YOU GET WHAT YOU PAY FOR: THE RISE OF THE INDEX FUND AND EXPLORATION IN R&D

Abstract

We examine the effect of index fund ownership of public corporations on R&D. Drawing on symbolic management theory, we argue that index ownership increases R&D expenditures while decreasing R&D exploration due to multilevel decoupling. To reconcile the normative desirability of R&D investment as a signal of a manager's long-term orientation with managers' career concerns, managers maintain or increase R&D expenditures but adjust the harder-to-monitor R&D strategy to be more exploitative. This decoupling is facilitated and exacerbated by index ownership because index funds engage in decoupling themselves. We argue that the same features that make index funds effective financial instruments—low expense ratios and broad portfolios— may limit their efficacy as providers of corporate governance.

Keywords: Decoupling, exploration, institutional investors, corporate governance

INTRODUCTION

The agency problem faced by large corporations with fragmented ownership has long been recognized: the owners have limited incentives and ability to control the corporation while the managers are the primary influence on corporate behavior (Berle and Means (B&M), 1932). Significant attention has been devoted to its consequences for investments with long-term, uncertain payoffs like R&D and capacity expansion (e.g., Asker et al., 2015; Bernstein, 2015; Ferreira et al., 2014; Kaul et al., 2018). Meanwhile, the sustained growth of institutional investors as large and often dominant shareholders with greater capacity and incentive to monitor management has been argued to provide a mechanism by which the B&M agency problem may be ameliorated (e.g., Aghion et al., 2013). As scholars examine this possibility, the investment style of institutional investors has emerged as a key contingency for whether managers really prioritize the long-term interests of the firm (e.g., Bushee, 1998; Sampson & Shi, 2023; Zhang & Gimeno, 2010). Yet the corporate governance implications of the fastest-growing (and now close to largest) category of institutional ownership, ownership by index funds, have received limited attention both theoretically and empirically. In this paper, we consider whether the growth in index ownership can mitigate the B&M problem by examining its consequences for R&D investment.

Index funds include passively-managed mutual funds and exchange-traded funds (ETFs) that seek to deliver the returns of a market index such as the S&P 500 or the Russell 2000. Consequently, unlike actively-managed funds, index funds are nonstrategic traders with portfolios that are both especially diversified and especially low-turnover (Appel et al., 2016; Bebchuck & Hirst, 2019). They also offer very low fees relative to actively-managed funds because they do not invest as much in portfolio management. Index fund ownership of the U.S. stock market doubled over the past decade to reach 16% by the end of 2021, and assets under the management of index funds increased from 20% of total assets under the management of mutual funds and ETFs in 2011 to 43% in 2021 (Investment Company Institute, 2022). The accompanying legitimacy of index investing signals that the growth is likely to continue. Because they offer both diversification and low fees, index funds are frequently recommended as the investment vehicle of choice for the smart retail investor.[1] Jack Bogle, creator of the first index fund, famously advised, "Don't let the miracle of long-term compounding returns be overwhelmed by the tyranny of long-term compounding costs."[2] The observed return to index investing bears out this logic (Carhart, 1997; Fama & French, 2010), leading to the index fund's pole position as an investment vehicle.

Despite the significant growth in, and scale of, index fund ownership of corporations, research on the implications of index funds as corporate owners has only recently accelerated (e.g., Appel et al., 2016; Bebchuck & Hirst, 2019; Fisch, 2022). Scholars have long raised questions about index funds' abilities and incentives to monitor management effectively given their highly-diversified portfolios and mandate to replicate indices while keeping fees low (Bebchuck & Hirst, 2019; Porter, 1992; Sampson & Shi, 2023). Yet recent research suggests that index funds actually do have considerable incentive and ability to monitor firm management (Appel et al., 2016; Fisch, 2022; Gormley et al., 2022; Lewellen & Lewellen, 2022). Index fund managers themselves claim to be stewards of the long-term interests of their portfolio firms, frequently insisting that they are the ultimate long-term investors (Booraeum, 2019; Fink, 2018; Lacaille, 2019).

However, whether index ownership really encourages managers to prioritize the long-term interests of the firm remains an open question. Though prior research shows that index ownership is associated with the adoption of certain best practices in corporate governance (Appel et al., 2016), more board gender diversity (Gormley et al., 2022), and lower carbon dioxide emissions (Azar et al., 2021), a debate is bubbling over whether this is evidence of index funds acting as good stewards of the long-term interests of their portfolio firms or merely demonstrates a broad-scale, one-size-fits-all approach to corporate governance in which only a few simply-measured, easy-to-monitor standard practices are pushed (Gormley et al., 2022; Rock & Kahan, 2021).

[1] https://www.cnbc.com/2017/05/12/warren-buffett-says-index-funds-make-the-best-retirement-sense-practically-all-the-time.html
[2] https://www.forbes.com/sites/janetnovack/2014/06/18/invest-like-jack-bogle-buy-index-funds-and-stop-thinking-about-stocks

We address this void by examining how the shift toward index ownership affects corporate R&D. Measures of R&D investment are commonly used to study the implications of institutional ownership for corporate governance because it has been argued that R&D exemplifies the B&M problem (Aghion et al., 2013; Baysinger et al., 1991; Bushee, 1998; Eng & Shackell, 2001; Francis & Smith, 1995; Kaul et al., 2018). While critical for firm performance, especially in the long-run, the uncertain outcomes and relatively long investment horizons conflict with managers' interest in ensuring strong short-term performance in service of their reputations and career prospects (Aghion et al., 2013; Arrow, 1962; Holmström, 1989). In empirical analyses examining whether index ownership causes managers to "swing for the fences" i.e. take significant research risks that may benefit the firm in the long-run but put short-term performance at risk (e.g., Aghion et al., 2013), scholars have concluded that index fund ownership has no effect on R&D expenditures or productivity (measured as cite-weighted patent counts per R&D dollar) and attribute this apparent failure to mitigate B&M concerns to index funds having neither the incentive to monitor management nor the power of exit or voice that is needed to do so effectively (Aghion et al., 2013; Bushee, 1998). However, both theoretical and empirical concerns raise questions about such conclusions.

First, there is no reconciliation of this non-finding with the growing evidence that directly counters the assumption that index funds lack either the incentive or power to exercise voice (Appel et al., 2016; Azar et al., 2021; Gormley et al., 2022). Indeed, a close theoretical examination (as below) raises concerns about whether the shift toward ownership by index funds should really have no effect on research risk-taking.

Second, R&D expenditures and patent counts can offer only limited insight into whether index fund ownership alleviates B&M concerns because neither measure sufficiently captures whether managers are prioritizing the long-term over the short-term. It is possible to invest substantially in R&D while pursuing search strategies that prioritize more immediate, measurable, and predictable returns over long-term performance (Ahuja & Lampert, 2001; Fleming, 2001;

March, 1991). Even increases in cite-weighted patent counts are more likely to reflect a shift away from relatively risky, long-term oriented R&D approaches than a shift toward swinging for the fences (e.g., Fleming, 2001). Truly assessing whether index fund ownership encourages managers to prioritize long-term performance requires both theoretically and empirically analyzing the kind of research risk-taking that yields long-term performance benefits but may compromise short-term performance, such as the pursuit of a more exploratory, distant search strategy (Ahuja & Lampert, 2001; Fleming, 2001; Levinthal 1997; March, 1991).

Finally, these prior studies do not analyze index ownership directly but instead analyze Bushee's (1998, 2001) measure of ownership by "quasi-indexers." As our theorizing below suggests, analyses of quasi-index ownership cannot tell us very much about the implications of corporate ownership by the fast-growing category of passively-managed index funds whose portfolios are strictly dictated by a benchmark index. Quasi-indexers are identified at the fund group level as fund groups whose holdings, aggregated across all their individual funds, are relatively diversified with relatively low turnover (Bushee, 2001). As a result, the classification is more of a catchall than a meaningful measure of ownership by institutional investors following true index strategies. On average, 70% of institutional investors are classified as quasi-indexers each year.[3] As few as 10% of all institutions classified as quasi-indexers have stated index strategies; the remaining are actively-managed funds with longer-term buy-and-hold strategies (Bushee, 1998, 2001). Moreover, it is possible, and common, for institutions to change category from year to year (Bushee, 1998, 2001).[4] We address these theoretical and empirical limitations in the current paper.

To hypothesize the effect of true index ownership on research risk-taking, we draw from agency theory and the symbolic management literature. To reconcile the premise that investing in R&D often conflicts with managers' interest in ensuring strong short-term performance (Aghion

[3] This number is stable. Using the most recently available data (https://accounting-faculty.wharton.upenn.edu/bushee/permanent-transient-quasi-indexer-dedicated-classification-number-by-year <accessed July 2023>), 71% of institutional investors were classified as quasi-indexers in both 1991 and 2021.
[4] For example, in Bushee's (2001) analysis, 20% of institutions switched between quasi-index and transient classification per year.

et al., 2013; Arrow, 1962; Holmström, 1989) with the argument that investing in R&D is often both substantively and symbolically important for managers (Ahuja & Novelli, 2017; Bebchuck & Stole, 1993; Tinn, 2010), we draw on symbolic management theory which has long highlighted the principle of decoupling (Meyer & Rowan, 1977; Westphal et al., 2021; Westphal & Park, 2020). If a policy is perceived as normatively desirable to key external stakeholders but does not align with the interests of the managers themselves, then managers seek to adopt visible indicators of the policy while tailoring the actual implementation to reflect their own interests (Crilly et al., 2012; Meyer & Rowan, 1977; Westphal & Zajac, 1998). This suggests that an easily visible indicator of managers' commitment to the long-term interests of the firm—e.g., the magnitude of R&D investment—may be decoupled from how long-term oriented research efforts truly are since the direction of research is harder to observe. Drawing upon the exploration literature, we argue that it is possible to invest substantially in R&D while eschewing a high research-risk, long-term oriented, exploratory strategy for a more exploitative approach that will yield more immediate, measurable, and predictable returns (Ahuja & Lampert, 2001; Fleming, 2001; March, 1991).

