Designing Index Provision*

Yizhou Xiao§ Yan Xiong‡

Abstract

Despite the importance of indices, little is known about the index provision market. To understand the market's competitive landscape, we develop a model that incorporates three key players: retail investors, passive funds, and index providers. Index providers, established to mediate the conflict of interest between the other two, often prioritize the interests of their fund clients. Retail investors can influence the industrial-organizational structure of the index provision market by deciding how many indices are admitted. Contrary to conventional wisdom, we demonstrate that retail investors prefer a concentrated index provision market with index providers commanding substantial market power over passive funds.

JEL Classification: G11, G23, L10

Keywords: Index construction, Index providers, Passive investing, Benchmark regulation

*We thank Yu An, Simon Gervais, Benjamin Hebert, Uday Rajan, Zhigang Qiu, Zacharias Sautner, Hongda Zhong, conference participants at the 2023 Fall FTG Meeting, 2024 Cambridge Corporate Finance Theory Symposium, and seminar participants at Hong Kong University of Science and Technology and University of Chinese Academy of Sciences for their helpful comments.

§The Chinese University of Hong Kong. Email: yizhou@cuhk.edu.hk

‡The Hong Kong University of Science and Technology. Email: yanxiong@ust.hk

Disclosure Statements

Yizhou Xiao has received financial support from the Research Grants Council of the Hong Kong Special Administrative Region, China [project no. HKUST 14502023] for the research described in this article. There are no other conflicts of interest to disclose.

Yan Xiong has received financial support from the Research Grants Council of the Hong Kong Special Administrative Region, China [project no. HKUST 14502023] for the research described in this article. There are no other conflicts of interest to disclose.

1 Introduction

Many investments in financial assets are now entrusted to institutional asset managers who track certain indices. PWL Capital estimates that passive funds comprised 45% of the U.S. market share in 2023 and 37% of the global market share at the end of 2022. Governments, securities issuers, and financial intermediaries also rely on indices when making crucial decisions. Exponential growth in the number, complexity, and use of indices in capital allocation decisions, coupled with the potential risk to investors and markets, have made index regulation a focal point for financial regulators worldwide. The Securities and Exchange Commission (SEC) in the U.S. and the Financial Conduct Authority (FCA) in the UK recently initiated studies to scrutinize disclosure and competition in the index provision markets.[1] Furthermore, the European Union's Benchmarks Regulation was enacted in 2016 and came into effect on January 1st, 2018.[2]

Despite the importance of indices, the index provision market is not well understood. Why is there a need for an index provider when fund professionals can easily design and maintain indices themselves? Do index providers deliver value to the end users, namely, retail investors? Considering recent research revealing the highly concentrated nature of the index provision market and the substantial markups charged by index providers to passive funds (An, Benetton, and Song, 2023), how can a limited number of index providers manage to maintain such significant profit margins, especially when creating an index and entering the market appears relatively straightforward? Should regulators strive for a more competitive index provision market? To answer these questions, we study a general equilibrium model that incorporates three key participants in passive investment: retail investors, passive funds, and index providers.

Retail investors, although not directly involved in the index provision market, are crucial to our study. They seek portfolios with specific risk exposures but often lack the expertise to identify or construct the optimal portfolio composition to achieve these exposures. As a result, they must delegate their investments to passive funds that promise certain risk profiles.

In our model, the primary friction in the index provision market arises from the conflict

[1] See https://www.sec.gov/news/press-release/2022-92 and https://www.fca.org.uk/publication/call-for-input/call-for-input-accessing-and-using-wholesale-data.pdf.

[2] See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.171.01.0001.01.ENG.

of interest between retail investors and passive funds. Passive funds may be incentivized to deviate from portfolios that meet the precise needs of retail investors, resulting instead in a bias toward their interests. Cheng, Massa, and Zhang (2019) find that passive funds with flexible portfolio composition, such as synthetic Exchange-Traded Funds (ETFs), deviate from benchmark indices to capitalize on private information. Many studies have found that passive funds strategically deviate from tracking indices to reduce tracking costs (e.g., Brogaard, Heath, and Huang, 2021; Dekker, Gider, and De Jong, 2021; Molk and Robertson, 2023). The need to lower tracking costs implies a natural desire for a twisted benchmark, with more exposure to liquid securities or assets within the fund's trading expertise, to facilitate tracking cost minimization strategies.[3] It is also widely documented that passive funds sometimes deviate from benchmarks to manage liquidity more effectively in anticipation of future fund flows (Reilly, 2022; Xiao, 2022). Another strand of the literature shows that index investing, far from being purely passive, in fact, involves various incentives to trade actively (Akey, Robertson, and Simutin, 2021; Robertson, 2019; Molk and Robertson, 2023).

Regulators and industry professionals have also expressed concerns regarding the incentives associated with ETFs. For example, the Financial Services Authority has identified conflicts of interest as a substantial concern, stressing the "extreme importance" for ETF providers to differentiate clearly between standard ETFs and "more intricate investment strategies" that may include derivatives (Flood, 2012). BlackRock also acknowledges that "potential conflicts of interest arise when a synthetic ETF provider engages in derivative agreements with its investment banking parent" (Davies, 2012).

To address this agency problem, retail investors rely on a third party, namely index providers, to construct tracking indices.[4] Ideally, index providers would be compensated directly by retail investors, ensuring that they act in the best interests of these investors. However, our analysis shows such an arrangement is not feasible in equilibrium because retail investors can free-ride on the payments made by others to the index provider (i.e., investing in the same passive fund without directly compensating the index provider). Consequently, index providers are typically compensated through passive fund licensing fees.

[3]Our study abstracts from tracking errors and focuses on potential deviations in index design and updates. However, we still consider tracking errors as a source of conflicts of interest between passive funds and retail investors.

[4]Robertson (2019) finds that while self-indexing is indeed relevant to small ETFs, large ETF issuers and index providers, which account for over 95% of total assets under management, are not affiliated with each other.

The dynamic between index providers and retail investors is similar to the credit rating shopping problem (e.g., Bolton, Freixas, and Shapiro, 2012). Index providers, who derive their revenue from licensing fees paid by fund clients rather than direct dealings with retail investors, may be incentivized to cater to the preferences of ETFs. As a result, index providers may prioritize the interests of their fund clients over those of retail investors when constructing indices. Consequently, the indices created by index providers may not align with the precise risk exposures sought by retail investors. In equilibrium, index providers strategically design their index reporting strategies to maximize the interests of a representative fund among their client funds, while ETFs decide on their index tracking approach based on these strategies.

Our analysis characterizes the features of index reporting strategies and the set of client funds in equilibrium. The potential for new entrants, as admitted by retail investors, adds discipline to the market. As a result, the equilibrium index design should reflect the optimal risk exposure sought by retail investors, conditional on the information they infer from the index report. If not, other index providers could gain dominance by changing each index signal to the corresponding conditional optimal risk exposure for retail investors. The index design strategy allows us to characterize the set of client funds in equilibrium. We show that index providers share the same interest with their representative client funds, that is to say, they behave like a fund with the average bias among their equilibrium set of client funds. Given those results, we then show that the index construction problem parallels a standard cheap-talk model à la Crawford and Sobel (1982). In this scenario, the index provider, who has better information about the underlying risk exposure than the retail investors, acts as a signal sender but shares the same biases as the representative client fund. The index that is constructed is the signal sent by the index provider. Because in equilibrium the index tracked by passive funds represents the conditional optimal risk exposure sought by retail investors, retail investors who invest in tracking funds are effectively the receivers of this signal. By observing the constructed index, they can infer the appropriate investment strategy that passive funds should adopt.

We next analyze how to design the index provision market structure. Given the index provider's actions in the index reporting stage, retail investors can influence the index provision market by selecting the index providers that they endorse. These selected index providers compete for licensing fees from funds by designing optimal index reporting strategies, which in turn affect fund managers' decisions on which index to track. In this way, retail investors indirectly shape the organizational structure of the index provision market, ensuring a sufficiently informative index for the desired risk exposure.

Our analysis of the index provision market reveals that contrary to the common belief that more competition benefits retail investors, they in fact prefer a market dominated by a single index provider. In scenarios where multiple index providers coexist for the same risk exposure, they adopt different biased positions in index design to target specific subgroups of passive funds. This leads to a substantial conflict of interest and less informative indices. Conversely, having a single index provider responsible for designing an index implies that all passive funds follow the same provider. This monopolistic index provider thus, considers the interests of *all* funds, thereby representing the systematic bias across all passive funds. This approach minimizes the bias inherent in index construction by eliminating the idiosyncratic biases of individual funds. As a result, a monopolistic market structure for index provision best aligns with the risk exposure preferences of retail investors. The index created under this market structure is the most informative, and retail investors achieve the second-best capital allocation possible given the presence of agency frictions. It is worth noting that we emphasize that retail investors benefit from a concentrated index provision market. In the extension discussed in Section 4.3, we demonstrate that, even when retail investors allow more than one index provider to coexist in equilibrium, the index provision market still exhibits concentration.

A natural implication of our analysis is that an industry structure with a few dominant index providers may be optimal. This is supported by recent empirical evidence. For example, in a paper highly relevant to our research, An, Benetton, and Song (2023) find that the index provision market is dominated by a limited number of index providers with substantial market power, leading to substantial markups on passive funds. Their structural model estimates that index licensing fees account for about one-third of all ETF expenses, and 60% of these fees are markups. Their counterfactual analyses show that the entry of a new index provider does little to foster price competition. An, Benetton, and Song (2023) take as given the stable pairings between ETFs and index providers observed in the data and posit frictions that hinder switching. Our study complements this important work by proposing the agency problem between retail investors and passive funds as the main source of such friction. We show that the strong market power of index providers can help mitigate this issue, allowing the concentrated index provision market to persist despite the high markups and the low entry costs.

Our paper also contributes to the active policy debate on the index provision market, particularly regarding the efficacy of a competitive marketplace and the value that index providers offer end users. Notably, regulatory bodies, such as the FCA in the UK, are currently reviewing whether limited competition in benchmarks and indices can lead to increased costs for investors and affect investment decisions. Our model provides new insights by showing that retail investors can benefit from an index provision market with limited competitors, given the substantial friction caused by conflicts of interest between retail investors and funds. Consequently, any regulatory interventions to foster competition may inadvertently harm retail investors. Furthermore, as regulators become more concerned about index-related conflicts of interest – a concern that has directly prompted benchmark regulation in the EU – our model indicates that these conflicts of interest can stem from the relationship between index funds and their end investors. This underscores the need for a more comprehensive perspective that considers the root frictions and the accuracy and integrity of benchmarks.

