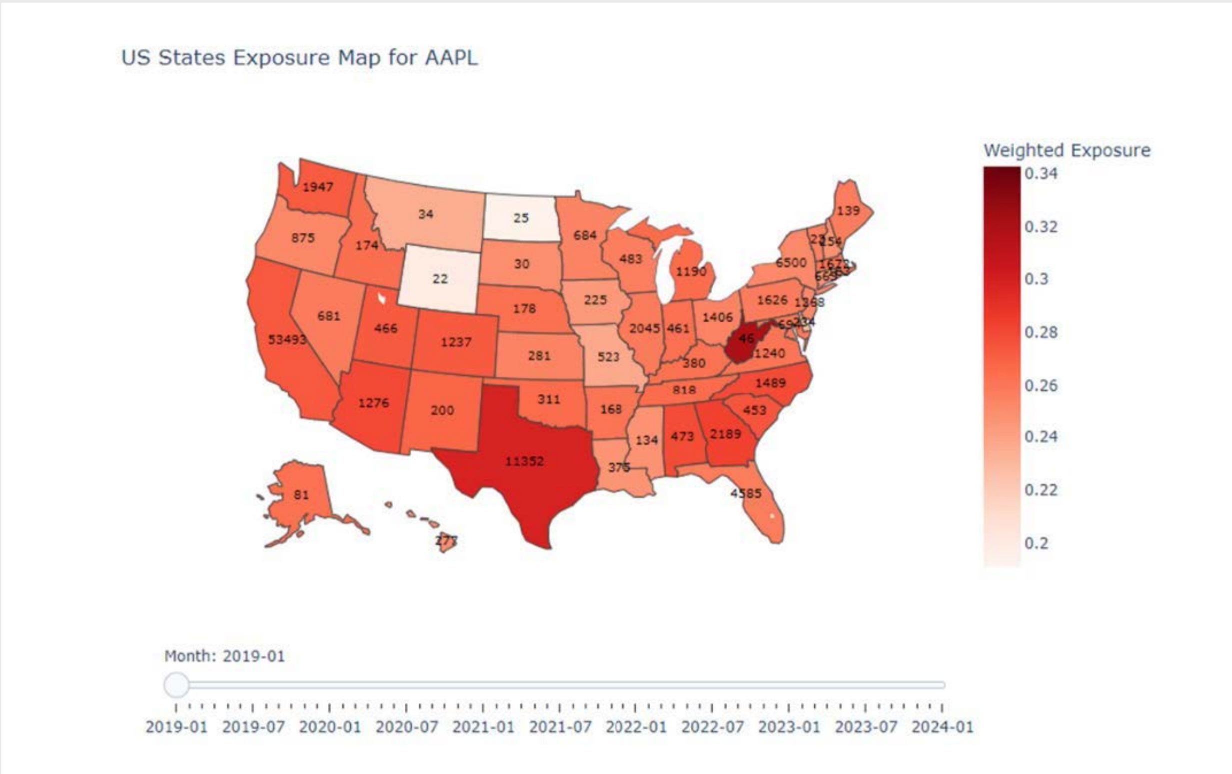
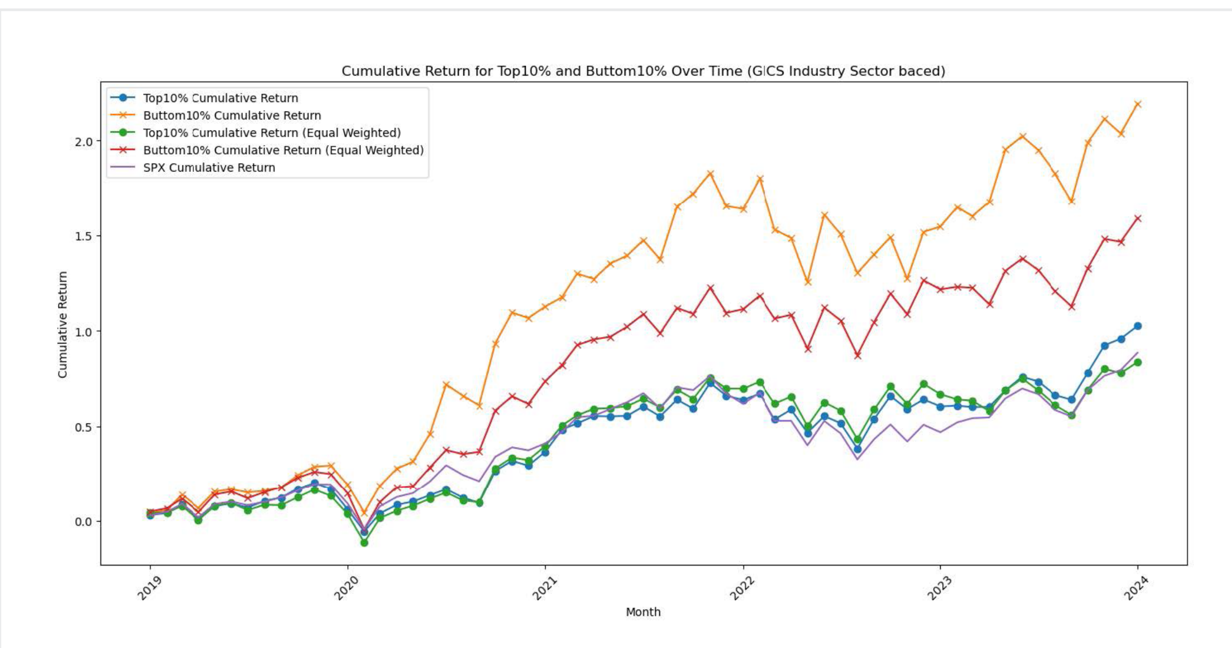
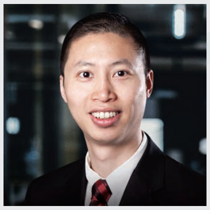


Figure 3: Cumulative Return for the Portfolios





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Dr. Tony Zhang currently serves as Portfolio Manager for the Focus Growth Strategy leveraging his dynamic experience in quantitative methodologies and fundamental analysis.

Tony combines his expertise in quantitative investing, machine learning, and big data analytics with his practice experience in analytical finance. Tony holds a Ph.D. in Industrial and Computer Engineering, an M.B.A (with honors) in Analytical Finance, and the CFA designation. His research accolades include three best paper awards and the publication of more than 20 papers in top international journals and conferences.

In his spare time, Tony is an Adjunct Professor at the Gies School of Business, University of Illinois at Urbana Champaign. He has served as an academic advisor for the CFA Institute Research Challenge, and an academic advisor for the Chicago Mercantile Exchange Global Annual Trading Competition.

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