Further, while incurring the costs of providing the high-quality monitoring needed to ensure managers make investments with long-term, uncertain payoffs for each of their portfolio firms conflicts with the mandate to compete on low fees (e.g., Bebchuck & Hirst, 2019; Porter, 1992), index funds face normative pressures from their external stakeholders to provide effective corporate governance (Fisch, 2022). Therefore, we argue that index funds themselves decouple visible indicators of their commitment to being stewards of the long-term interests of their portfolio firms—like their stated governance goals and their advocacy of standard governance practices—from the quality of monitoring they actually provide. This creates the opportunity for their portfolio firms to decouple the magnitude and direction of R&D. Moreover, the governance practices that index funds do successfully promote increase incentives to prioritize short-term performance (Balsmeier et al., 2017; Schoenfeld, 2017). This *multilevel* decoupling leads us to two novel, nuanced predictions for the effect of index ownership on corporate R&D: (1) a positive relationship between index ownership and R&D expenditures and (2) a negative relationship between index ownership and R&D exploration.

To test our predictions, we analyze patterns of R&D expenditures and exploration in U.S. public corporations from 1991-2015. We use various patent measures to capture the degree of R&D exploration. The results are consistent with our hypotheses and are robust to several efforts to rule out alternative explanations and selection issues, including within-firm effects and IV estimation. Furthermore, our predictions hold only for ownership by index funds that follow the classic approach to index investing, in which the objective is to match the return of the benchmark index by constructing the portfolio to match the composition and weightings of the index.

To summarize, we contribute to the corporate governance literature by providing a novel theoretical and empirical case for how index ownership, although promoted as a sound investment vehicle for the retail investor, falls short as a corporate owner in mitigating the B&M agency problem (e.g., Aghion et al., 2013; Bushee, 1998; Zhang & Gimeno, 2010) and facilitating research risk-taking. The same features that make index funds effective financial instruments—low expense ratios and broad portfolios—may limit their efficacy as providers of corporate governance. We also contribute to the symbolic management literature. While scholars have posited previously that decoupling can occur at or be driven by multiple levels of corporate governance (Bromley & Powell, 2012; Crilly et al., 2012; Westphal & Park, 2020), we provide a novel illustration and analysis of the consequences of multi-level decoupling for corporate outcomes and introduce the possibility that decoupling needs of principals themselves can be a key enabler of agents' decoupling behavior. Finally, to the exploration literature we add a novel determinant of exploration behavior–ownership structure.

THEORY AND HYPOTHESES

We build on two key precepts established in the symbolic management literature. First, we follow prior literature that sees decoupling as broader than simply a deviation between an externally committed discrete policy in an organization and its practice within the organization. Rather, we see decoupling as encompassing a broader distinction between appearances and reality both in corporate governance, specifically, and organizational life, more generally (Westphal & Park, 2020). Second, we build on the idea that decoupling can occur at different levels in the governance system simultaneously. As Westphal and Park (2020, p. 2) note in their articulation of symbolic management,

> "*A key tenet of our theory is that there is a pervasive separation between appearances and reality, or between symbol and substance, at each level of the governance system. In effect, symbolic management theory broadens the traditional, neo-institutional concept of decoupling beyond organizational structure and policy…We suggest that symbolic decoupling is a pervasive feature of organizational life which occurs at every level of analysis, from dyadic relations within organizations (e.g., relations between chief executive officers (CEOs) and directors, and between top managers and lower-level employees), to relations between firm leaders and external constituents, to relations between groups of leaders and groups of constituents.*"

We are agnostic though to another feature sometimes invoked in symbolic management research—that decoupling necessarily represents malfeasance or is a form of "calculated deception," to use Crilly et al.'s (2012) words. Although decoupling may arise from deceptive intent, it may also arise for other reasons. For example, pervasive uncertainty may make the outcomes of a given policy difficult to predict, so decoupling can be used to moderate the risks or learn about a specific context (Bromley & Powell, 2012; Crilly et al., 2012). Our limited postulate is that, whatever the underlying motivation, the possibility of decoupling makes it necessary to consider how index fund ownership might affect research risk-taking in corporations other than through the easily visible and externally measurable indicators of R&D investment.

With these precepts in place, we build to our hypotheses in three parts. First, we draw upon agency theory to describe the incentives managers of public corporations have to decouple their more visible commitment to the long-term interests of the firm (the magnitude of R&D investment) from the less visible implementation of R&D strategy. Second, we describe the role of shareholders in enabling or preventing decoupling in R&D. Third, we make the case that index fund ownership is more likely than both other institutional ownership and retail ownership to foster R&D decoupling because index funds themselves decouple their visible, public commitments to being stewards of the long-term interests of their portfolio firms from the actual implementation of governance. Hence, decoupling occurs at two levels simultaneously: managers with respect to research risk-taking, and their index-fund owners with respect to governance. Jointly, these behaviors constitute *multi-level decoupling* that enables the primary effect of increasing index ownership to fall on the direction of research—specifically, to reduce willingness to pursue exploratory research—not the level of research per se.

Managerial Decision-making in R&D

Our main premise with regard to managerial decision-making in R&D is that managerial concerns about career and reputation have conflicting implications for R&D investment. On the one hand, investing in R&D often conflicts with managers' interest in ensuring strong short-term performance. A persistent concern for managers is how their firm's current performance will affect their reputation and future career prospects (Gibbons & Murphy, 1992; Sanders & Hambrick, 2007). Since a manager's true ability is unobservable, the market for managers uses firm performance as a key indicator of managerial ability and updates beliefs about the manager's ability based on current firm performance (Fredrickson et al., 1988; Gibbons & Murphy, 1992; Holmström, 1999; Kaplan & Minton, 2006; Wiersema & Zhang, 2011). Accordingly, firm performance significantly affects a manager's ability to recontract favorably (Aghion et al., 2013; Graffin & Ward, 2010; Wang et al., 2017). Research suggests that the primary career effect of corporate poor performance on senior managers is the loss of mobility resulting from a failure to find a new position (Cannella et al., 1995; Schepker & Barker, 2018). Even if a new position is found, it is likely to be relatively inferior (Fee & Hadlock, 2004).

Therefore, managers tend to favor investments with predictable, proximate returns that are more likely to shore up managerial reputations by improving short-term performance, even at the expense of their firms' long-term interests (Aghion et al., 2013; Campbell & Marino, 1994; Holmström, 1999; Narayanan, 1985). In a survey of U.S. executives, the majority said they would avoid initiating a positive net present value (NPV) project that might jeopardize current earnings (Graham et al., 2005). Moreover, the short-termism induced by career concerns can persist despite the presence of incentive contracts; the possibility of termination undermines even incentive schemes explicitly designed to reward long-term success (Gibbons & Murphy, 1992; Ederer & Manso, 2013). R&D is particularly vulnerable to managerial career and reputation concerns (Aghion et al., 2013). Even positive-NPV R&D projects put current earnings at risk due to the typically-long investment horizons and failures that are an inevitable part of the experimentation process (Khanna et al., 2016). For these reasons, managers may underinvest in R&D (Arrow, 1962; Holmström, 1989).

On the other hand, the demands of legitimacy may constrain the willingness of managers to minimize or avoid investment in R&D outright. R&D is associated with innovation, productivity, and wealth creation (Ahuja & Novelli, 2017; Hall et al., 2010), a fortiori for technology-intensive industries. Further, it is closely followed by investors and researchers as it is open to manipulation to manage earnings (Bushee, 1998; Roychowdhury, 2006). R&D expenditures are also systematically measured and reported in "spreadsheet-able" fashion making monitoring it easy and mechanically possible. Investing in a long-term effort like R&D signals to stakeholders that a manager is acting in the best interests of the firm and avoiding temptations to favor short-term earnings over long-term performance (Bebchuck & Stole, 1993; Tinn, 2010).

Symbolic management theory suggests that managers may manage this tension by effectively decoupling visible indicators of their commitment to the long-term interests of the firm from the less visible, less easily measured R&D strategy itself. In particular, through selection and approval over projects and activities in R&D, managers have discretion over how exploratory R&D is. Exploratory R&D is characterized by a distant search strategy involving seeking and experimenting with new knowledge and technological components (Fleming, 2001). It broadens the firm's knowledge base, yielding multiple benefits for long-term performance such as generating breakthrough innovations, superior adaptation to complex and changing environments, and staving off organizational myopias and competency traps (Ahuja & Lampert, 2001; Levinthal, 1997; Levinthal & March, 1993; Levitt & March, 1988).

However, to increase the likelihood that R&D activities will boost short-term performance and burnish managerial reputation, managers may choose less exploratory approaches offering more predictable and proximate returns (March, 1991). A more exploitative R&D strategy embodies less distant, more local search; it involves experimenting with familiar or well-established technological components in order to quickly and reliably produce incremental improvements to existing successful innovations (Fleming, 2001). Economic uncertainty is lower since firms can expect to leverage existing organizational assets and value networks (Ahuja & Lampert, 2001; Christensen & Rosenbloom, 1995). The predictability of outcomes also makes it easier for managers to credibly communicate the risk of a given R&D effort, making them more willing to take on activities with uncertain outcomes (Holmström, 1999).

Unlike R&D expenditures, which are highly visible, recorded publicly on income statements, and very easy to monitor, the exploitativeness of R&D strategy is not systematically reported in a standard format, and given the uncertainty inherent to the process, is hard to mechanistically and monitor. Hence, it is possible for managers to visibly conform to the normative expectations around R&D by maintaining or increasing R&D budgets yet pursue less exploratory, more exploitative R&D in order to suit their reputational and career interests. Importantly, this does not presume duplicitous behavior but can simply be a response to the high uncertainty and lack of a clear link between efforts and outcomes in exploratory R&D (Bromley & Powell, 2012; Crilly et al., 2012). The critical insight is that the possibility of decoupling, whatever the underlying motivation, means that any evaluation of the implications of different types of corporate owners must explore outcomes beyond R&D expenditures or patent counts as these measures alone may not fully reflect the extent to which managers prioritize the short-term over the long-term.

Shareholder Monitoring and Decoupling

For decoupling to actually occur, those to whom managers are answerable must fail to prevent it via effective monitoring (Crilly et al., 2012; Marquis & Qian, 2014; Meyer & Rowan, 1977). Whether the kind of decoupling in R&D described above actually occurs depends on the extent to which shareholders are willing and able to incur the costs of gathering and interpreting information beyond simple measures of firm performance. For example, by engaging with firm management in an ongoing rapport (Dobrzynski, 1993; Zhu & Shen, 2016) and carefully analyzing quarterly and annual reports (Bushee & Noe, 2000; Entwistle, 1999), shareholders can craft a better understanding of the merits of R&D strategies in the context of firm fundamentals and industry characteristics. Better-informed shareholders are more likely to discern how R&D efforts contribute to current versus longer-term performance and to distinguish stochastic delays or failures that are par-for-the-course in the R&D process—a byproduct of quality efforts at experimentation (Khanna et al., 2016)—from poor performance that is rightly attributable to poor managerial ability (Aghion et al., 2013; Dobrzynski, 1993). This makes it feasible to evaluate managerial ability independent of the firm's current performance. Shareholders communicate this information to the market via either voice or trading decisions, thereby loosening the link between short-term firm performance and managerial reputation (Aghion et al., 2013; Edmans, 2009). With their reputations and career prospects more insulated from the risks that R&D exploration poses to short-term performance, managers become more willing to actually pursue exploratory R&D (Aghion et al., 2013; Edmans, 2009; Manso, 2011).