To address the high fees charged by index providers, some market participants propose direct indexing, which allows retail investors to bypass the intermediary and access customized indices directly. Morningstar launched the "Open Index Project" in 2016 to "lower the cost of equity indices and improve outcomes of all investors."[5] However, we argue that specialized index providers exist precisely to address the conflicts of interest between retail investors and funds. The high licensing fees charged by these providers are a byproduct of the concentrated market structure, which in turn reduces the adverse impact of these conflicts on retail investors. In line with our findings, the launch of the Morningstar Open Indexes Project did not lead to meaningful changes in the licensing fees of the major index providers. Moreover, interest in tracking Morningstar open indices has been minimal, attracting just three tracking ETFs with total assets of less than $0.8 billion as of December 2021.

Our analysis also contributes to the ongoing debate regarding where the emerging ESG index provision market should head. The ESG index provision market has been growing rapidly, attracting many entrants. While some argue that increased competition can enhance market efficiency and reduce licensing fees, others contend that intense competition can lead

[5] For more details, see https://indices.morningstar.com/open-index-project.

to distorted indices. Our analysis aligns with the trend toward consolidation in the ESG index market. As Longley (2019) observes, "The ESG space is seeing some new ratings and index agencies emerge under the noses of the larger houses ... But we are now beginning to see consolidation here too."

Our paper relates to studies on the activeness of passive funds, revealing that such funds often have incentives to deviate from their benchmark indices. For example, recent studies investigate how passive funds reduce their transaction fees at the expense of substantial tracking errors (Brogaard, Heath, and Huang, 2021; Dekker, Gider, and De Jong, 2021; Koont, Ma, Pastor, and Zeng, 2022; Li, 2022). Cheng, Massa, and Zhang (2019) find that ETFs sometimes actively deviate from their benchmarks to exploit information gathered by their affiliated banks. Akey, Robertson, and Simutin (2021) show that a third of passive index funds and ETFs are more active than the median actively managed fund, increasingly blurring the line between "active" and "passive" funds. Robertson (2019) and Lund and Robertson (2023) also highlight that index investing is far from passive. Our paper contributes to this field by first examining the structure of the index provision market, focusing on incentives for passive funds to deviate.

Our paper is also related to recent research on the index provision market. Mahoney and Robertson (2021) discuss the legal perspective of index providers in the investment advising industry, Kostovetsky and Warner (2021) find that ETFs tracking larger index providers also attract more capital, and An, Benetton, and Song (2023) document for the first time the structure of competition among index providers. We study how misaligned interests between retail investors and passive funds can shape the index provision market.

Our paper also adds to the emerging literature on the industrial organization structure of financial markets (Egan, Hortaçsu, and Matvos, 2017; Benetton, 2018; Buchak, Matvos, Piskorski, and Seru, 2018, 2020; Jiang, 2020; Antill, 2022; Craig and Ma, 2022), particularly the asset management industry (Hortacsu and Syverson, 2004; Koijen and Yogo, 2019; Kojien and Nieuwerburgh, 2020). Adams, Mansi, and Nishikawa (2009) note that very few index providers have a significant market share. Egan, MacKay, and Yang (2021) infer the demand curve of retail investors from ETF market data. As mentioned above, An, Benetton, and Song (2023) highlight the concentration of the market and the large markups to passive funds charged by a few powerful index providers. Our study explains the lack of new entrants despite low entry costs and the consolidation trend in the ESG index market (Harty and

Tor, 2020).

Finally, our paper adds to the theory of cheap-talk games. Building on the seminal work of Crawford and Sobel (1982), subsequent research explores various extensions, such as strategic interactions among multiple senders (Gilligan and Krehibiel, 1989; Krishna and Morgen, 2001a,b; Levit and Malenko, 2011; Kakhbod, Loginova, Malenko, and Malenko, 2023), the existence of a neutral mediator (Myerson, 1989; Lehrer and Sorin, 1997; Ganguly and Ray, 2005), the optimal organizational design (Avery and Meyer, 2003; Dessein and Santos, 2003), dynamic communication (Grenadier, Malenko, and Malenko, 2016), and so on. Our focus is on how the competitive structure within the industrial organization of index providers inherently determines the incentives of an index provider (sender).

The rest of the paper is organized as follows. Section 2 sets up the model. Section 3 characterizes the equilibrium. Section 4 presents the extensions and variations of the model. Section 5 discusses the implications of the model, and Section 6 concludes the paper.

2 The Model

Consider a four-period economy, $t \in \{0, 1, 2, 3\}$, which comprises a continuum of retail investors in the range $[0, 1]$, a continuum of ETF managers (i.e., passive fund managers) in the range $[0, 1]$, and a countable set of index providers. Retail investors are ex-ante identical, each having one unit of endowment to invest to obtain a specific risk exposure. ETF managers, in contrast, have no initial endowment and rely on investment from retail investors to launch their funds. These funds track specific indices that are created and maintained by index providers.

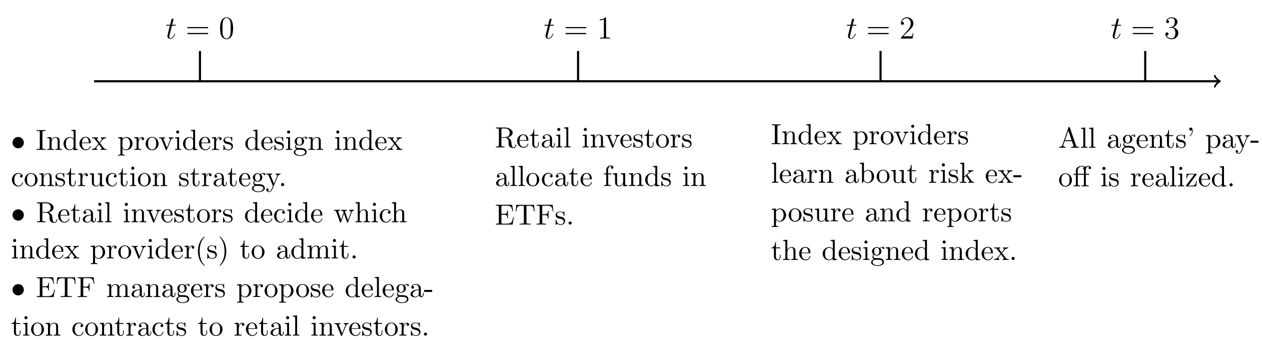

Figure 1: Timeline of events

Figure 1 illustrates the timeline of events in the model. In period 0, index providers design their index construction strategy. Following this, retail investors select the indices that they wish to admit, i.e., the indices that they will consider for investment. ETF managers then offer portfolio delegation contracts to retail investors, specifying the index to be tracked and the associated fees. In period 1, retail investors evaluate all the portfolio delegation contracts and allocate their investment in ETFs. In period 2, index providers report their indices after observing the actual risk exposure. Finally, in period 3, all agents, including retail investors, ETF managers, and index providers, realize their payoffs.

2.1 Retail Investors

Retail investors seek a specific risk exposure, denoted as θ, which may include exposure to the domestic stock market, the global economy, a particular industry sector, and so on. The variable θ can be understood as part of the optimal asset allocation solution for retail investors, potentially subject to a particular investment objective, risk-return profiles, dividend taxation, geographic exposure, or other factors. However, determining the optimal portfolio composition and constructing the portfolio can be complex. Therefore, we assume that retail investors lack knowledge of the precise portfolio required to achieve their desired risk exposure, and they also lack the ability to create the portfolio themselves.

To capture the idea in the simplest way, we model θ as a one-dimensional random variable following the uniform distribution $\theta \sim U[0, 1]$.[6] Retail investors are aware of the distribution of θ, but they cannot observe its actual realization. Consequently, a retail investor $i \in [0, 1]$ who wishes to invest and obtain the desired risk exposure must enter into a contract with an ETF manager e to delegate her investment.

Suppose that in period 1 retail investor i invests her endowment in the portfolio constructed by ETF manager e, denoted as y_e.[7] The payoff for the retail investor from this investment can be represented by a quadratic form:

$$U_i^e = U_0 - (y_e - \theta)^2 - f_e - g_{m,i}. \tag{1}$$

[6]For example, consider a financial market consisting of two stocks. Retail investors aim to construct a specific portfolio with a desired weight, denoted as θ, in the first stock. In this context, the variable θ represents the desired risk exposure or portfolio allocation sought by retail investors.

[7]Our results still hold if we allow investors to form a portfolio of ETFs.

Here, $U_0 > 0$ represents the benefit that the retail investor derives from investing in the desired risk exposure, and f_e denotes the asset management fee paid to ETF manager e for the delegation service. We assume that U_0 is sufficiently high to ensure the participation of retail investors. To simplify our analysis, we assume that the asset management fee f_e is a constant fraction $\alpha_0 \in (0, 1)$ of the retail investor's expected payoff. Moreover, the last term $g_{m,i}$ is the potential fee paid by retail investor i to the index provider, whose index is tracked by the retail investor's ETF.

The function form in equation (1) implies that the retail investor experiences disutility $-(y_e - \theta)^2$ when the investment portfolio y_e deviates from her desired risk exposure θ. As the objective of the investment is to achieve a specific risk exposure, any deviation, regardless of whether it leads to superior performance, will undermine the overall portfolio allocation efficiency for retail investor i.

In addition to the fund allocation decision in period 1, after observing the index construction strategy of index providers, retail investors also have the option to decide on the indices that they will admit in period 0. This means that these investors acknowledge a set of indices that they will consider for future investments. Any funds that track indices outside of this set will not be considered.

Overall, retail investors make decisions regarding the admitted index providers in period 0 and the invested ETFs in period 1 with the goal of maximizing the expected payoff, $E[U_i^e]$, where U_i^e is given by equation (1).

2.2 ETF Managers

Unlike retail investors, ETF managers can construct an investment portfolio. In period 0, each ETF manager, denoted as e, offers a delegation contract, represented by y_e, to retail investors. This delegation contract corresponds to an investment portfolio that tracks a specific index or benchmark.

As mentioned in Section 2.1, the delegation fee, denoted as f_e, is associated with the expected utility of retail investors from the delegation portfolio y_e. Once retail investors have knowledge of all the delegation contracts available, they make investment decisions with the goal of maximizing their expected utility.