The small, fragmented shareholders of the classic B&M corporation—i.e., retail investors—are unlikely to be willing or able to insulate managers from the risks that R&D

exploration poses to short-term performance in this way. A free-rider problem in which the benefit of one shareholder's efforts to improve the value of a firm by gathering costly information about managerial ability accrues to all shareholders weakens the incentive to do so (Edmans, 2009). Furthermore, small shareholders with small ownership stakes are limited in their ability to influence managerial reputation via either voice or trading activity (Edmans, 2009). But institutional investors are large enough to have the means and incentive to engage in costly information-gathering as more of the benefit can be captured by the shareholder (Aghion et al., 2013; Edmans, 2009). The trading decisions of shareholders with larger shares are also more influential; a decision to express either dissatisfaction with or support for firm management is more likely to actually affect managerial reputation (Aghion et al., 2013; Edmans, 2009).

Index Funds' Incentives and Ability for Managerial Oversight

Prima facie index funds appear to be the kind of shareholders that would enable their portfolio firms to both invest in R&D and pursue the kind of exploratory projects that benefit the firm in the long-term. Since their trading decisions are dictated by client purchases and redemptions or the rare change to the composition of the benchmark index itself, they have a weak exit option and investment horizons so long that they have been likened to "permanent" investors. Though their stated objective is to match the returns of a benchmark index, the possibility of increasing overall fund value in the long-run provides incentives to engage in monitoring and stewardship activities for their portfolio firms (Appel et al., 2016; Lewellen & Lewellen, 2022). And while they may not have the power of exit, they do hold relatively large ownership stakes in their portfolio firms, giving them the power of "voice", e.g., voting power, both to enact corporate governance policies and to support managers (Appel et al., 2016).

However, two key characteristics of index funds combine to limit their incentives to incur the costs of the thorough managerial oversight needed to insulate managers from the risks that R&D exploration poses to short-term performance. First, they face a competitive imperative to keep expense ratios as low as possible. The expense ratio is the fee charged annually to fund clients that covers fund operating expenses. Index funds are able to offer especially low expense ratios because they do not have to invest resources into researching, selecting, and closely monitoring stocks. For clients, the low expense ratio is the basis for an index fund's advantage over an actively-managed fund. Since index funds with the same benchmark index are aiming to generate the same gross returns, fund survival requires achieving scale and minimizing fund expenses in order to keep the expense ratio as low as possible. Accordingly, the average asset-weighted expense ratio for U.S. index equity mutual funds plummeted from 27 basis points in 2000 to 6 basis points in 2021 (Investment Company Institute, 2022) as investing in index funds became more popular and competition among index funds intensified. Further reflecting the demand for low-cost funds, over 80% of passively-managed fund assets were held by funds in the lowest quartile of expense ratios (Investment Company Institute, 2022). Thus, limiting the cost of fund operations is a first-order concern for index fund managers.

Second, the free rider problem often associated with shareholder oversight is particularly acute for index fund managers. If an index fund manager seeks costly information about managerial ability, the benefits of those efforts accrue to other shareholders, including direct competitors since funds with the same benchmark index have very similar portfolios. Increasing the expense ratio to cover increased costs would induce an exodus of clients to competitor funds who can offer the same gross return at lower cost. Thus, in combination, the imperative to maintain a low expense ratio and the particularly acute free rider problem create little incentive to incur the costs of thorough managerial oversight.

There are also two structural constraints on their ability to insulate managers from the risks that R&D exploration poses to short-term performance. First, their large portfolios make undertaking efforts to engage managers or to understand the R&D strategies of each portfolio firm exceedingly expensive. Investment management companies typically centralize oversight activities across their index funds with the recognition that there may be significant overlap in portfolio firms across index funds, but their stewardship teams still face monitoring a very large number of firms (Bebchuck & Hirst, 2019). The "Big Three" investment management companies that have dominated the index fund sector—BlackRock, Inc, Vanguard Group, and State Street Global Advisors—each held over 11,000 total firms in their portfolios in 2019, including over 3,000 U.S. firms (Bebchuck & Hirst, 2019). Obtaining costly information about managerial ability for even a subset of firms would require significant resources that their commitment to low operating expenses precludes.

Second, index funds require liquidity to facilitate their nonstrategic approach to trading. The trading decisions of index funds are driven by client purchases and redemptions or the occasional change to the composition of the benchmark index. To keep trading costs low, index funds have a strong preference for liquidity in the stocks in the benchmark index, and therefore they encourage frequent disclosures from their portfolio firms with regard to financial metrics and firm conditions in order to increase liquidity (Schoenfeld, 2017). Flooding the stock market with such disclosures puts even greater emphasis on current performance, exacerbating the managerial incentive to avoid projects or activities that may jeopardize it.

Taken together, these four features make gathering costly information about managerial ability and appropriating the benefits of doing so very difficult for index funds and preclude tailoring corporate governance to the strategic needs of individual portfolio firms. Thus, despite their larger stakes and greater resources relative to retail investors, index funds do not have the incentive and ability to insulate managers from the career risk associated with pursuing R&D exploration that other institutional investors might have. However, this does not imply that index ownership is interchangeable with retail ownership.

Although index funds may be hard-pressed to closely monitor R&D strategy given the above constraints of resources and their own procedural needs, as prominent owners of public corporations index funds face strong normative pressures from external stakeholders to provide effective corporate governance (Fisch, 2022). Abdicating this responsibility would be normatively unacceptable (Meyer and Rowan, 1977). Decoupling, again, provides a solution—namely, espousing good governance visibly and publicly while adapting the actual practice of governance to be consistent with their own interests and limitations. Scholars have noted that decoupling is often accompanied by fervent proclamations and "talk" of commitment to normatively appropriate behavior and broad or generic language (Brunsson, 1989; Crilly et al., 2016; Fiss & Zajac, 2006). Research indeed shows that while index funds prominently vocalize a commitment to good governance in the service of long-term value[5] (Booraeum, 2019; Fink, 2018; Lacaille, 2019), they simultaneously take a low-cost, "check-the-box" approach to governance. They diffuse boilerplate nostrums that are widely accepted as "good" governance in service of long-term value—e.g., independent boards, no antitakeover provisions, no dual class shares—while, in practice, they opt out of deep engagement with individual firms and do not attempt to influence governance practices that might require costly information gathering or accounting for the nuances of each firm's competitive context (Appel et al., 2016). Central to the decoupling at both levels is the relative variation in opacity across these variables (Briscoe & Murphy, 2012). Identifying changes in R&D expenditures is easy for both index-funds and the broader public; identifying changes in R&D exploration is harder for both index funds (the stakeholders for the managers) and broader society (the stakeholders for index funds themselves).

Furthermore, the governance practices that index funds advocate and diffuse in their portfolio firms exacerbate managers' concerns about reputation and career, thereby inhibiting managers' willingness to take on the risks of exploratory R&D. Independent boards have been

[55]In their investor stewardship commentary, Vanguard states, "We have a clear mandate to safeguard and promote long-term shareholder value at the companies in which our funds invest… As a steward, we seek to promote governance practices that drive long-term value for Vanguard-advised funds and their investors." https://corporate.vanguard.com/content/corporatesite/us/en/corp/how-we-advocate/investment-stewardship/index.html. In 2018, BlackRock's CEO claimed, "…our responsibility to engage and vote is more important than ever. In this sense, index investors are the ultimate long-term investors…" https://www.blackrock.com/corporate/investor-relations/2018-larry-fink-ceo-letter.

shown to constrain risk-taking in R&D (Balsmeier et al., 2017; Manso, 2011). Antitakeover provisions such as poison pills and dual class share structures have been found to spur innovation by insulating managers from equity market pressures (Chemmanur & Tian, 2018), implying that removing those provisions reduces firm management's willingness to pursue riskier R&D projects.

Thus, the incentives and constraints of index funds not only suggest that index funds are unlikely to curtail the negative effect of managerial concerns about reputation and career on R&D exploration, but they exacerbate the incentive to "decouple" R&D—to maintain or increase R&D expenditures while shifting R&D strategy away from exploratory approaches—by promoting governance practices that put even more emphasis on measurable short-term firm performance. This generates two refutable hypotheses:

Hypothesis 1: Higher levels of index ownership in a firm do not reduce R&D expenditures.

Hypothesis 2: Higher levels of index ownership in a firm reduce levels of R&D exploration.

METHODS

We analyze patterns in patenting in 1,680 publicly-listed firms from 1991-2015. For index ownership, rather than use a measure of quasi-indexer ownership based on fund group characteristics, we follow recent work examining the implications of index ownership for corporate governance practices and use a measure based on whether individual funds have stated index strategies (e.g., Appel et al., 2016; Gormley et al., 2023). However, this work aggregates three types of index funds flagged by the CRSP mutual fund database—pure index, enhanced index, and index-based—into one measure of "passive ownership." In contrast, we keep pure index ownership disaggregated and focus our empirical analysis on it. Our theoretical arguments pertain to ownership by funds that take the classical approach to index investing, where the object is to produce the return of an underlying index by investing in virtually all securities in that index and weighting portfolios to match the weightings of the index. Trading is nonstrategic, portfolios are large, and expense ratios are low. Only "pure" index funds meet all three of these criteria; enhanced index and index-based funds engage in strategic portfolio selection and aim to beat benchmark indices (CRSP, 2018). We combine enhanced index and index-based funds into a separate control and use it as a kind of placebo test, as we discuss in the results.

To build confidence in our results and interpretation we systematically address the potential sources of endogeneity here (reverse causality, selection and measurement problems) as well as alternative explanations that might drive any observed relationship between index ownership and R&D (Table 4, Appendices A through E). First, we address the (relatively unlikely) possibility that although pure index funds may be nonstrategic traders, index composition algorithms themselves are biased toward R&D investment and against R&D exploration in terms of either selection or weighting mechanisms. To be clear, there is no evidence that any of the indices benchmarked by index funds include R&D strategy in their selection criteria or their weighting mechanisms.[6] But to account for the possibility that selection criteria or weighting mechanisms are inadvertently biased against R&D exploration, we control for various firm characteristics. Most importantly, we control for market capitalization and total sales because most index weighting mechanisms favor higher market capitalization. But it should be noted that size is imperfectly correlated with index ownership overall (see Table 1) because benchmarking indices cover a wide range of firm sizes. We also estimate within-firm effects of pure index ownership. Within-firm variation in index ownership during our sample period was largely generated by the growth in popularity of index investing, requiring index funds to increase their holdings in their portfolio firms as client purchases increased. Within-firm growth is therefore plausibly unrelated to the R&D strategies of the individual firms.

A second alternative explanation for an observed relationship between pure index ownership and R&D investment and exploration is measurement error in CRSP's classification of

[6] For example, the S&P 500, 600, and 400 Indices are among the most popular benchmarking indices. The selection criteria aims to select representative firms rather than the best-performing firms or firms following a particular strategy (S&P Dow Jones Indices Methodology, 2019). Market indices like the Russell 3000 and the Wilshire 5000 are even less likely to have biased selection criteria. Weighting mechanisms are either equal-weight or size-based.

mutual funds. We address the possibility of measurement and selection errors by using the weighted average expense ratio across all mutual funds holding a firm's shares in place of measures of index ownership. We also use total assets under the management of pure index mutual funds as an instrument for pure index ownership (detailed later).

Data Sources and Sample

We combine four major data sources. Compustat provides firm industry affiliation (NAICS), R&D expenditures, sales, and other balance sheet variables. CRSP provides firms' market capitalizations. We combine the Thomson Reuters s12 database with the CRSP mutual fund database to develop measures of mutual fund ownership for each firm. CRSP's mutual fund database provides fund expense ratios. To construct patent-based measures of exploration in R&D, we use Stoffman et al.'s (2022) patent database, which is an update and extension of Kogan et al.'s (2017) patent database.[7] We have also conducted all analyses using the NBER patent database and found the same pattern of results. We report the results using Stoffman et al.'s (2022) data because it offers ten additional years of data during which index fund ownership grew significantly.

The unit of analysis is firm-year. Our sample period starts in 1991 because mutual fund holdings data from Thomson Reuters prior to 1991 is unreliable (Aghion et al., 2013; Appel et al., 2016). Our sample period ends in 2015 in order to minimize the truncation problem arising from the time gap between patent application and approval. The average patent is granted within 22-24 months of the file date (*USPTO Pendency*, 2022), and the data we use from Stoffman et al.'s (2022) patent database was last updated in 2021. There is an important tension in our sample selection process. We use patent-based measures to capture changes in R&D exploration, yet not all firms use patenting as the primary tool for intellectual property protection. Thus, while including the population of publicly-listed firms in our sample minimizes sample selection bias, including hundreds of firms for which technological search efforts are unlikely to be reflected in patenting

[7] This patent database is regularly updated and available at https://www.mikewoeppel.com/data.

activity introduces the possibility of bias. To manage this tension, we run all analyses on two samples. Our "full" sample includes the following 2-digit NAICS industries in which R&D efforts include processes of technological invention and technological inventions are often patented: agricultural forestry, fishing, and hunting; mining, quarrying, and oil and gas extraction; construction; and manufacturing. Our "technology-intensive" subsample includes 9 manufacturing industries identified at the 4-digit NAICS level in which R&D is especially normatively important and patenting is more likely to be a primary tool for protecting intellectual property.[8]

For both the full and technology-intensive samples, we eliminate firms that have missing or inconsistent institutional ownership data. To address the possibility that firms that never patent and/or never have any index ownership drive our results, we restrict both samples to firms that patented at least once in our sample period, had positive R&D expenditures each year, and have nonzero index ownership at some point during our sample period. The resulting full sample consists of 1,680 firms while the nine-industry subsample consists of 1,067 firms.

Dependent Variables

We create a variable for annual *R&D* spending using Compustat data. To capture exploration in R&D, we use a set of measures based on the patents filed by a firm in a given year. *Number of exploratory patents* is the sum of three types of patents that each reflect a type of exploration: the number of potentially radical patents, the number of patents citing unfamiliar technology, and the number of patents citing emerging technology. These three components of exploration are drawn from prior research and defined below. Unlike R&D expenditures, patent counts, and forward patent citations, they directly capture exploration of new domains, which is indicative of a more exploratory, higher-risk R&D strategy. Some patents may be double-counted or triple-counted as exploratory patents because a given patent might be potentially radical, cite

[8] The nine technology-intensive industries are: pharmaceutical and medicine; industrial machinery; computer and peripheral equipment; communications equipment; audio and video equipment; semiconductor and other electronic components; navigational, measuring, electromedical, and control instruments; other electrical equipment and components; and medical equipment and supplies.

unfamiliar technology, and cite emerging technology. This gives greater weight to patents that are indicative of exploration on multiple dimensions.

Number of potentially radical patents captures the type of exploration that involves drawing on knowledge that is fundamentally new to the field (Ahuja & Lampert, 2001; Dewar & Dutton, 1986; Eggers & Kaul, 2018; Henderson, 1993). To measure the degree to which a firm pursues this form of exploration, we use the number of potentially radical patents as defined by Eggers and Kaul (2018). A patent is potentially radical if its "distant" score is above the 90th percentile in any given year. The distant score of patent p in technology class i is given.

$$DISTANT_p = 1 - \min_{\mathrm{J_p}} \left\{ LINK_{ij} = \frac{\sum_{-5}^{-1} citations_{tij}}{\sum_{-5}^{-1} citations_{ti}} \right\}$$

for each technology class $j \in J_p$, where J_p is the set of technology classes cited by patent p, and $LINK_{ij}$ is the percentage of citations made by all patents in technology class i to technology class j in the prior five years. The lower $LINK_{ij}$, the less frequently patents in technology class i have cited technology class j, indicating a more distant the search effort.

Number of patents citing unfamiliar technology captures a type of exploration that involves drawing on knowledge or technology that is new to the firm, regardless of whether it is new to the field (Ahuja & Lampert, 2001). We count the number of patents citing unfamiliar technology, where a patent cites unfamiliar technology if it cites a patent class which the firm has not cited in the past five years. *Number of patents citing emerging technology* captures a type of exploration involves drawing on emerging technologies (Ahuja & Lampert, 2001). We count the number of patents citing emerging technology, where a patent is defined to be citing emerging technology if the average age of patents cited by the focal patent is less than two years.

Ownership Variables

Percent pure index mutual fund ownership is the percentage of a firm's common shares held by pure index mutual funds and ETFs. The objective of a pure index fund is "to match the total investment performance of a publicly recognized securities market index. The fund will hold virtually all securities in the noted index with weightings equal to those in the index," (CRSP, 2018, p. 8). CRSP flags these funds for the sample 1998-2015 but does not populate the pure index fund flag prior to 1998. We assume that funds identified as pure index funds by CRSP in 1998 operated as pure index funds prior to 1998. The consistency of fund characteristics—name, the number of stocks, and expense ratio—across the whole sample period supports this assumption.

Percent other index mutual fund ownership is the percentage of a firm's common shares held by non-pure index mutual funds and ETFs. This includes index-based and enhanced index funds as identified by CRSP. We assumed that funds identified by CRSP as such in 1998 operated as index-based funds prior to 1998; the consistency of fund characteristics supports this assumption. We followed prior literature in using string analysis of fund names to identify any index funds that may not have been flagged by CRSP.[9] We included these in this "other index" category because both the average number of firms held by string-identified index funds and the average expense ratio are more similar to index-based and enhanced index funds than pure index funds. We combined these three types into one "other" category for parsimony and because ownership by these funds is relatively small; however, the results are robust to disaggregation.

Percent active mutual fund ownership is the percentage of a firm's common shares held by actively-managed mutual funds. Following prior literature (e.g., Appel et al., 2016), we categorized any mutual fund in the CRSP database as actively-managed if it was neither flagged by CRSP as a type of index fund nor flagged as an index fund in our string analysis. *Percent unclassified mutual fund ownership* is the percentage of a firm's common shares held by the small number of mutual funds that did not find a match in the CRSP database. This means do we do not have expense ratio data for them. We followed prior literature (e.g., Appel et al., 2016) and included a control for ownership by any such funds that were not flagged as an index fund by the

[9] We followed Appel, Gormley, and Keim (2016) in searching fund names for the following strings in both upper and lower cases: "INDEX", "IDX", "S&P", "S & P", "SANDP", "S AND P", "SP 500", "SP 600", "SP 400", "SP 900", "SP 1000", "SP 1500", and "WILSHIRE".

string analysis. *Percent non-mutual fund institutional ownership* is the percentage of a firm's common shares held by institutional investors that are not mutual funds.

Figures 1 and 2 show that pure index mutual funds are consistent with both our characterization of index funds and CRSP's definitions: they hold a higher number of firms in their portfolios but have lower expense ratios than other-index mutual funds, actively-managed mutual funds, and unclassified mutual funds. These figures also demonstrate that disaggregating pure index funds from other types of index funds is important; pure index funds most starkly exhibit the characteristics typically assigned to passively-managed funds more broadly.