Let W_e represent the total investment received by ETF manager e. Consequently, the final-period payoff for ETF manager e is determined by

$$V^e = W_e[\pi(b_e) - (y_e - \theta - b_e)^2 + f_e] - \nu_{m,e}. \tag{2}$$

Here, b_e denotes the bias of ETF manager e. $\pi(b_e)$ represents the private benefit that manager e receives when constructing portfolios for retail investors, which can be associated with the manager bias b_e. And $\nu_{m,e}$ signifies the transfer between manager e and index provider m. A detailed explanation of $\nu_{m,e}$ is provided below. The interaction form of W_e and f_e indicates that the delegation fee also serves as the unit fee – the fee that retail investors pay to the ETF for each dollar they invest.

The term b_e reflects the conflicts of interest between ETF manager e and retail investors regarding portfolio construction, which is the underlying friction in our model. In our model, the ETF manager's desired risk exposure is $\theta + b_e$, and he suffers the disutility $-(y_e - \theta - b_e)^2$ if the constructed portfolio y_e deviates from his desired level $\theta + b_e$. In practice, the bias b_e stems from various sources. For example, research suggests that passive funds actively manage tracking errors and transaction costs (e.g., Brogaard, Heath, and Huang, 2021; Dekker, Gider, and De Jong, 2021). Cheng, Massa, and Zhang (2019) provide evidence of ETF managers deviating from the index to execute trades based on private information held by their fund house. Moreover, even S&P 500 ETFs regularly deviate significantly from the S&P 500 index (Molk and Robertson, 2023). Collectively, these studies highlight the *inherent* inclination of passive funds to deviate from the preferences of retail investors.

We assume that the bias b_e for each ETF manager follows the uniform distribution $b_e \sim U[b - \mu, b + \mu]$, where $b, \mu \in R$. b represents the systematic bias shared among all ETF managers and μ captures how divergent the ETF managers' conflicts of interest are. We also assume that index providers can observe the bias preferences of the ETF managers, while retail investors are only aware of their distribution. Finally, given the conflicts of interest, while ETF managers may have knowledge of the true risk exposure θ, retail investors, who seek exposure to specific risks, only recognize ETFs that track a particular index.

In summary, ETF managers offer the delegation contract, which consists of the index to track and thus the constructed portfolio, to retail investors and the delegation fee, to maximize the expected payoff $E[V^e]$, where V^e is given by equation (2).

2.3 Index Providers

There exists a countable set of index providers, denoted as $m \in \{1, 2, \ldots, M\}$. These index providers have the ability to learn about risk exposure θ. Each index provider can make an announcement, denoted as $s_m \in [0, 1]$, about the underlying risk exposure, which we interpret as an index. Specifically, in period 0, index provider m designs their index, denoted as $s_m(\theta)$. The specific signal associated with the index value will be realized in period 2.

In period 0, index provider m charges licensing fees to the ETF managers that choose to follow its announced index value, and maybe paid directly by retail investors. In this model, we denote the set of ETFs that choose to follow index provider m as Ω_m, and the transfer between ETF manager $e \in \Omega_m$ and index provider m as $\nu_{m,e}$, which represents the licensing fee paid by ETF manager e to index provider m to use the designed index. Let Θ_m be the set of retail investors that pay fees directly to the index provider m and $g_{m,i}$ be the fee paid by the retail investor $i \in \Theta_m$. Thus, the expected total fees collected by index provider m is

$$\nu_m = \int_{\Omega_m} \nu_{m,e} \mathrm{d}e + \int_{\Theta_m} g_{m,i} \mathrm{d}i. \tag{3}$$

We assume that the determination of the licensing fee $\nu_{m,e}$ follows a Nash bargaining game. The bargaining power of the index provider over ETFs is denoted as β, where $\beta \in [0, 1]$. Given Ω_m, the index provider collects the total licensing fee from all of these following ETFs.

Each index provider designs his optimal index reporting strategy s_m in period 0 to maximize the expected total fee and reports the realized index in period 2.

2.4 Equilibrium Definition

The equilibrium in this economy is defined as follows.

Definition 1 (Equilibrium definition)
An equilibrium consists of index providers' index reporting strategies $\{s_m(\theta)\}_{m\in\{1,2,3,\ldots,M\}}$*, ETF managers' delegation contracts* $\{y_e\}_{e\in[0,1]}$*, and retail investors' index admission strategy* M *and allocation strategies* $W^i = e \in [0, 1]$*, where* $i \in [0, 1]$*, such that:*

1. *In period* 0*, given index providers' index reporting strategy and the set of index providers*

admitted by retail investors, ETF manager e formulates the delegation contract y_e that maximizes their expected payoff $E[V^e]$, where V^e is determined by equation (2).

2. *In period 0, given index providers' index reporting strategy and ETF managers' delegation contracts, retail investors decide on the number M of indices they admit to invest to maximize the expected utility $E[U_i^e]$, where U_i^e is given by (1).*

3. *In period 0, given the set of ETFs that track their index and retail investors' index admission strategy, index provider m chooses the reporting strategy $s_m(\theta)$ to maximize the licensing fee ν_m, where ν_m is determined by (3).*

4. *In period 1, given the delegation contracts $\{y_e\}_{e\in[0,1]}$ offered by ETF managers, retail investor i selects an ETF to invest in such that their expected utility is maximized.*

3 Equilibrium Characterization

Given that index providers announce their indices in period 2 after collecting fees in period 0, it is always possible for a babbling equilibrium to exist in which the announced index is completely uninformative about the risk exposure. These equilibria are of little interest to our analysis because in reality, retail investors and passive funds may punish the index provider by switching to a competitor or new entrants. In the subsequent analysis, we exclude such trivial equilibria. Instead, we focus on equilibria in which index providers announce their indices in period 2 according to their designed period-0 rules.

We solve the equilibrium using backward induction. In the first step, we analyze the index provider's optimal index reporting strategy given the endogenous group of tracking funds. Then, anticipating the index reporting strategy in the subsequent stage, we discuss how retail investors should influence index construction via their index admission decisions.

3.1 Index Providers' Optimal Index Design

Suppose that in equilibrium there is a number $M \geq 1$ of index providers admitted by retail investors. To analyze the optimal index design by index providers, we begin by presenting several lemmas that help us understand the characteristics of equilibrium in this economy.

Our first lemma examines the relationship between the signals sent by index providers and the optimal portfolios for retail investors conditional on these signals. All of the proofs are presented in the appendix.

Lemma 1 (Conditionally optimal index reporting)
Let $a(s_m)$ be the retail investors' optimal portfolio construction given index provider m's index reporting strategy $s_m(\theta)$. Then, in equilibrium, $s_m = a(s_m)$. Moreover, for two admitted index providers m and m', in equilibrium, $E[s_m] = E[s_{m'}]$.

Lemma 1 asserts that in equilibrium, the signal from an index provider aligns with the optimal portfolio construction of retail investors, given that signal. If an index provider chooses to send a signal that violates this condition, i.e., $s_m \neq a(s_m)$, then another unadmitted index provider m' can outperform them with a reporting strategy $s_{m'} = a(s_m)$. This contradicts the optimal admission strategy of retail investors.

The second finding in Lemma 1 stems from the principle that homogeneous retail investors should not exhibit any systematic difference in their portfolios, even when they invest in ETFs tracking different indices. Because in equilibrium, signals sent by index providers always correspond to the conditional optimal portfolios, there should be no unconditional disparity between the signals transmitted by two distinct index providers.

Equipped with Lemma 1, we are ready to analyze the tracking decisions made by ETFs. Let Ω_m denote the set of ETFs that track index provider m. The subsequent lemma demonstrates that ETFs with similar realized biases are inclined to select the same index provider to track, which suggests that in equilibrium, $\{\Omega_m\}$ must follow a partition structure.

Lemma 2 (Partition structure of the index provision market)
In any equilibrium, for each index provider m, its client ETF set Ω_m is an interval.

Following Lemma 2, we can simplify the analysis by ranking ETF managers based on their realized biases. Without loss of generality, we can express the bias as

$$b_e = b - \mu + 2\mu \cdot e. \tag{4}$$

By doing so, we can also establish a ranking for index providers based on the set of ETFs that track them. Specifically, for index provider $m \in \{1, ..., M\}$, the set of ETFs that track the index provider's index is denoted as $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$, where $\bar{e}_0 = 0$ and $\bar{e}_m \in [0, 1]$

represents the bias of the ETF manager who is indifferent between index provider m and $m+1$. Consequently, ETFs that track the same index m construct identical portfolios $y_e = s_m(\theta)$, generate the same expected payoff for retail investors, and charge the same delegation fee to retail investors $f_{e,m} = f_m$, for $\forall e \in \Omega_m$.

We next move to index providers' total profit. Given the conflicts of interest between retail investors and ETF managers as the main friction in our analysis, one may conjecture that index providers should charge retail investors directly to have aligned interests. However, the following lemma shows that in equilibrium, index providers should be paid by ETFs only.

Lemma 3 (No direct payments from retail investors)
In any equilibrium, no retail investors directly pay the index providers, i.e., $\Theta_m = \varnothing$.

Lemma 3 demonstrates that, similar to the rating agency industry, a direct payment structure may not be viable because of the issue of free-riding. If certain investors pay the index provider directly, others can benefit without paying by investing in the same fund. Consequently, in any equilibrium, the fees charged by the index provider to retail investors must be tied to fund investments, with the funds effectively bearing the cost.

Index providers, when collecting licensing fees from ETFs, have incentives to prioritize the preferences of ETF managers rather than those of retail investors. This creates a misaligned interest problem for retail investors. We analyze the determination of index provider m's licensing fee through a Nash bargaining game with their client ETF managers, where $m = \{1, 2, .., M\}$. In this agreement, index provider m collects the licensing fee $\nu_{m,e}$ from an ETF and the ETF manager obtains the payoff $E[V^{m,e}]$, where from equation (2) we know $V^{m,e} = W_e\big(\pi(b_e) - (s_m(\theta) - \theta - b_e)^2 + f_m\big) - \nu_{m,e}$. If there is disagreement, both parties receive zero payoffs.[8] To determine index provider m's licensing fee $\nu_{m,e}$ from ETF manager e, we solve the maximization problem: $\max_{\nu_{m,e}} \nu_{m,e}^{\beta} \left(E[V^{m,e}]\right)^{1-\beta}$. This optimization yields the equilibrium licensing fee:

$$\nu_{m,e} = \beta E\left[W_e\left(\pi(b_e) - (s_m(\theta) - \theta - b_e)^2 + f_m\right)\right]. \tag{5}$$

Moreover, given the client ETF set $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$, the total licensing fee for index

[8] In the appendix, we verify that the outside option of ETF managers is zero in equilibrium.

provider m is calculated as

$$\nu_m = \int_{\Omega_m} \nu_{m,x} \mathrm{d}x, \tag{6}$$

where $\nu_{m,e}$ is given by equation (5). Simple calculations generate the following result.

Lemma 4 (Index providers' profit)
Given $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$, index provider m's total licensing fee is determined by:

$$\nu_m = C(\bar{e}_{m-1}, \bar{e}_m) + \beta(\bar{e}_m - \bar{e}_{m-1}) \cdot \nu_{m,\bar{b}_m}, \tag{7}$$

where $C(\bar{e}_{m-1}, \bar{e}_m)$ is given by equation (A8) in the appendix, $\nu_{m,x}$ is given by equation (5), and $\bar{b}_m = \frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}$.

Lemma 4 presents a decomposition of the total licensing fee charged by the index provider. In equation (7), the first term $C(\bar{e}_{m-1}, \bar{e}_m)$ is solely determined by the fund client set Ω_m provided, and it does not directly depend on the index provider m's decision regarding the index provision or reporting strategy.

The second term in equation (7) reveals that the index provider's profit, given the fund client set Ω_m, is determined by the licensing fee collected from the ETF manager with bias $\bar{b}_m$. It is important to note that the bias $\bar{b}_m$ corresponds to the average bias of ETF managers within the index provider's client set Ω_m. Consequently, the index provider effectively serves the average ETF manager within its client set. By maximizing the licensing fee obtained from the ETF manager with bias $\bar{b}_m$, the index provider m maximizes its profit, which is equivalent to maximizing the total licensing fee.

Furthermore, because the average ETF manager in the client set has a bias of $\bar{b}_m$, any deviation from the desired risk exposure, $\theta + \bar{b}_m$, regardless of retail investors' preferences, negatively impacts the index provider's total profit. In other words, any deviation from the desired risk exposure for the average ETF manager within the client set has adverse financial implications for the index provider. Therefore, the index provider's objective is aligned with the average ETF manager within its client set.

By Lemma 1, in any equilibrium, the index provider m always reports the retail investors' conditional optimal action $s_m = a(s_m)$. It is crucial for ETF managers to track the index recognized by retail investors. If they fail to do this, investors may withdraw their funds and invest in other ETFs that closely follow the specified index. The ETF managers use the signal provided by the index provider to construct their portfolios, which is the retail investors' optimal portfolio allocation conditional on the index signal s_m.

We can then map the index design subgame to an equivalent game between retail investors and an index provider m. In this game, the index provider m has a bias $\bar{b}_m$ and sends retail investors a signal $s_m(\theta)$ about the state of the world $\theta \in [0, 1]$. Retail investors learn the signal $s_m(\theta)$ and decide their optimal action $a(s_m)$. The payoffs for both retail investors and index provider m depend on the state of the world θ and action $a(s_m)$. Without loss of generality, we can impose the constraint $s_m = a(s_m)$ because only action matters conditional on the realization of θ. If two signals result in the same action, the index provider can combine them into one.

In summary, the index design subgame parallels the seminal cheap talk model à la Crawford and Sobel (1982). The index provider, who has knowledge of the underlying risk exposure θ and designs the index, i.e., the reporting strategy of θ, is the sender in the cheap talk game with an average ETF client bias $\bar{b}_m$. Retail investors are the receivers and take actions $a(s_m)$ conditional on the signal. The bias $\bar{b}_m$ captures the potential misalignment of interests between the index provider (sender) and the retail investors (receiver).

The following proposition summarizes the optimal reporting strategy, or index, by the index provider.

Proposition 1 (Index provider's optimal reporting strategy)
Suppose that there is a number M of index providers admitted by retail investors. Given a index provider m's client ETF set $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$, the index provider m's reporting strategy follows a partition structure in which the state space $[0, 1]$ is divided into N_m intervals denoted by $[\theta_{m,k-1}, \theta_{m,k}]$ with $\theta_{m,k} = \frac{k}{N_m} + 2\bar{b}_m k(k - N_m)$, $k = 1, ..., N_m$, $\theta_{m,0} = 0$, and $\theta_{m,N_m} = 1$. We then select the most informative equilibrium with N_m being the largest integer satisfying

$$2N_m(N_m - 1)\bar{b}_m < 1. \tag{8}$$

Thus, when $\theta \in [\theta_{m,k-1}, \theta_{m,k}]$, the index created by the index provider is $s^*_m(\theta) = \frac{\theta_{m,k-1}+\theta_{m,k}}{2}$.

Understanding how the reporting strategy affects the ETF manager's portfolio construction, the index provider designs the optimal reporting strategy $s_m(\theta)$, or the index, by trading off the informativeness of the index and its representative ETF client's private benefit in tilting the portfolio. Following the cheap talk literature, we focus on partition equilibria in which the state space $[0,1]$ is divided into N_m intervals denoted by $[\theta_{m,k-1}, \theta_{m,k}]$ with $\theta_{m,k} = \frac{k}{N_m} + 2\bar{b}_m k(k - N_m)$, $\theta_{m,0} = 0$, and $\theta_{m,N} = 1$. Among multiple equilibria, we select the most informative equilibrium that is featured with N_m being the largest integer satisfying $2N_m(N_m - 1)\bar{b}_m < 1$. This is because ex-ante, retail investors find that a more refined partition reporting strategy strictly dominates a less refined one. Similar to Lemma 1, index providers will propose the most refined reporting strategy given the potential competition from other index providers.

Given the subintervals and uniform distribution, we can solve index providers' optimal action. The index created depends only on the subinterval; that is, for any $\theta \in [\theta_{m,k-1}, \theta_{m,k}]$, index provider m's optimal index is

$$s^*_m(\theta) = E[\theta | s^*_m(\theta)] = \frac{\theta_{m,k-1} + \theta_{m,k}}{2}. \tag{9}$$

This optimal reporting strategy emphasizes that for a given client set Ω_m, index provider m adopts the same partition reporting strategy as the sender in a standard cheap talk game.

Furthermore, Proposition 1 enables us to compute retail investors' expected payoff when investing in a fund that tracks index m, that is, $e \in \Omega_m$. Denote by $\sigma^2_{\theta,m}$ the residual variance that retail investors expect to have after receiving the equilibrium index created by the index provider m. We can derive that

$$\sigma^2_{\theta,m} \equiv \sum_{k=1}^{N_m} \int_{\theta_{m,k-1}}^{\theta_{m,k}} \left[\theta - \frac{\theta_{m,k-1} + \theta_{m,k}}{2}\right]^2 \mathrm{d}\theta = \frac{1}{12N_m^2} + \frac{(b_{\bar{e}_{m-1}} + b_{\bar{e}_m})^2 (N_m^2 - 1)}{12}. \tag{10}$$

As the delegation fee is assumed to constitute a fraction α_0 of retail investors' expected utility, we can further derive the retail investors' payoff in the following corollary.

Corollary 1 (Payoff of retail investors)
Define $\alpha \equiv \frac{\alpha_0}{1+\alpha_0}$. Suppose that there is a number M of index providers. Given a index provider m's client ETF set $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$, the payoff of the retail investors that invest in the ETF that tracks the index m is

$$E[U^{m,i}] = (1 - \alpha)\left(U_0 - \sigma^2_{\theta,m}\right), \tag{11}$$

where $\sigma^2_{\theta,m}$ is given by (10).

3.2 Retail Investors' Optimal Index Admission

Section 3.1 characterized the index providers' optimal reporting strategy for a given set of admitted index providers and given sets of fund clients. In this section, we discuss retail investors' optimal index admission decisions. The following proposition summarizes the results.

Proposition 2 (Retail investors' optimal index admission)
In equilibrium, retail investors only admit one monopolistic index provider. Moreover, when there is a monopolistic index provider:

1. *For the index provider, there exists a partition equilibrium of size N interval, where N is the largest positive integral satisfying $|b| < \frac{1}{2N(N-1)}$. The partition is characterized by $0 = \theta_0 < \theta_1 < \theta_2 < \cdots < \theta_N = 1$, where $\theta_k = \frac{k}{N} + 2bk(k-N)$. In equilibrium, when θ falls into the kth interval, the index provider's index is $s(\theta) = \frac{\theta_{k-1}+\theta_k}{2}$;*

2. *ETF manager e tracks the sole index $y_e = s(\theta)$ to construct the portfolio and collects the delegation fee*

$$f = \alpha \left(U_0 - \sigma_\theta^2 \right) \tag{12}$$

from retail investors, where σ_θ^2 is given by

$$\sigma_\theta^2 = \frac{1}{12N^2} + \frac{b^2(N^2-1)}{3}. \tag{13}$$

3. *Retail investors randomly pick an ETF in which to invest.*

In essence, retail investors, via their index admission decisions, determine the effective bias of the index providers and thus the informativeness of the index. Proposition 2 shows that retail investors prefer an index offered by a monopolistic index provider. It is important to note that the monopoly structure in the index provision market should not be interpreted literally. Rather, we emphasize that retail investors benefit most from a concentrated index provision market. Our extension in Section 4.3 demonstrates that, when considering a more general bargaining game between index providers and ETFs, a concentrated index provision market still emerges, but with more than one index provider.

The key factor underlying this result is the conflict of interest between retail investors and ETF managers. A monopolistic index provider, by representing the collective interests of ETF managers, eliminates any individual biases and ensures the least possible overall bias. As a result, the index offered by the monopolistic provider is best aligned with the interests of retail investors, making it highly sought after. In summary, Proposition 2 emphasizes that retail investors can benefit from a concentrated index provision market.

Finally, we compute the payoff of various agents in equilibrium in the following corollary.

Corollary 2 (Monopolistic index provider: Agents' payoff)
In the monopolistic index provision market, retail investors' expected utility is

$$E[U] = (1-\alpha)\left(U_0 - \sigma_\theta^2\right), \tag{14}$$

ETF managers' expected utility is

$$E[V] \equiv \int_0^1 V^x \mathrm{d}x = (1-\beta)\left(\int_0^1 \pi(b_x)\mathrm{d}x + f - (\sigma_\theta^2 + b^2)\right), \tag{15}$$

and the monopolistic index provider's total profit is

$$\nu = \beta \int_0^1 \left(\pi(b_x) - b^2 + b_x^2\right)\mathrm{d}x + \beta \cdot f - \beta(\sigma_\theta^2 + b^2), \tag{16}$$

where f and σ_θ^2 are given by equations (12) and (13) respectively. The total welfare is $TS = E[U] + E[V] + \nu$.

4 Variations and Extensions

In this section, we discuss several variations and extensions of our baseline model to demonstrate the robustness of its key insight; that is, a concentrated index provision market benefits retail investors the most.