--- INSERT FIGURES 1 & 2 HERE ---

Control Variables

Prior research suggests that analyst coverage may influence both the magnitude and direction of R&D (Benner, 2010; Benner & Ranganathan, 2012; He & Tian, 2013). Therefore, we control for *analyst coverage* using the average number of analysts that covered firm k in year t obtained from the I/B/E/S database. We also conditioned on the following firm characteristics at the end of year t: *market capitalization*, *sales*, the *capital-labor ratio*, and *cashflow per share*. To account for the possibility that firms with a larger knowledge base may be more likely to take risks in R&D because it is more likely to pay off (Katila & Ahuja, 2002), we include *R&D stock* as described in Hall, Jaffe, and Trajtenberg (2005) as a proxy for cumulative knowledge (Aghion et al., 2013).[10] To account for differences in the patenting patterns across firms, we include *patent stock*, which is the average number of patents over the prior three years. To account for the possibility that our results are driven by a general trend toward less exploration over time, we follow Arora et al. (2018) and include a decade-level *time* trend variable. In models with firm fixed effects, we include two measures of industry conditions: average industry sales in the prior three

[10] R&D stock for firm i in year t is $(1 - \delta)-1 + Rt$, where Gt is the lagged R&D stock, δ is the private depreciation rate of knowledge, and Rt is the R&D expenditures for year t.

years and product market competition.[11]

Estimation

Our main models estimate the effect of index ownership on (1) R&D expenditures and (2) the number of exploratory patents. We followed recent literature (e.g., Arora et al., 2018, 2021) by estimating OLS models for these main analyses such that

$$\ln(R\&D_{it+1}) = \alpha \ln(\%\ Pure\ Index\ MF\ ownership_{it}) + \boldsymbol{\theta x}_{it} + \psi_{\mathrm{i}} + \sigma \qquad (1)$$

$$\ln(1 + \#\ Exploratory\ Patents_{it+2}) = \beta \ln(\%\ Pure\ Index\ MF\ ownership_{it}) + \boldsymbol{\phi x}_{it} + \delta_i + \epsilon \qquad (2)$$

where $\boldsymbol{x}_{it}$ is the set of control variables for firm i in year t; ψ_i and δ_i are firm fixed effects; and σ and ϵ are error terms. We implement a one-year lag structure for the R&D models but a two-year lag structure for patent models to account for the time required for a change in R&D search strategy to be reflected in patent applications. For robustness, we report estimates of alternative lag structures in Appendix A. This includes a distributed lag model with the lagged year-to-year changes in pure index ownership, which allows us to more carefully examine how any effect evolves over time and to take an additional step towards accounting for time trends in the data. In Appendix B, we report negative binomial models for the number of exploratory patents.

RESULTS

Figure 3 shows that pure index mutual fund ownership consistently increased during our sample period. In our sample, an average of 0.1 percent of a firm's shares were held by pure index mutual funds in 1991, increasing to 7.1 percent by 2013. Pure index mutual funds collectively held more of a firm's shares than any single actively-managed institutional shareholder in only 0.1 percent of firms in 1991, but reached 38.6 percent in 2013.[12]

--- INSERT FIGURE 3 HERE ---

[11] We follow Aghion et al. (2013) in measuring industry product market competition as 1-Lerner Index in the four-digit NAICS industry.

[12] This statistic was calculated by identifying firms for which the total shares held by pure index mutual funds is larger than (1) the maximum shares held by any single actively-managed mutual fund and (2) the maximum shares held by any single non-mutual fund institutional investor. The maximum shares held by any single actively-managed mutual fund were calculated at the fund level based on S12 data. However, the maximum shares held by any single non-mutual fund investors were calculated at the fund institution level based on S13 data.

Correlations in Tables 1 and 2 are broadly consistent with the established view that average index ownership grew mechanically as an increase in the popularity of index investing among households and individuals produced an influx of cash to index funds, requiring index funds to buy more shares in the firms comprising their benchmark indices (Appel et al., 2016; Davis, 2008). In Table 1, the correlation between pure index ownership and retail ownership is -0.51 while correlations between pure index ownership and other types of institutional ownership are positive. The correlations between year-over-year changes in ownership in Table 2 are generally smaller; the correlation between pure index ownership and retail is -0.10.

--- INSERT TABLES 1 & 2 ---

Main Results

Table 3 presents the estimated effect of pure index ownership on the magnitude and direction of R&D. Retail ownership is the baseline ownership category. The estimated coefficients on pure index mutual fund ownership can be interpreted as the percent increase in R&D expenditures or exploratory patenting associated with a one percent increase in pure index fund ownership, holding types of institutional ownership constant. Columns (1)-(4) display the estimates for the R&D expenditure models. Column (1) estimates include industry fixed effects. Column (2) includes firm fixed effects. Column (3) adds an interaction between an indicator for technology-intensive industries and pure index mutual fund ownership. Column (4) displays the technology-intensive subsample estimates.

Columns (5)-(9) display the estimates for the exploratory patenting models. The dependent variable is the log of one plus the number of exploratory patents. Column (5) includes industry fixed effects, and Column (6) includes firm fixed effects. Column (7) includes overall patent output in year $t+2$ as an offset variable, meaning the coefficient for over overall patent output is constrained to 1. The estimated coefficients can be interpreted as the effect on exploratory patents relative to total patent output. Columns (8) and (9) show the technologically-intensive subsample estimates without and with the patent control, respectively.

--- INSERT TABLE 3 ---

Looking across the columns, there is broad support for our predictions. Increases in pure index ownership are associated with increases in R&D expenditures, particularly in technology-intensive industries but less exploratory patenting. For example, Column (2) indicates that a 1.00 percent increase in pure index mutual fund ownership is associated with a 0.06 percent increase in R&D investment (p=0.070). To contextualize this effect, a one-standard deviation increase in pure index mutual fund ownership (2.71 percentage points) above the mean (1.93 percent pure index fund ownership) is associated with a 5.5 percent increase in R&D investment.

Column (3) shows that the effect of pure index ownership is significantly stronger in technology-intensive industries (p=0.010). The coefficient on pure index ownership is actually insignificant (p=0.831) and negative for industries that are less technology intensive. This is consistent with the proposed mechanism; our argument for a positive relationship between pure index ownership and R&D expenditures is predicated on a normative expectation that managers invest in R&D. The normative expectation is weaker in less technology-intensive industries (Ahuja & Novelli, 2017; Bromley & Powell, 2012), and so the relationship between pure index ownership and R&D expenditures should be weaker as well. Column (4) indicates that, for technology-intensive industries, a one-standard deviation increase in pure index mutual fund ownership above the mean is associated with a 10.3 percent increase in R&D (p=0.010).

Columns (6) and (7) indicate that a one-standard deviation increase in pure index mutual fund ownership above the mean is associated with a 14.2 percent decrease in exploratory patenting (p=0.000) and a 10.5 percent decrease in the number of exploratory patents relative to total patent output (p=0.000). Columns (8) and (9) indicate that, for technology-intensive industries, a one-standard deviation increase in pure index mutual fund ownership above the mean is associated with a 12.2 percent decrease in exploratory patenting (p=0.000) and an 8.7 percent decrease in the number of exploratory patents relative to total patent output (p=0.000).

The pattern of results is robust to estimation with alternative lag structures and a distributed lag model, reported in Appendix A, and to estimation of negative binomial models, reported in

Appendix B. In Appendix C, analyses estimating the effect of pure index mutual fund ownership on exploitative patent productivity and the percent of patents that are exploratory provide further evidence of a shift away from exploratory R&D as pure index mutual fund ownership increases.

Placebo Test

In each of the models in Columns (1)-(8), "other" index mutual fund ownership provides a sort of placebo test for the effect of pure index ownership. Since neither enhanced index nor index-based funds operate as nonstrategic traders, have such large portfolios, or face such strong pressures to keep fees low, our predictions do not apply to "other" index ownership. Indeed, we find that, if anything, other index mutual fund ownership has a negative effect on R&D investment and no significant effect on R&D exploration. Wald tests of the equivalence of the coefficients consistently reject the hypothesis that other index mutual fund ownership has the same effect on R&D as pure index mutual fund ownership. The analysis also reinforces the importance of disaggregating index ownership, which has not been done in prior research.

Types of Distant Search

We also estimated models with each of the three component variables of exploratory patenting as the dependent variable in Appendix D. We find that the decrease in exploratory patenting as index ownership increases is driven by decreases in potentially radical patents and patents citing unfamiliar technology. The effect on patents citing emerging technology is statistically insignificant but positive. As we discuss in more detail in Appendix D, this likely reflects that the measure is a relatively noisy indicator of R&D exploration because, for example, the distance between the emerging technology that is being cited and a firm's existing knowledge and capability base may vary quite a bit.

Addressing Measurement Error and Selection

We address concerns about measurement error in the classification of mutual funds in two ways, presented in Table 4. First, in columns (1)-(4), we use the weighted average expense ratio across all mutual funds holding a firm's shares as an alternative independent variable:

$$Weighted\ Average\ Expense\ Ratio_{kt} = \frac{1}{S_{kt}} \sum_{i=1}^{S_{kt}} e_{ikt} * s_{ikt}$$

where e_{ikt} is the expense ratio for mutual fund i holding shares in firm k in year t, s_{ikt} is the number of shares held by mutual fund i in firm k in year t, and S_{kt} is the total number of shares outstanding held by mutual funds in firm k in year t. Since pure index funds have lower expense ratios than other types of mutual funds, we expect a negative relationship between the weighted average expense ratio and R&D investment and a positive relationship with exploratory patents. But because the weighted average expense ratio reflects the relative distribution of pure index fund ownership for a given level of mutual fund ownership, we expect these predicted relationships to be moderated by the total percentage of a firm's shares held by mutual funds. The relative distribution of mutual fund ownership between pure index and other funds should matter much less for firms that have only 0.5 percent mutual fund ownership than for firms with 50 percent.

To interpret the marginal effects in these models, we examine the response surface in Figures 4 and 5. The average share of a firm held by mutual funds in our sample is 11.2 percent with standard deviation of 9.8 percentage points. As expected, as the percent of total mutual fund ownership increases, the relationships between the weighted average expense ratio and R&D measures become stronger. Given 11.2 percent mutual fund ownership, a one-standard deviation decrease in the weighted average expense ratio below the mean is associated with a 10.9 percent increase in R&D (p=0.057) and a 24.0 percent decrease in exploratory patents per patent (p=0.000). In the technology-intensive industries subsample, a one-standard deviation decrease in the weighted average expense ratio below the mean is associated with a 24.9 percent increase in R&D (p=0.000) and a 13.4 percent decrease in exploratory patents per patent (p=0.000).

--- INSERT FIGURES 4 & 5 --

We also estimate two-staged least squares (2SLS) models in Columns (5)-(10) of Table 4, using total assets under the management of pure index mutual funds in a given year as an instrument for pure index mutual fund ownership. Within a given firm listed in a given index, pure index fund ownership must grow mechanically as pure index mutual funds tracking that index receive influxes of cash in the form of client purchases, meaning they must buy more shares in the firms comprising the benchmark indices (Appel et al., 2016; Davis, 2008). Therefore, since index membership is quite stable over this period (for instance, average tenure of a stock in the S&P 500 over the study period is over 21 years per Statista data), variation in the total assets under the management (AUM) of pure index funds tracking that index should explain variation in the level of pure index mutual fund ownership for that firm. Yet there is little reason to believe that this variation in total AUM is driven by the R&D strategy of the individual firm, satisfying the exclusion restriction. With this logic in mind, for each firm-year observation, we calculate the AUM of pure index mutual funds whose benchmark indices include that firm. To address the concern that AUM might vary with economic conditions, which may affect management's willingness to take risks, we include annual GDP growth in addition to our usual controls for industry conditions, product market competition and average industry sales in the prior three years. Appendix E discusses the instrument and the subsample we use for this analysis due to data constraints in much more detail.