4.1 Time Varying Bias

In our baseline model, managers of ETFs learn their time-invariant random biases before they choose the tracking index. However, in the real world, as the market evolves, fund managers may adopt different trading strategies to reduce transaction costs or to respond to new information for informed trading. As a result, the bias of a passive fund may change over time, even as it continues to track the same benchmark index. To accommodate this, we now extend the model to include multiple periods, allowing time-varying biases after the initial fund benchmark choices at period 0. Now, without loss of generality, if we consider the original baseline model as one period, then at each time $t \in \{0, 1, 2, \ldots\}$, the time t bias of each fund is

$$b_{e,t} = b_e + \eta_t + \epsilon_{e,t}, \tag{17}$$

where b_e is fund e's fixed bias realized at time 0, η_t is the systematic noise at time t, and $\epsilon_{e,t}$ is fund e's time t idiosyncratic noise. Both noise terms are i.i.d. and have a mean of 0. For simplicity, let us assume that the systematic noise term η_t is public and that investors do not learn the idiosyncratic noise term $\epsilon_{e,t}$. Assuming a common discount factor δ, retail investors try to maximize their discounted utility:

$$E[\sum_{t=1}^{\infty} \delta^{t-1} U_{i,t}]. \tag{18}$$

Similarly, ETF managers maximize their expected discounted payoff and index providers maximize their expected discounted licensing fee. The following proposition shows that our result is robust even when ETF biases vary over time.

Proposition 3 (Time varying bias)
There exists a unique equilibrium in which all ETFs track the same index.

This result arises because a concentrated index provider can mitigate conflicts of interest between retail investors and ETFs, whether time-varying or not.

To illustrate this idea, consider two groups of ETFs, Ω_1 and Ω_2 that follow the two indices m_1 and m_2, respectively. Let the time t average bias for each group be $b_{\Omega_i,t}$ and let $L(\Omega_i)$ be each group's market share. Following our baseline model analysis, $b_{\Omega_i,t}$ is the effective bias at time t for each index provider. The convexity of absolute value implies that

$$E[|L(\Omega_1)b_{\Omega_1,t} + L(\Omega_2)b_{\Omega_2,t}|] \leq L(\Omega_1)E[|b_{\Omega_1,t}|] + L(\Omega_2)E[|b_{\Omega_2,t}|], \tag{19}$$

where the equality holds if and only if $b_{\Omega_1,t} = b_{\Omega_2,t}$. Thus in equilibrium, the monopolistic provider always has the lowest possible expected bias. Given their concave utility functions, retail investors prefer to admit only one index regardless of the time-varying bias of ETFs.

4.2 Multiple Exposures and Indices

Our model predicts that retail investors can benefit from a concentrated index provision market, as such a market can reduce potential conflicts of interest between retail investors and index providers. However, this does not imply that there should be literally a single index provider. Retail investors may seek various risk exposures, each requiring a corresponding index and an index provider.

Our emphasis on potential conflicts of interest is still relevant for the industrial organization structure of an index provision market with many indices. Large fund houses such as Vanguard, which offer many ETFs covering various risk factors, have strong bargaining power over index providers. To reduce concerns about catering to the biases of large fund houses, retail investors may want to enhance the index provider's market power by admitting many indices designed by the same provider. When there are two risk factors and corresponding indices, and if most ETFs covering these two factors are offered by the same fund houses, retail investors could benefit by relying on a single index provider even when these two risk factors appeal to two different groups of retail investors. Given the limited number of fund houses that manage many ETFs covering a wide range of risk factors, we expect to see the market served by a very limited number of index providers offering many index products.

4.3 Bargaining Power and Multiple Index Providers

In the baseline model, we conclude that the optimal market structure for index provision is a monopolistic index provider that covers a certain risk exposure. This corner result is partly driven by the assumption that the bargaining power of index providers is unrelated to the number of competitors. In this section, we extend our model to incorporate an index provider's bargaining power $\beta(M)$ as a function of the number of competitors M. Intuitively, as M increases, the index provider's bargaining power over ETFs decreases, that is, $\beta(M)$ is strictly decreasing in M. For simplicity, we further assume that α, as defined in Corollary 1 and representing the asset management fee as a fraction of retail investors' expected payoff, is a function of β, with $\alpha'(\beta) > 0$ and $\lim_{\beta \to 1} \alpha = 1$. The assumption captures the idea that when index providers possess strong bargaining power, it reduces the profit margin of ETFs, leading ETFs to charge higher fees to retail investors. The following proposition shows that when the competition between index providers significantly influences their bargaining power, an oligopoly market for index provision may emerge.

Proposition 4 (Index providers' bargaining power)
For any $\beta(2) \in (0,1)$*, there exists a threshold* $\overline{\beta} \in (0,1)$ *such that retail investors prefer the duopolistic market as long as* $\beta(1) \geq \overline{\beta}$*.*

The extended bargaining power of index providers introduces a tradeoff that determines the equilibrium number of index providers. On the one hand, having fewer index providers reduces the misalignment of interests between the index provider and retail investors, a novel force highlighted in the baseline model. On the other hand, having more index providers promotes competition, leading to lower licensing fees and lower overall costs for retail investors. However, this same competition also incentivizes index providers to prioritize the interests of ETFs, potentially misaligning with retail investors' interests. Proposition 4 demonstrates that when the benefits of competition are significant, retail investors may favor an oligopoly market over a monopolistic market. However, even in the case of multiple providers, the index provision market remains concentrated.

5 Discussion

5.1 Model Predictions

Our model helps predict the industrial organization structure of the index provision market in various settings. We argue that a concentrated index provision market grants high bargaining power to index providers over the funds that follow their indices, effectively reducing conflicts of interest on the fund side and disciplining the designed index. This suggests that our model is more applicable to plain vanilla index funds than to narrowly focused index funds. Retail investors who seek exposure to popular risk profiles and thus consider plain vanilla indices are more likely to benefit from this mechanism. Conversely, narrowly focused indices only cater to niche markets where the limited number of associated index funds already have considerable bargaining power over the index provider. Therefore, limiting competition in the index provision market would help little in such cases.

Our story also revolves around the agency problem between retail investors and financial professionals, which stems from the asymmetry of information regarding risk exposure and expertise in portfolio construction. Consequently, our model is particularly applicable to indices that allow for a high degree of managerial discretion. Indices managed with more flexibility are more likely to exhibit a more concentrated market structure than those managed by strict rules.

Furthermore, the higher sophistication and knowledge of institutional investors compared with that of retail investors mean that retail-oriented index funds tend to be associated with a more concentrated market for index provision than institution-oriented funds. Similarly, newly introduced indices are often more opaque to end investors than well-established indices and are thus more likely to feature a more concentrated market for index provision.

Another interesting aspect of our model is the prediction that index providers tend to rebalance their indices infrequently. Despite changing market fundamentals and the availability of new information, index providers typically update the composition of their indices only periodically. For instance, the S&P 500 – the most frequently updated stock market index – rebalances quarterly, while other indices, such as the Dow Jones, rebalance even less often. Our model aligns with this behavior of infrequent index updating, which is due to the partitioned nature of the index reporting strategy. Specifically, as outlined in Proposition 2, provided that the fundamental value θ falls within the interval $[\theta_{k-1}, \theta_k]$, the index provider continues to report the same index value, which is the midpoint $s = \frac{\theta_{k-1}+\theta_k}{2}$.

Finally, proposals for direct indexing have been suggested as a way to reduce the high fees charged by index providers. By eliminating intermediaries, self-indexing funds could offer indices to retail investors more affordably. However, we contend that index providers emerge precisely to address the agency problem between retail investors and fund managers. Consequently, removing these intermediaries may adversely affect investors rather than benefiting them. As mentioned in the introduction, it is thus not surprising that Morningstar's Open Indexes Project has not been able to substantially reduce the cost of equity indices.

5.2 Investor Welfare and Concentration in Index Provision

Currently, a limited number of large index providers dominate the index provision market (e.g., Robertson, 2019; Kostovetsky and Warner, 2021; Petry, Fichtner, and Heemskerk, 2021; An, Benetton, and Song, 2023). In the U.S. equity ETF market, the five largest index providers – S&P Dow Jones, CRSP, FTSE Russell, MSCI, and NASDAQ – collectively account for approximately 95% of the entire ETF market (An, Benetton, and Song, 2023).

This concentration has resulted in high licensing fees and substantial markups for these leading providers. There is growing concern that the market dominance of these providers is hindering innovation and preventing a reduction in fees (e.g., Andrew, 2021). The FCA is currently reviewing whether this limited competition in the benchmark and index markets is increasing investor costs and affecting investment choices. Similarly, the SEC has called for studies on disclosure and competition in the U.S. index provision markets. Regulatory attention has shifted toward ensuring a functional competitive market and assessing whether index providers are delivering value to end users.

Given the simplicity of designing and maintaining an index, and the significant licensing fees and markups involved, it can be puzzling to observe a concentrated index provision market. Our model offers a rationale for this concentration. It suggests that a concentrated market helps address the agency problem between retail investors and fund managers. Strong market power granted to the index provider ensures that retail investors are protected from the negative effects of conflicts of interest, leading to optimal portfolio construction that aligns with their interests. Therefore, despite the criticisms of limited competition and high fees, limited competition among index providers may in fact benefit retail investors.

This insight from our model suggests that introducing competition through regulation may adversely affect retail investor welfare. Therefore, any regulatory measures to increase competition in the index provision market should be carefully evaluated to avoid any unintended negative consequences on retail investors.

Our argument that retail investors may benefit from a concentrated index provision aligns with the recent trend in the ESG index space, where significant growth has led to increased concentration. As noted by Longley (2019), new ratings and index agencies are emerging, yet consolidation is occurring.

Moreover, our paper emphasizes that the concentration in the index provision market is the result of retail investors' choices. Retail investors typically favor only a few established index providers. This preference sustains the market dominance of these providers despite potential competition from other new entrants. Retail investors' recognition and trust in these providers underscores their brand value (Kostovetsky and Warner, 2021; An, Benetton, and Song, 2023). That is, when choosing ETFs, investors care about the identities of index providers, even when returns across the various indices that these providers construct show minimal differences.

5.3 Various Sources for the Agency Problem in the Delegation Market

The starting point for our analysis is the agency problem between retail investors and passive funds. In addition to studies cited in the introduction and Section 2.2, such as Cheng, Massa, and Zhang (2019), Brogaard, Heath, and Huang (2021), and Dekker, Gider, and De Jong (2021), which imply fund managers' incentives to deviate, scholars from various fields provide a different perspective on this market friction. For example, Robertson (2019) provides a rationale for investors' preference for index funds, which follow predetermined rules, over actively managed funds. Robertson (2019) argues that index funds are distinct from other funds because they allow fund managers to commit in advance to an investment strategy: "Rather than having wide discretion, by committing to following some specified index, the fund manager can credibly commit to potential investors how she will invest their money. To the extent that investors want to limit the discretion of fund managers, this constraint may be desirable to them."

This perspective aligns with our view that there are inherent conflicts of interest between retail investors and fund managers. Although funds are requested to track an index, thereby limiting the discretion of fund managers and aligning the portfolio with retail investors' risk exposure needs, this may not be sufficient. Some passive funds exhibit active strategies (Akey, Robertson, and Simutin, 2021; Easley, Michayluk, O'Hara, and Putniņš, 2021), which suggests that the incentives of fund managers to deviate from the ideal risk exposure desired by retail investors still exist.

Our study explores the further implications of this agency friction for structuring the index provision market. Retail investors intentionally grant index providers market power over the passive funds that they follow, which ensures that the indices and portfolios created align closely with their interests. Therefore, if retail investors are concerned about agency issues with fund managers, they can benefit from a concentrated index provision market.

Although a concentrated index provision market helps retail investors reduce bias on the fund side, it cannot eliminate it entirely because index providers collect fees from fund clients and thus tend to cater to their preferences. For example, anecdotal evidence suggests that in the corporate bond market index designers may intentionally exclude certain illiquid bonds to enhance the trackability of the index. This strategy aims to attract more funds and increase the assets under management that track the index, highlighting the potential conflicts of interest between retail investors and fund managers.

6 Conclusion

We build a model to understand the competitive landscape in the index provision market, particularly the puzzling coexistence of large markups charged by index providers alongside easy market entry. We show that because of the conflict of interest between retail investors and passive funds, retail investors prefer a concentrated index provision market with limited competition. That is, retail investors admit only a limited number of indices when delegating their investments to passive funds, thus ensuring that the index products better meet the needs of the end retail investors.

References

Adams, J. C., S. A. Mansi, and T. Nishikawa (2009). Internal governance mechanisms and operational performance: Evidence from index mutual funds. *Review of Financial Studies 23*(3), 1261–1286.

Akey, P., A. Robertson, and M. Simutin (2021). Closet active management of passive funds. *Working Paper*.

An, Y., M. Benetton, and Y. Song (2023). Index providers: Whales behind the scenes of ETFs. *Journal of Financial Economics 149*(3), 407–433.

Andrew, T. (2021). Can anyone disrupt the dominance of the 'Big Three' index providers? *ETF Stream*.

Antill, S. (2022). Do the right firms survive bankruptcy? *Journal of Financial Economics 144*(2), 523–546.

Avery, C. and M. Meyer (2003). Designing hiring and promotion procedures when evaluators are biased. *Working Paper*.

Benetton, M. (2018). Leverage regulation and market structure: An empirical model of the UK mortgage market. *Working Paper*.

Bolton, P., X. Freixas, and J. Shapiro (2012). The credit ratings game. *Journal of Finance 67*(1), 85–111.

Brogaard, J., D. Heath, and D. Huang (2021). The heterogeneous effects of passive investing on asset markets. *Working Paper*.

Buchak, G., G. Matvos, T. Piskorski, and A. Seru (2018). Fintech, regulatory arbitrage, and the rise of shadow banks. *Journal of Financial Economics 130*(3), 453–483.

Buchak, G., G. Matvos, T. Piskorski, and A. Seru (2020). Beyond the balance sheet model of banking: Implications for bank regulation and monetary policy. *Technical report*.

Cheng, S., M. Massa, and H. Zhang (2019). The unexpected activeness of passive investors: A worldwide analysis of ETFs. *Review of Asset Pricing Studies 9*(2), 296–355.

Craig, B. and Y. Ma (2022). Intermediation in the interbank lending market. *Journal of Financial Economics 145*(2), 179–207.

Crawford, V. P. and J. Sobel (1982). Strategic information transmission. *Econometrica 50*(6), 1431–1451.

Davies, A. (2012). BlackRock calls for action on conflicts of interest in ETFs. *Reuters*.

Dekker, L., J. Gider, and F. De Jong (2021). How do funds deviate from benchmarks? Evidence from MSCI's inclusion of Chinese A-shares. *Working Paper*.

Dessein, W. and T. Santos (2003). The demand for coordination. *Working Paper*.

Easley, D., D. Michayluk, M. O'Hara, and T. J. Putniņš (2021). The active world of passive investing. *Review of Finance 25*(5), 1433–1471.

Egan, M., A. Hortaçsu, and G. Matvos (2017, January). Deposit competition and financial fragility: Evidence from the US banking sector. *American Economic Review 107*(1), 169–216.

Egan, M., A. MacKay, and H. Yang (2021). Recovering investor expectations from demand for index funds. *Review of Economic Studies 89*(5), 2559–2599.

Flood, C. (2012). UK regulator declares ETF concerns. *Financial Times*.

Ganguly, C. and I. Ray (2005). On mediated equilibria of cheap-talk games. *Working Paper*.

Gilligan, T. W. and K. Krehibiel (1989). Asymmetric information and legislative rules with a heterogeneous committee. *American Journal of Political Science 33*(2), 459–490.

Grenadier, S. R., A. Malenko, and N. Malenko (2016). Timing decisions in organizations: Communication and authority in a dynamic environment. *American Economic Review 106*(9), 2552–2581.

Harty, D. and M. Tor (2020). Consolidation among ESG data providers continues amid COVID-19 pandemic. Technical report, S&P Global market Intelligence.

Hortacsu, A. and C. Syverson (2004). Product differentiation, search costs, and competition in the mutual fund industry: A case study of S&P 500 index funds. *Quarterly Journal of Economics 119*(2), 403–456.

Jiang, E. X. (2020). Financing competitors: Shadow banks' funding and mortgage market competition. *Working Paper*.

Kakhbod, A., U. Loginova, A. Malenko, and N. Malenko (2023). Advising the management: A theory of shareholder engagement. *Review of Financial Studies 36*(4), 1319–1363.

Koijen, R. S. J. and M. Yogo (2019). A demand system approach to asset pricing. *Journal of Political Economy 127*(4), 1475–1515.

Kojien, R. S. and S. V. Nieuwerburgh (2020). Lecture note Section 6: Mutual funds and hedge funds. *Online Notes*.

Koont, N., Y. Ma, L. Pastor, and Y. Zeng (2022). Steering a ship in illiquid waters: Active management of passive funds. Technical report, National Bureau of Economic Research.

Kostovetsky, L. and J. B. Warner (2021). The market for fund benchmarks: Evidence from ETFs. *Working Paper*.

Krishna, V. and J. Morgen (2001a). Asymmetric information and legislative rules: Some amendments. *American Political Science Review 95*(2), 435–457.

Krishna, V. and J. Morgen (2001b). A model of expertise. *Quarterly Journal of Economics 116*(2), 747–775.

Lehrer, E. and S. Sorin (1997). One-shot public mediated talk. *Games and Economic Behavior 20*(2), 131–148.

Levit, D. and N. Malenko (2011). Nonbinding voting for shareholder proposals. *Journal of Finance 66*(5), 1579–1614.

Li, S. (2022). Should passive investors actively manage their trades? *Working Paper*.

Longley, S. (2019). ETF insight: Is self-indexing the solution to index providers' high fees? *ETF Stream*.

Lund, D. S. and A. Robertson (2023). Giant asset managers, the big three, and index investing. *Yale Journal on Regulation*.

Mahoney, P. G. and A. Robertson (2021). Advisers by another name. *Virginia Law and Economics Research Paper*.

Molk, P. and A. Z. Robertson (2023). Discretionary investing by 'passive' S&P 500 funds. *Yale Journal on Regulation, Forthcoming*.

Myerson, R. B. (1989). Credible negotiation statements and coherent plans. *Journal of Economic Theory 48*(1), 264–303.

Petry, J., J. Fichtner, and E. Heemskerk (2021). Steering capital: The growing private authority of index providers in the age of passive asset management. *Review of International Political Economy 28*(1), 152–176.

Reilly, C. (2022). The hidden cost of corporate bond ETFs. *Working Paper*.

Robertson, A. Z. (2019). Passive in name only: Delegated management and index investing. *Yale Journal on Regulation 36*, 795.

Xiao, H. (2022). The economics of ETF redemptions. *Working Paper*.

Appendix: Proofs

Proof of Lemma 1

We prove the first part of the lemma by contradiction. Suppose that in equilibrium, there exists one admitted index provider m with signal $s_m \neq a(s_m)$. Then another unadmitted index provider m' can dominate him with a reporting strategy $s_{m'} = a(s_m)$. By construction, $s_{m'}$ is a one-to-one mapping with s_m, but associated with a strictly higher expected payoff for retail investors. Thus, retail investors will have an incentive to deviate, a contradiction.

Similarly, for the second part of the lemma, suppose that in equilibrium, there exists an index provider m such that $E[s_m] = E[\theta] + \kappa$, where κ is a constant. Then one can rewrite $s_m = \theta + x(\theta) + \kappa$, with $E[x] = 0$. For retail investors, their expected utility from investing in a fund tracking s_m is the following (note that we omit the subscript i):

$$
\begin{aligned}
& U_0 - E(s_m - \theta)^2 - f_e - g_m \\
=& U_0 - f_e - g_m - E(\theta + x + \kappa - \theta)^2 \\
=& U_0 - f_e - g_m - E[x^2] - 2E[x]\kappa - E[\kappa^2] \\
<& U_0 - f_e - g_m - E[x^2] \\
=& U_0 - E(s_m - \kappa - \theta)^2 - f_e - g_m.
\end{aligned}
$$

Then, retail investors find it strictly better off to pick a conditional portfolio $s_m - \kappa$, contradicting with $a_m = s_m$. Therefore, for any m and m', $E[s_m] = E[\theta] = E[s_{m'}]$.

Proof of Lemma 2

Given the set $[0, 1]$ of ETF managers being compact and the set of potential index providers being countable, we only need to show that if two ETFs e_1 and e_2 with realized bias $b_{e_1} < b_{e_2}$ track the same index $s_m(\theta)$, then all ETFs with a realized bias in between $b_e \in (b_{e_1}, b_{e_2})$ also track the same index $s_m(\theta)$.