Columns (5) and (8) show that, as in the full sample, there is a positive relationship between pure index mutual fund ownership and R&D investment but a negative relationship with exploratory patenting. The relationship between pure index mutual fund ownership and exploratory patenting is actually statistically insignificant (p=0.205), but it is significantly negative (p=0.021) in the technology-intensive subsample analyses shown in Table E in Appendix E. Columns (6) and (9) are the first stage estimates in which the log of pure index mutual fund ownership is regressed on pure index mutual fund assets. There is no indication that pure index mutual fund assets is a weak instrument. Pure index mutual fund assets strongly predicts pure index mutual fund ownership, with p-values less than 0.001, and explains a large portion of the variation in pure index mutual fund ownership, with adjusted R-squared values of at least 0.64. Kleibergen-Paap F-statistics are above 400, far exceeding the Stock and Yogo (2005) critical values (ranging between 5.53 and 16.38) and thereby providing a strong rejection of the null that the instrument is weak. Second stage estimates in columns (7) and (10) show that our predictions still hold. A one-standard deviation increase in pure index mutual fund ownership above the mean is associated with a 41.2 percent increase in R&D investment (p=0.000) and a 15.3 percent decrease in exploratory patents relative to total patent output (p=0.001).

--- INSERT TABLE 4 ---

DISCUSSION AND CONCLUSION

We examined the effect of index fund ownership on corporate R&D quantum and direction. Our theory and results have implications for the literatures on symbolic management, corporate governance, and exploration. We extend symbolic management ideas to the innovation domain and theorize and find that index ownership increases overall R&D expenditures, especially in technology-intensive industries, but decreases R&D exploration. The former is highly visible, recorded publicly on income statements, and very easy to monitor. The latter is not systematically reported and much harder to measure and monitor. This makes it possible for managers to effectively decouple—to support the principle of a long-term perspective visibly through their R&D expenditures while simultaneously reducing the risk to reputation and career that may accompany extensive R&D exploration. Index fund ownership facilitates this decoupling. Index funds face limitations on how closely they can monitor and provide customized governance to individual firms given the number of firms they own and their commitment to low expense ratios. This commitment effectively bounds governance budgets, constraining their ability both to call out managerial decoupling in their portfolio firms and to foster managerial risk-taking.

Consistent with Crilly et al. (2012), our explanation for the above decoupling occurs through a multilevel analysis and invokes asymmetric information. Both corporate managers and index fund owners are part of the decoupling of R&D magnitude from its degree of exploration because the fund owners cannot easily observe or measure the manager's exploratory risk-taking. However, in our setting, we identify another level of simultaneous decoupling: the index-fund owners are engaged in a decoupling of their own. Despite the competitive imperative to keep expense ratios low, index funds face normative pressures to fulfill their mandate to be responsible owners (Bebchuck & Hirst, 2019; Fisch, 2022). Decoupling allows index funds to respond with broad platforms highlighting appropriate-sounding "good governance practices" in very visible and public ways (Booraeum, 2019; Fink, 2018; Lacaille, 2019) while reducing the pressure to actually conduct costly, customized governance in the corporations they own. Collectively, these multiple levels of decoupling in the governance-management chain of the index fund world provide a novel illustration of the hierarchies of decoupling in corporate governance as posited by scholars (Westphal & Park, 2020). Furthermore, past work has suggested several explanations for what makes decoupling possible for agents: asymmetric information (Crilly et al., 2012), organizational learning (Crilly et al., 2012), and stakeholders or principals turning a blind eye (Meyer & Rowan, 1977). We add a new explanation and insight: the stakeholders or principals may be limited in their ability to check decoupling because they are subject to normative pressures themselves and decoupling may be central to their own stakeholder management strategies. We thus identify an unusual cause of a common problem. Traditionally, incentive *misalignment* between principals and agents is held responsible for potentially adverse outcomes, but we identify a situation in which incentive *alignment* does so–these multiple levels of decoupling suit both parties.

Since the 1980s, the Berle and Means (B&M) corporation with diffused ownership has given way to a new empirical reality in which institutional investors increasingly dominate ownership of public corporations with concentrated holdings, raising questions anew about how significantly shareholders might influence corporate governance and managerial decision-making (Davis, 2008), potentially mitigating the B&M problem. Yet our research suggests that the continuing rise of index investing raises the possibility of a partial return to a Berle and Means world. Ownership may no longer be diffuse, but the resources to engage in stewardship are increasingly limited. The title of this paper draws attention to the core conflict that index funds pose: their effects on firm R&D strategy operate partly through the same mechanisms that provide their investment benefit for retail investors: broad portfolios and low expense ratios. The former ensures replication of the market return, and the latter improves shareholder net benefits; but jointly, they also limit the resources for good stewardship of the individual corporation. In other words, you get what you pay for. If good governance is a desired attribute of corporate owners, then a race to the bottom on governance costs is unlikely to yield it.

Our results give merit to recent concerns about index funds' low-cost, one-size-fits-all approach to corporate governance (Appel et al., 2016; Gormley et al., 2023; Rock & Kahan, 2021). The corporate governance guidance that index funds do provide only exacerbates incentives to decouple R&D strategy from R&D investment (e.g., Balsmeier et al., 2017; Keum, 2021). Thus, we complement a broader stream of research that has highlighted how functional innovations or institutional practices may generate unintended and possibly dysfunctional consequences (e.g., Balsmeier et al., 2017; Kaul et al., 2018; Keum, 2021). There is an old adage in the military: every general fights the last war. Index funds are implementing current corporate governance orthodoxy at scale (Appel et al., 2016; Gormley et al., 2023) just as research increasingly raises the possibility that corporate governance best practices may need to be reexamined in the context of technology-intensive industries and a technologically dynamic economy (Balsmeier et al., 2017; Keum, 2021). Our findings show there are real-economy consequences of this trend, underlining the need for index funds—and potentially other institutional investors—to review how well corporate governance principles set up for more stable, mature companies with the goal of minimizing manager abuse of cash flow apply to dynamic, technology-intensive sectors.

Finally, we contribute to the search and learning literature by highlighting ownership composition as an important factor in the extent to which firms pursue exploration in R&D. It has long been established that a key appeal of exploitation over exploration is the more predictable and immediate returns (Ahuja & Lampert, 2001; Cohen & Levinthal, 1990; Levinthal & March, 1993; March, 1991), implying that short-term performance commands priority for firm managers.

Much of the prior work on exploration and search focuses on how certain organizational characteristics counteract or exacerbate the learning traps and inertial tendencies that lead to more exploitative, local search processes in R&D, implicitly taking this preference for the short-term as given. This paper articulates how ownership structure may exacerbate these tendencies in the R&D context, portending such an effect with respect to other types of risky, long-horizon investments.

It is important to note what our results do not speak to as well. Our results do not establish that ownership by index funds leads to bad research investment decisions by firm management, even in the narrow context that we examine, as that is beyond the scope if this study. Nor can our study be taken as evidence that the observed reduction in exploration is a prima facie indicator or precursor of a broader decline in national technological competitiveness. Even if we assume that less exploration implies lower technological advantage (which we do not study or establish), our study only covers publicly-listed firms. It may well be that within the national innovation system this purported "deficiency" already stands corrected via the division of innovative labor across different actors, where start-ups, private firms, universities, or some combination thereof have shifted toward greater exploration. However, our research draws attention to the need to keep this effect of index ownership in mind in broader evaluations of innovation in the United States.

In conclusion, the sheer scale and speed of index fund ownership growth and the likelihood that the incentive and ability mechanisms identified by us could be affecting other corporate outcomes beyond R&D exploration suggests urgency is merited in examining the consequences of this index ownership for corporations. Exploration and managerial risk-taking are not just relevant to R&D; many outcomes for society at large entail long-term oriented corporate risk-taking. If larger and larger swathes of corporate America are controlled by index funds, thereby putting the beneficial outcomes of exploration at risk, then what is the true cost of this financial innovation for the real economy? Our paper is not positioned to answer that question but draws attention to its importance and urgency.

REFERENCES

Aghion, P., Van Reenen, J., & Zingales, L. (2013). Innovation and institutional ownership. *American Economic Review*, *103*(1), 277–304.
Ahuja, G., & Lampert, C. M. (2001). Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal*, *22*(6–7), 521–543.
Ahuja, G., & Novelli, E. (2017). Activity overinvestment: The case of R&D. *Journal of Management*, *43*(8), 2456–2468.
Allison, P. D., & Waterman, R. P. (2002). Fixed–effects negative binomial regression models. *Sociological Methodology*, *32*(1), 247–265.
Appel, I. R., Gormley, T. A., & Keim, D. B. (2016). Passive investors, not passive owners. *Journal of Financial Economics*, *121*(1), 111–141.
Appel, I. R., Gormley, T. A., & Keim, D. B. (2019). Standing on the shoulders of giants: The effect of passive investors on activism. *Review of Financial Studies*, *32*(7), 2720–2774.
Arora, A., Belenzon, S., & Patacconi, A. (2018). The decline of science in corporate R&D. *Strategic Management Journal*, *39*(1), 3–32.
Arora, A., Belenzon, S., & Sheer, L. (2021). Knowledge Spillovers and Corporate Investment in Scientific Research. *American Economic Review*, *111*(3), 871–898.
Arrow, K. (1962). Economic Welfare and the Allocation of Resources to Invention. NBER and the Committee on Economic Growth of the Social Science Research Councils (Ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors* (pp. 467–492). Princeton Univ Press.
Asker, J., Farre-Mensa, J., & Ljungqvist, A. (2015). Corporate investment and stock market listing: A puzzle? *Review of Financial Studies*, *28*(2), 342–390.
Azar, J., Duro, M., Kadach, I., & Ormazabal, G. (2021). The Big Three and corporate carbon emissions around the world. *Journal of Financial Economics, 142*(2), 674–696.
Balsmeier, B., Fleming, L., & Manso, G. (2017). Independent boards and innovation. *Journal of Financial Economics*, *123*(3), 536–557.
Baysinger, B. D., Kosnik, R. D., & Turk, T. A. (1991). Effects of board and ownership structure on corporate R&D strategy. *Academy of Management Journal*, *34*(1), 205–214.
Bebchuck, L., & Hirst, S. (2019). Index funds and the future of corporate governance: Theory, evidence, and policy. *Columbia Law Review*, *119*(8), 2029–2145.
Bebchuck, L., & Stole, L. A. (1993). Do short-term objectives lead to under- or overinvestment in long-term projects? *Journal of Finance*, *48*(2), 719–729.
Benner, M. J. (2010). Securities analysts and incumbent response to radical technological change: Evidence from digital photography and internet telephony. *Organization Science*,
Benner, M. J., & Ranganathan, R. (2012). Offsetting illegitimacy? How pressures from securities analysts influence incumbents in the face of new technologies. *AMJ*, *55*(1), 213–233.
Bernstein, S. (2015). Does going public affect innovation? *Journal of Finance*,*70*(4), 1365–1403.
Blundell, R., Griffith, R., & van Reenen, J. (1999). Market share, market value and innovation in a panel of British manufacturing firms. *The Review of Economic Studies*, *66*(3), 529–554.
Booraeum, G. (2019, April). *What we do. How we do it. Why it matters. Vanguard Investment Stewardship Commentary*. https://www.institutional.vanguard.co.uk/documents/vg-investment-stewardship-why-it-matters.pdf
Briscoe, F., & Murphy, C. (2012). Sleight of Hand? Practice Opacity, Third-party Responses, and the Interorganizational Diffusion of Controversial Practices. *Administrative Science Quarterly*, *57*(4), 553–584.
Bromley, P., & Powell, W. W. (2012). From Smoke and Mirrors to Walking the Talk: Decoupling in the Contemporary World. *Academy of Management Annals*, *6*(1), 483–530.
Brunsson, N. (1989). *The Organization of Hypocrisy: Talk, Decisions and Actions in Organizations*. Wiley.
Bushee, B. J. (1998). The influence of institutional investors on myopic R&D investment behavior. *The Accounting Review*, *73*(3), 305–333.
Bushee, B. J. (2001). Do Institutional Investors Prefer Near-Term Earnings over Long-Run