Consider a fund e_3 with the bias $b_{e_3} = \eta b_{e_1} + (1-\eta) b_{e_2}$, where $\eta \in (0, 1)$. If m is the only index provider in the equilibrium, then ETF e_3 tracks $s_m(\theta)$. If, in equilibrium, there also exists a different index provider m' that designs index $s_{m'}(\theta)$. By Lemma 1, $E[s_m] = E[s_{m'}]$. Then we can rewrite $s_{m'}(\theta) = s_m(\theta) + \epsilon(\theta)$, satisfying $E[\epsilon(\theta)] = 0$. Because funds with bias e_1 track $s_m(\theta)$, the fund manager must derive a higher payoff from tacking index m than index m'. That is,

$$\begin{aligned} E[V^{m,e_1}] &= E[\pi(b_{e_1}) - (y_m - \theta - b_{e_1})^2 + f_{e_1}] - \nu_{m,e_1} \\ &= (1-\beta)E[\pi(b_{e_1}) - (y_m - \theta - b_{e_1})^2 + f_{e_1}] \\ &\geq (1-\beta)E[\pi(b_{e_1}) - (y_{m'} - \theta - b_{e_1})^2 + f_{e_1}] \\ &= E[V^{m',e_1}]. \end{aligned}$$

Hence,

$$E[(y_m - \theta - b_{e_1})^2] \leq E[(y_{m'} - \theta - b_{e_1})^2]. \tag{A1}$$

Similarly, since the fund with bias e_2 also tracks the index m, we can conclude

$$E[(y_m - \theta - b_{e_2})^2] \leq E[(y_{m'} - \theta - b_{e_2})^2]. \tag{A2}$$

Next, we examine the payoff of the fund with bias e_3 from tracking the index m.

$$\begin{aligned} E[V^{m,e_3}] =&(1-\beta)E[\pi(b_{e_3}) - (y_m - \theta - b_{e_3})^2 + f_{e_3}] \\ =&(1-\beta)E[\pi(b_{e_3}) - (\eta(y_m - \theta - b_{e_1}) + (1-\eta)(y_m - \theta - b_{e_2}))^2 + f_{e_3}], \end{aligned}$$

where the second equation follows $b_{e_3} = \eta b_{e_1} + (1-\eta) b_{e_2}$. Thus,

$$\begin{aligned} \frac{1}{1-\beta}E[V^{m,e_3}] = \pi(b_{e_3}) - \Big[&\eta^2 E[(y_m - \theta - b_{e_1})^2] + (1-\eta)^2 E[(y_m - \theta - b_{e_2})^2] \\ &+ 2\eta(1-\eta)E[(y_m - \theta - b_{e_1})(y_m - \theta - b_{e_2})] + f_{e_3}\Big], \\ =\pi(b_{e_3}) - \Big[&\eta^2 E[(y_m - \theta - b_{e_1})^2] + (1-\eta)^2 E[(y_m - \theta - b_{e_2})^2] \\ &+ 2\eta(1-\eta)E[(y_m - \theta - b_{e_1})^2 + (b_{e_1} - b_{e_2})(y_m - \theta - b_{e_1})] + f_{e_3}\Big]. \end{aligned}$$

Together with inequalities (A1) and (A2), we know that

$$\begin{aligned}
\frac{1}{1-\beta}E[V^{m,e_3}] \geq\ & \pi(b_{e_3}) - \Big[\eta^2 E[(y_{m'} - \theta - b_{e_1})^2] + (1-\eta)^2 E[(y_{m'} - \theta - b_{e_2})^2] \\
& + 2\eta(1-\eta)E[(y_{m'} - \theta - b_{e_1})^2 + (b_{e_1} - b_{e_2})(y_m - \theta - b_{e_1})] + f_{e_3}\Big] \\
=\ & \pi(b_{e_3}) - \Big[\eta^2 E[(y_{m'} - \theta - b_{e_1})^2] + (1-\eta)^2 E[(y_{m'} - \theta - b_{e_2})^2] \\
& + 2\eta(1-\eta)E[(y_{m'} - \theta - b_{e_1})^2 + (b_{e_1} - b_{e_2})(y_{m'} - \epsilon(\theta) - \theta - b_{e_1})] + f_{e_3}\Big] \\
=\ & E[\pi(b_{e_3}) - (y_{m'} - \theta - b_{e_3})^2 + f_{e_3}] \\
=\ & \frac{1}{1-\beta}E[V^{m',e_3}],
\end{aligned}$$

where the first equation follows $s_{m'}(\theta) = s_m(\theta) + \epsilon(\theta)$ from Lemma 1, or $y_{m'} = y_m + \epsilon(\theta)$. Therefore, like funds e_1 and e_2, the fund e_3 also prefers index m to m'.

Proof of Lemma 3

We prove this lemma by contradiction. Suppose instead there exists an equilibrium in which some retail investors in the group Θ_m pay the index provider m and invest in ETF e, m. However, in such a scenario, every retail investor in the group Θ_m would find it strictly better off to deviate from paying the index provider while still investing in the fund e, m, which contradicts the equilibrium assumption. Hence, in any equilibrium, any fee charged by the index provider to retail investors must be based on the fund investment, indicating that it is effectively the funds that pay. In other words, in any equilibrium $\Theta_m = \varnothing$.

Proof of ETF managers' outside option being zero

When considering the bargaining game between ETF manager $e \in (\bar{e}_m, \bar{e}_{m+1})$ and index provider m, we argue that the ETF manager's outside option is zero even though she may bargain with another index provider. We here prove this.

In the bargaining game with index provider m, when the agreement is reached, the index provider collects licensing fee $\nu_{m,e}$ whereas the ETF manager e obtains the payoff

$$V^{m,e} = f_m + (\bar{e}_m - \bar{e}_{m-1})\big(\pi(b_e) - (s_m(\theta) - \theta - b_e)^2\big) - \nu_{m,e}. \tag{A3}$$

In disagreement, index provider m obtains zero. Suppose that the ETF manager approaches another adjacent index provider $m' \in \{m-1, m+1\}$. Under the licensing fee $v_{m',e}$, the ETF manager obtains

$$V^{m',e} = f_{m'} + (\bar{e}_{m'} - \bar{e}_{m'-1})\big(\pi(b_e) - (s_{m'}(\theta) - \theta - b_e)^2\big) - \nu_{m',e}. \tag{A4}$$

Thus, the licensing fee $\nu_{m,e}$ is determined by solving the optimization problem

$$\max_{\nu_{m,e}} \nu_{m,e}^{\beta} E\left(V^{m,e} - V^{m',e}\right)^{1-\beta}.$$

Together with $f_m = f_{m'}$ in equilibrium, we obtain that

$$\begin{aligned}\nu_{m,e} = \beta E\Big(&(\bar{e}_m - \bar{e}_{m-1})\big(\pi(b_e) - (s_m(\theta) - \theta - b_e)^2\big) \\ &-(\bar{e}_{m'} - \bar{e}_{m'-1})\big(\pi(b_e) - (s_{m'}(\theta) - \theta - b_e)^2\big) + \nu_{m',e}\Big).\end{aligned} \tag{A5}$$

Similarly, when studying ETF manager e's bargaining game with index provider m', we can determine the licensing fee $\nu_{m',e}$ as following:

$$\begin{aligned}\nu_{m',e} = \beta E\Big(&(\bar{e}_{m'} - \bar{e}_{m'-1})\big(\pi(b_e) - (s_{m'}(\theta) - \theta - b_e)^2\big) \\ &-(\bar{e}_m - \bar{e}_{m-1})\big(\pi(b_e) - (s_m(\theta) - \theta - b_e)^2\big) + \nu_{m,e}\Big).\end{aligned} \tag{A6}$$

Solving equations (A5) and (A6) yields

$$\begin{aligned}\nu_{m,e} = \frac{\beta}{1+\beta} E\Big(&(\bar{e}_m - \bar{e}_{m-1})\big(\pi(b_e) - (s_m(\theta) - \theta - b_e)^2\big) \\ &-(\bar{e}_{m'} - \bar{e}_{m'-1})\big(\pi(b_e) - (s_{m'}(\theta) - \theta - b_e)^2\big)\Big)\end{aligned}$$

and $\nu_{m',e} = -\nu_{m,e}$. Since ETF manager e lies in index provider m's client set, i.e., $e \in (\bar{e}_m, \bar{e}_{m+1})$, we know that $\nu_{m,e} > 0$. As such, we must have $\nu_{m',e} < 0$, which suggests that index provider m' will not collect any fee from the ETF manager and thus will not provide any service. Therefore, when bargaining with index provider m, ETF manager e's outside option is zero.

Proof of Lemma 4

In any equilibrium, retail investors are indifferent among all ETFs, so the expected investment $W_e = 1$ for all funds. Given the characterization of $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$, the total licensing fee for index provider m, denoted as $\nu_m \equiv \int_{\bar{e}_{m-1}}^{\bar{e}_m} \nu_{m,x} \mathrm{d}x$, can be simplified to the following:

$$
\begin{aligned}
\nu_m =& \beta \int_{\bar{e}_{m-1}}^{\bar{e}_m} E\left[\left(\pi(b_x) - (s_m(\theta) - \theta - b_x)^2 + f_m\right)\right] \mathrm{d}x \\
=& \beta \int_{\bar{e}_{m-1}}^{\bar{e}_m} \left(\pi(b_x) + f_m\right) \mathrm{d}x - \beta \int_{\bar{e}_{m-1}}^{\bar{e}_m} E\left[(s_m(\theta) - \theta)^2 - 2\left(b - \mu + 2\mu x\right)\left(s_m(\theta) - \theta\right) + b_x^2\right] \mathrm{d}x \\
=& \beta \int_{\bar{e}_{m-1}}^{\bar{e}_m} \left(\pi(b_x) + f_m\right) \mathrm{d}x - \beta \int_{\bar{e}_{m-1}}^{\bar{e}_m} E\Big[(s_m(\theta) - \theta)^2 - 2\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}\left(s_m(\theta) - \theta\right) \\
&+ \left(\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}\right)^2 - \left(\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}\right)^2 + b_x^2\Big] \mathrm{d}x \\
=& \beta \int_{\bar{e}_{m-1}}^{\bar{e}_m} \left(\pi(b_x) - \left(\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}\right)^2 + b_x^2\right) \mathrm{d}x - \beta(\bar{e}_m - \bar{e}_{m-1})\pi(\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}) \\
&+ \beta(\bar{e}_m - \bar{e}_{m-1}) E\left(\pi(\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}) + f_m - (s_m(\theta) - \theta - \frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2})^2\right).
\end{aligned}
\tag{A7}
$$

Define $\bar{b}_m \equiv \frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}$ and

$$
C(\bar{e}_{m-1}, \bar{e}_m) \equiv \beta \int_{\bar{e}_{m-1}}^{\bar{e}_m} \left(\pi(b_x) - \left(\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}\right)^2 + b_x^2\right) \mathrm{d}x - \beta(\bar{e}_m - \bar{e}_{m-1})\pi(\bar{b}_m). \tag{A8}
$$

Then, together with equation (5), we can rewrite ν_m in equation (A7) as in equation (6).