Value?. *Contemporary Accounting Research*, *18*(2), 207–246.
Bushee, B. J., & Noe, C. F. (2000). Corporate disclosure practices, institutional investors, and stock return volatility. *Journal of Accounting Research*, *38*, 171–202.
Campbell, T. S., & Marino, A. M. (1994). Myopic investment decisions and competitive labor markets. *International Economic Review*, *35*(4), 855–875.
Cannella, A. A., Fraser, D. R., & Lee, D. S. (1995). Firm failure and managerial labor markets evidence from Texas banking. *Journal of Financial Economics*, *38*(2), 185–210.
Carhart, M. M. (1997). On persistence in mutual fund performance. *J of Finance*, *52*(1), 57–82.
Chemmanur, T. J., & Tian, X. (2018). Do antitakeover provisions spur corporate innovation? A regression discontinuity analysis. *Journal of Finan and Quanti Analysis*, *53*(3), 1163–1194.
Christensen, C. M., & Rosenbloom, R. S. (1995). Explaining the attacker's advantage: Technological paradigms, organizational dynamics, and the value network. *Research Policy*, *24*(2), 233–257.
Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152.
Crilly, D., Hansen, M., & Zollo, M. (2016). The Grammar of Decoupling: A Cognitive-Linguistic Perspective on Firms' Sustainability Claims and Stakeholders' Interpretation. *Academy of Management Journal*, *59*(2), 705–729.
Crilly, D., Zollo, M., & Hansen, M. T. (2012). Faking it or muddling through? Understanding decoupling in response to stakeholder pressures. *Acad of Man Journal*, *55*(6), 1429–1448.
CRSP. (2018). *Survivor-Bias-Free US Mutual Fund Guide for CRSPSift*. Wharton Research Data Services.
Davis, G. F. (2008). A new finance capitalism? Mutual funds and ownership re-concentration in the United States. *European Management Review*, *5*(1), 11–21.
Dewar, R. D., & Dutton, J. E. (1986). The adoption of radical and incremental innovations: An empirical analysis. *Management Science*, *32*(11), 1422–1433.
DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Rev*, *48*(2), 147–160.
Dobrzynski, J. H. (1993, March). Relationship investing. *Business Week*, 68–75.
Ederer, F., & Manso, G. (2013). Is pay for performance detrimental to innovation? *Management Science*, *59*(7), 1496–1513.
Edmans, A. (2009). Blockholder trading, market efficiency, and managerial myopia. *Journal of Finance*, *64*(6), 2481–2513.
Eggers, J. P., & Kaul, A. (2018). Motivation and ability? A behavioral perspective on the pursuit of radical invention in multi-technology incumbents. *Acad of Manag Journal*, *61*(1),67–93.
Eng, L. L., & Shackell, M. (2001). The implications of long-term performance Plans and Institutional ownership for firms' research and development (R&D) investments. *Journal of Accounting, Auditing & Finance*, *16*(2), 117–139.
Entwistle, G. M. (1999). Exploring the R&D disclosure environment. *Accounting Horizons*, *13*(4), 323–342.
Fama, E. F., & French, K. R. (2010). Luck versus Skill in the Cross-Section of mutual fund returns. *Journal of Finance*, *65*(5), 1915–1947.
Fee, C. E., & Hadlock, C. J. (2004). Management turnover across the corporate hierarchy. *Journal of Accounting and Economics*, *37*(1), 3–38.
Ferreira, D., Manso, G., & Silva, A. C. (2014). Incentives to innovate and the decision to go oublic or private. *Review of Financial Studies*, *27*(1), 256–300.
Fink, L. (2018). *Larry Fink's 2018 letter to CEOs*. BlackRock. https://www.blackrock.com/corporate/investor-relations/2018-larry-fink-ceo-letter
Fisch, J. (2022). The Uncertain Stewardship Potential of Index Funds. In D. W. Puchniak & D. Katelouzou (Eds.), *Global Shareholder Stewardship* (pp. 454–470). Cambridge Univ Press.
Fiss, P. C., & Zajac, E. J. (2006). The Symbolic Management of Strategic Change: Sensegiving Via Framing and Decoupling. *Academy of Management Journal*, *49*(6), 1173–1193.
Fleming, L. (2001). Recombinant uncertainty in technological search. *Management Science*, *47*(1), 117–132.

Francis, J., & Smith, A. (1995). Agency costs and innovation some empirical evidence. *Journal of Accounting and Economics*, *19*(2), 383–409.
Fredrickson, J. W., Hambrick, D. C., & Baumrin, S. (1988). A model of CEO dismissal. *Academy of Management Review*, *13*(2), 255–270.
Gibbons, R., & Murphy, K. J. (1992). Optimal incentive contracts in the presence of career concerns: Theory and evidence. *Journal of Political Economy*, *100*(3), 468–505.
Gilson, S. C. (1989). Management turnover and financial distress. *Journal of Financial Economics*, *25*(2), 241–262.
Gormley, T. A., Gupta, V. K., Matsa, D. A., Mortal, S. C., & Yang, L. (2022). *The Big Three and Board Gender Diversity: The Effectiveness of Shareholder Voice* (Working Paper 30657). National Bureau of Economic Research.
Gormley, T. A., Gupta, V. K., Matsa, D. A., Mortal, S. C., & Yang, L. (2023). The Big Three and board gender diversity: The effectiveness of shareholder voice. *Journal of Financial Economics*, *149*(2), 323–348.
Graffin, S. D., & Ward, A. J. (2010). Certifications and reputation: Determining the standard of desirability amidst uncertainty. *Organization Science*, *21*(2), 331–346.
Graham, J. R., Harvey, C. R., & Rajgopal, S. (2005). The economic implications of corporate financial reporting. *Journal of Accounting and Economics*, *40*(1), 3–73.
Greene, W. (2004). Fixed effects and bias due to the incidental parameters problem in the tobit model. *Econometric Reviews*, *23*(2), 125–147.
Hall, B. H., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations. *The RAND Journal of Economics*, *36*(1), 16–38.
Hall, B. H., Mairesse, J., & Mohnen, P. (2010). Measuring the returns to R&D (pp. 1033–1082) *Handbook of the Economics of Innovation*. Elsevier. https://econpapers.repec.org/bookchap/eeehaechp/v2_5f1033.htm
He, J. (Jack), & Tian, X. (2013). The dark side of analyst coverage: The case of innovation. *Journal of Financial Economics*, *109*(3), 856–878.
Henderson, R. M. (1993). Underinvestment and incompetence as responses to radical innovation: Evidence from the photolithographic alignment equipment industry. *The RAND Journal of Economics*, *24*(2), 248–270.
Holmström, B. (1989). Agency costs and innovation. *Journal of Economic Behavior & Organization*, *12*(3), 305–327.
Holmström, B. (1999). Managerial incentive problems: A dynamic perspective. *The Review of Economic Studies*, *66*(1), 169–182.
Investment Company Institute. (2022). *Investment Company Factbook: A Review of Trends and Activities in the Investment Company Industry* (p. 262). Investment Company Institute. https://www.ici.org/doc-server/pdf%3A2022_factbook.pdf
Kaplan, S. N., & Minton, B. (2006). *How has CEO turnover changed? Increasingly performance sensitive boards and increasingly uneasy CEOs* (Working Paper 12465). NBER.
Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Acad of Management Journal*, *45*(6), 1183–1194.
Kaul, A., Nary, P., & Singh, H. (2018). Who does private equity buy? Evidence on the role of private equity from buyouts of divested businesses. *Strat Manag Journ*, *39*(5), 1268–1298.
Keum, D. D. (2021). Innovation, short-termism, and the cost of strong corporate governance. *Strat Manag Journ*, *42*(1)3-29.
Khanna, R., Guler, I., & Nerkar, A. (2016). Fail Often, Fail Big, and Fail Fast? Learning from Small Failures and R&D Performance in the Pharmaceutical Industry. *Academy of Management Journal*, *59*(2), 436–459.
Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. (2017). Technological Innovation, Resource Allocation, and Growth. *The Quarterly Journal of Economics*, *132*(2), 665–712.
Lacaille, R. (2019). *Annual Stewardship Report 2018-19*. State Street Global Advisors. https://www.ssga.com/investment-topics/environmental-social-governance/2019/09/annual-asset-stewardship-report-2018.pdf
Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management*