Proof of Proposition 1

Step 1: Cheap Talk Equilibria

Suppose that there is a number M of index providers admitted by retail investors. Lemma 2 suggests that for each index provider, he has a client ETF set $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$. Lemma 3 implies that the index provider's preference is aligned with the representative ETF among his clients. By Lemma 1, the equilibrium portfolio is effectively the optimal reaction from retail investors conditional on the announced index. In summary, the index provider m's index announcement game is effectively a cheap talk game. Following Crawford and Sobel (1982), in any equilibrium, the index provider m follows a partition structure in which the state space $[0,1]$ is divided into $1 \leq N_m$, with N_m being the largest integer satisfying

$$2N_m(N_m-1)\bar{b}_m < 1. \tag{A9}$$

Each interval is denoted by $[\theta_{m,k-1}, \theta_{m,k}]$ with $\theta_{N,k} = \frac{k}{N} + 2\bar{b}_m k(k-N)$, $\theta_{N,0} = 0$, and $\theta_{N,N} = 1$. The index created by the index provider is $s^*_m(\theta) = \frac{\theta_{N,k-1}+\theta_{N,k}}{2}$.

Step 2: Retail Investor Payoff

Step 1 enables us to compute retail investors' expected payoff when investing in a fund that tracks index m, that is, $e \in \Omega_m$. Denote $\sigma^2_{\theta,m}$ as the residual variance that retail investors expect to have after receiving the equilibrium index created by the index provider m with N_m intervals. We can derive that

$$\sigma^2_{\theta,m} \equiv \sum_{k=1}^{N_m} \int_{\theta_{m,k-1}}^{\theta_{m,k}} \left[\theta - \frac{\theta_{m,k-1}+\theta_{m,k}}{2}\right]^2 \mathrm{d}\theta = \frac{1}{12N_m^2} + \frac{(b_{\bar{e}_{m-1}} + b_{\bar{e}_m})^2(N_m^2-1)}{12},$$

as shown in equation (10).

As the delegation fee is assumed to constitute a fraction α_0 of retail investors' expected utility, after defining $\alpha = \frac{\alpha_0}{1+\alpha_0}$, we can derive the payoff of retail investors as the following:

$$EU^{m,i} = (1-\alpha)\left(U_0 - \sigma^2_{\theta,m}\right), \tag{A10}$$

where $\sigma^2_{\theta,m}$ is given by (10).

Step 3: Equilibrium Selection

In Crawford and Sobel (1982), there might be multiple equilibria because there might be multiple N_m satisfying $2N_m(N_m-1)\bar{b}_m < 1$. We next show that when index providers follow their announced index design strategies, in equilibrium they always pick the largest number N_m. Similarly to our discussion on babbling equilibria exclusion, when index providers choose to be consistent with their announced index design strategy, they always pick the most informative index design strategy featured with N_m. This is because, ex-ante, retail investors find a more refined partition reporting strategy strictly dominates a less refined one. Similar to Lemma 1, index providers will propose the most refined reporting strategy, in anticipation of the potential competition from other index providers.

Proof of Corollary 1

This corollary follows Step 2 of Proposition 1 directly.

Proof of Proposition 2

Suppose that retail investors admit a number M of index providers. Based on Proposition 1, for the index provider m whose ETF client set is $\Omega_m = [\bar{e}_{m-1}, \bar{e}_m]$, its effective bias is $\bar{b}_m = \frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}$. Based on Corollary 1, retail investors who invest in an ETF that tracks index m receive utility $E[U(|\bar{b}_m|)]$ as given by (11).

Define the market share of the index provider m as $L(\Omega_m) \equiv \bar{e}_m - \bar{e}_{m-1}$. Then, via the allocation of funds across the ETFs, the average bias faced by the retail investors is, by Jensen's inequality,

$$E\left[U\left(|\sum_{m=1}^{M} L(\Omega_m)\bar{b}_m|\right)\right] \geq \sum_{m=1}^{M} L(\Omega_m) E\left[U\left(|\bar{b}_m|\right)\right],$$

where the equality holds if and only if $\bar{b}_1 = \bar{b}_2 = ... = \bar{b}_M$. Thus, in equilibrium, retail investors can achieve the lowest possible expected bias by only admitting one index provider.

Proof of Corollary 2

The retail investors' expected utility $E[U]$ follows Corollary 1 directly.

Based on equation (7), the index provider's total profit is

$$\begin{aligned}\nu &= \beta \int_0^1 \left(\pi(b_x) - b^2 + b_x^2\right) \mathrm{d}x + \beta E\left(f - (s(\theta) - \theta - b)^2\right) \\ &= \beta \int_0^1 \left(\pi(b_x) - b^2 + b_x^2\right) \mathrm{d}x + \beta \cdot f - \beta(\sigma_\theta^2 + b^2),\end{aligned}$$

where f is given by (12). Based on equation (2) we know ETF manager e's payoff is $V^e = \pi(b_e) - (s(\theta) - \theta - b_e)^2 + f - \nu_e$ under the monopolistic index provider. Taking expectations yields

$$
\begin{aligned}
E[V] = E[V^e] &= E\left[\pi(b_e) - (s(\theta) - \theta - b_e)^2 + f - \nu_e\right] \\
&= (1-\beta)E\left[\pi(b_e) - (s(\theta) - \theta - b_e)^2 + f\right] \\
&= (1-\beta)\left(\int_0^1 \pi(b_x)\mathrm{d}x + f - (\sigma_\theta^2 + b^2)\right),
\end{aligned}
$$

where f is given by (12).

Proof of Proposition 3

If in equilibrium there are more than two groups of ETFs Ω_i that follow their own index m_i, respectively. Let the time t average bias for each group be $b_{\Omega_i,t}$, and $L(\Omega_i)$ be each group's market share. Similar to our baseline model analysis, $b_{\Omega_i,t}$ is the effective time t bias for each index provider. Jensen's inequality implies that

$$
E[|\sum L(\Omega_i) b_{\Omega_i,t}|] \leq \sum L(\Omega_i) E[|b_{\Omega_i,t}|],
$$

where the equality holds if and only if $b_{\Omega_i,t}$ are the same constant across i. Thus in equilibrium, the monopolistic provider always has the lowest possible expected bias, and retail investors prefer to accept only one index.

Proof of Proposition 4

Step 1: Number of index providers in equilibrium

Since the retail investors only aim to expose to the single risk θ, they must be indifferent among all ETFs tracking various indexes in equilibrium. That is, $EU^{m,i}$ is equal across all $m \in \{1, 2, ..., M\}$, where $EU^{m,i}$ is given by equation (11). The indifference condition thus suggests that

$$
\text{constant} = \frac{1}{12N_m^2} + \left(\frac{b_{\bar{e}_{m-1}} + b_{\bar{e}_m}}{2}\right)^2 \frac{(N_m - 1)^2}{3}, \ \forall m = \{1, ..., M\}. \tag{A11}
$$

Together with the determinant of N_m as given by the equation (8), the indifference condition (A11) suggests that the index provider's optimal bias admitted by retail investors, if exists, must share the same absolute representative bias. Consequently, in equilibrium, there can be at most two index providers, i.e., $M^* \leq 2$. To see this, suppose that there are $M \geq 3$ index providers admitted in equilibrium, then there must be at least two admitted index providers i and $i+1$ such that either $\frac{b_{\bar{e}_{i-1}}+b_{\bar{e}_i}}{2} \geq 0$ or $\frac{b_{\bar{e}_i}+b_{\bar{e}_{i+1}}}{2} \geq 0$. That is to say, the representative bias for admitted index providers i and $i+1$ are either both positive or negative. However, that implies $\frac{b_{\bar{e}_{i-1}}+b_{\bar{e}_i}}{2} \neq \frac{b_{\bar{e}_i}+b_{\bar{e}_{i+1}}}{2}$, a contradiction to the indifference condition.

Step 2: Index reporting in the duopolistic market

We then proceed by characterizing the equilibrium in the economy with duopolistic index providers ($M = 2$). Suppose that the ETF manager $\bar{e}$ is indifferent between the two index providers. Then, as derived above, we know that index provider 1 represents an average ETF manager with bias $\bar{b}_1 = b - \mu + \mu \cdot \bar{e}$ and index provider 2 represents an average ETF manager with bias $\bar{b}_2 = b + \mu \cdot \bar{e}$. The indifference condition (A11) thus becomes

$$\frac{1}{12N_1^2} + (b - \mu + \mu \cdot \bar{e})^2 \frac{(N_1 - 1)^2}{12} = \frac{1}{12N_2^2} + (b + \mu \cdot \bar{e})^2 \frac{(N_2 - 1)^2}{12}, \tag{A12}$$

where N_1 is the largest integer satisfying $|b - \mu + \mu \cdot \bar{e}| < \frac{1}{2N_1(N_1-1)}$ whereas N_2 is the largest integer satisfying $|b + \mu \cdot \bar{e}| < \frac{1}{2N_2(N_2-1)}$. Denote the payoff of the retail investors in this duopolistic index provision market as $U_0 - \sigma^2_{\theta,2}$.

Step 3: Market design

Given the retail investor's expected utility (11), retail investors prefer a duopolistic market structure if and only if

$$\begin{aligned} &(1 - \alpha(\beta(1)))(U_0 - \sigma^2_\theta) \leq (1 - \alpha(\beta(2)))(U_0 - \sigma^2_{\theta,2}) \\ \Rightarrow \quad &\frac{1 - \alpha(\beta(1))}{1 - \alpha(\beta(2))} \leq \frac{U_0 - \sigma^2_{\theta,2}}{U_0 - \sigma^2_\theta} < 1, \end{aligned} \tag{A13}$$

where σ^2_θ is given by (13) and the last inequality holds because $\sigma^2_\theta < \sigma^2_{\theta,2}$; that is, retail investors expect the lowest possible uncertainty about the risk exposure under the monopolistic index provision market. It is straightforward to see that for any $\beta(2) \in (0, 1)$, there exists a value $\overline{\beta} \in (0, 1)$ such that retail investors prefer a duopolistic market as long as $\beta(1) \geq \overline{\beta}$.