Journal, *14*(S2), 95–112.
Levitt, B., & March, J. G. (1988). Organizational Learning. *Annual Rev of Soc*, *14*(1), 319–338.
Lewellen, J., & Lewellen, K. (2022). Institutional Investors and Corporate Governance: The Incentive to Be Engaged. *Journal of Finance*, *77*(1), 213–264.
Manso, G. (2011). Motivating innovation. *Journal of Finance*, *66*(5), 1823–1860.
March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, *2*(1), 71–87.
Marquis, C., & Qian, C. (2014). Corporate Social Responsibility Reporting in China: Symbol or Substance? *Organization Science*, *25*(1), 127–148.
Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, *83*(2), 340–363.
Narayanan, M. P. (1985). Managerial incentives for short-term results. *Journal of Finance*, *40*(5), 1469–1484.
Porter, M. (1992). Capital Disadvantage: America’s Failing Capital Investment System. *Harvard Business Review*, *September-October*, 65–83.
Rock, E. B., & Kahan, M. (2021). Index Funds and Corporate Governance: Let Shareholders be Shareholders. *SSRN Electronic Journal*.
Roychowdhury, S. (2006). Earnings management through real activities manipulation. *Journal of Accounting and Economics*, *42*(3), 335–370.
Sampson, R. C., & Shi, Y. (2023). Are U.S. firms becoming more short-term oriented? Evidence of shifting firm time horizons from implied discount rates, 1980–2013. *Strategic Management Journal*, *44*(1), 231–263.
Sanders, Wm. G., & Hambrick, D. C. (2007). Swinging for the fences: The effects of CEO stock options on company risk taking and performance. *Acad of Managment Journal*, *50*(5), 1055–1078.
Schepker, D. J., & Barker, V. L. (2018). How stigmatized are dismissed chief executives? The role of character questioning causal accounts and executive capital in dismissed CEO reemployment. *Strategic Management Journal*, *39*(9), 2566–2586.
Schoenfeld, J. (2017). The effect of voluntary disclosure on stock liquidity: New evidence from index funds. *Journal of Accounting and Economics*, *63*(1), 51–74.
Scott, W. R. (1995). *Institutions and Organizations: Ideas, interests, and identities*.Sage Pub Inc.
Stoffman, N., Woeppel, M., & Yavuz, M. D. (2022). Small innovators: No risk, No return. *Journal of Accounting and Economics*, 101492.
Tinn, K. (2010). Technology adoption with exit in imperfectly informed equity markets. *American Economic Review*, *100*(3), 925–957.
USPTO Pendency. (2022). United States Patent and Trademark Office. https://www.uspto.gov/dashboard/patents/pendency.html
Wang, H., Zhao, S., & Chen, G. (2017). Firm-specific knowledge assets and employment arrangements: Evidence from CEO compensation design and CEO dismissal. *Strategic Management Journal*, *38*(9), 1875–1894.
Westphal, J. D., & Park, S. H. (2020). *Symbolic Management: Governance, Strategy, and Institutions*. Oxford University Press.
Westphal, J. D., & Zajac, E. J. (1998). The symbolic management of stockholders: Corporate governance reforms and shareholder reactions. *Admin Science Quarterly*, *43*(1), 127–153.
Westphal, J. D., Zhu, D. H., & Kunapuli, R. (2021). Seeking input when the train has left the station: The decoupling of participative strategic decision-making processes and the role of new technology in symbolic management. *Strategic Organization*, *0*(0).
Wiersema, M. F., & Zhang, Y. (2011). CEO dismissal: The role of investment analysts. *Strategic Management Journal*, *32*(11), 1161–1182.
Zhang, Y., & Gimeno, J. (2010). Earnings pressure and competitive behavior: Evidence from the U.S. electricity industry. *Academy of Management Journal*, *53*(4), 743–768.
Zhu, D. H., & Shen, W. (2016). Why do some outside successions fare better than others? The role of outside CEOs’ prior experience with board diversity. *Strategic Management Journal*, *37*(13), 2695–2708.

Table 1. Descriptive Statistics and Correlation Matrix

		Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1	# Patents (t+2)	41.23	152.66	1.00									
2	# Exploratory patents (t+2)	7.56	22.12	0.88	1.00								
3	# Potentially radical patents (t+2)	3.89	15.78	0.84	0.96	1.00							
4	# Patents citing unfamiliar technology (t+2)	2.83	4.53	0.47	0.64	0.49	1.00						
5	# Patents citing new technology (t+2)	0.85	5.68	0.72	0.73	0.56	0.34	1.00					
6	% Exploratory patents (t+2)	36.56	31.62	-0.18	-0.15	-0.13	-0.16	-0.10	1.00				
7	% Pure index MF ownership	1.93	2.71	0.05	-0.01	-0.01	0.01	-0.02	-0.10	1.00			
8	% Other index MF ownership	0.38	0.69	-0.04	-0.06	-0.05	-0.08	-0.03	0.06	0.10	1.00		
9	% Active MF ownership	7.42	7.31	0.05	0.04	0.02	0.13	0.00	-0.09	0.56	0.03	1.00	
10	% Unclassified MF ownership	1.30	1.81	0.04	0.04	0.02	0.09	0.01	-0.07	0.17	-0.02	0.29	1.00
11	% Non-MF institutional ownership	41.97	20.90	0.14	0.16	0.13	0.26	0.06	-0.09	0.30	0.00	0.40	0.21
12	% Retail ownership	47.00	26.57	-0.13	-0.14	-0.11	-0.25	-0.05	0.11	-0.51	-0.04	-0.67	-0.33
13	Weighted average MF expense ratio	0.01	0.01	-0.04	-0.02	-0.02	-0.02	-0.02	0.05	-0.12	-0.07	0.07	0.05
14	Analyst coverage	5.89	7.41	0.36	0.34	0.27	0.42	0.24	-0.20	0.19	-0.09	0.27	0.17
15	Patent stock	38.07	135.43	0.87	0.73	0.73	0.34	0.54	-0.20	0.06	-0.04	0.06	0.04
16	R&D (Mil. $)	152.94	633.24	0.57	0.41	0.38	0.27	0.35	-0.17	0.09	-0.03	0.06	0.06
17	R&D stock (Mil. $)	714.71	3067.59	0.55	0.39	0.36	0.26	0.30	-0.17	0.09	-0.03	0.06	0.05
18	Sales (Mil. $)	3489.68	15587.01	0.36	0.28	0.26	0.27	0.15	-0.13	0.08	-0.03	0.03	0.03
19	Cashflow per share	1.83	2.86	0.23	0.22	0.18	0.35	0.10	-0.06	0.12	-0.02	0.15	0.05
20	Capital-labor ratio	65899.73	126802.60	0.10	0.09	0.08	0.10	0.04	-0.09	0.12	-0.02	0.07	0.05
21	Market capitalization (Bil. $)	20.08	2.04	0.44	0.44	0.38	0.53	0.25	-0.24	0.31	-0.14	0.37	0.22
22	Product market competition	0.43	0.37	-0.02	-0.03	-0.02	-0.06	-0.02	-0.06	-0.03	-0.04	-0.06	0.06
23	Industry sales average (Bil. $)	2290.05	6284.09	0.07	0.05	0.04	0.09	-0.01	-0.03	0.14	0.00	0.07	0.01
24	Time	0.96	0.72	0.02	-0.05	-0.03	-0.10	-0.05	-0.06	0.60	0.07	0.34	0.03

		11	12	13	14	15	16	17	18	19	20	21	22	23	24
11	% Non-MF institutional ownership	1.00													
12	% Retail ownership	-0.94	1.00												
13	Weighted average MF expense ratio	0.02	-0.03	1.00											
14	Analyst coverage	0.38	-0.40	-0.03	1.00										
15	Patent stock	0.15	-0.14	-0.04	0.33	1.00									
16	R&D (Mil. $)	0.11	-0.11	-0.05	0.34	0.62	1.00								
17	R&D stock (Mil. $)	0.11	-0.11	-0.05	0.30	0.62	0.97	1.00							
18	Sales (Mil. $)	0.09	-0.09	-0.05	0.25	0.41	0.53	0.56	1.00						
19	Cashflow per share	0.29	-0.28	-0.04	0.32	0.22	0.23	0.22	0.38	1.00					
20	Capital-labor ratio	0.08	-0.10	-0.04	0.21	0.12	0.11	0.11	0.55	0.24	1.00				
21	Market capitalization (Bil. $)	0.56	-0.59	-0.04	0.68	0.45	0.44	0.43	0.42	0.49	0.27	1.00			
22	Product market competition	-0.04	0.05	-0.05	-0.02	-0.01	0.07	0.07	0.05	-0.01	0.08	0.03	1.00		
23	Industry sales average (Bil. $)	0.08	-0.10	-0.04	0.12	0.09	0.16	0.19	0.55	0.30	0.43	0.25	0.11	1.00	
24	Time	0.17	-0.30	-0.10	0.05	0.05	0.07	0.08	0.06	-0.03	0.07	0.11	-0.07	0.10	1.00

Table 2. Correlations between Year-over-Year Changes in Ownership

	Variable (Year over year changes)	1	2	3	4	5	6
1	Δ % Pure index MF ownership	1.00					
2	Δ % Other index MF ownership	0.05	1.00				
3	Δ % Active MF ownership	0.13	0.00	1.00			
4	Δ % Unclassified MF ownership	0.04	0.01	0.05	1.00		
5	Δ % Non-MF institutional ownership	-0.07	-0.04	-0.11	-0.02	1.00	
6	Δ % Retail ownership	-0.10	-0.03	-0.33	-0.15	-0.88	1.00

Table 3. Estimated Effect of Index Ownership on R&D (OLS)

	DV: ln(R&D expenditures), t+1				DV: ln(1 + # Exploratory Patents), t+2				
	Full Sample			Tech,-intensive	Full Sample			Technology-intensive	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(% Pure index MF ownership)	0.081	0.061	-0.011	0.112	-0.163	-0.175	-0.127	-0.148	-0.104
	[0.033]	[0.034]	[0.053]	[0.043]	[0.018]	[0.021]	[0.018]	[0.027]	[0.024]
	(0.016)	(0.070)	(0.831)	(0.010)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln(% Other index MF ownership)	-0.095	-0.012	-0.062	0.023	-0.001	-0.017	0.004	-0.022	0.005
	[0.039]	[0.030]	[0.041]	[0.038]	[0.021]	[0.021]	[0.020]	[0.028]	[0.027]
	(0.016)	(0.677)	(0.134)	(0.553)	(0.964)	(0.420)	(0.845)	(0.441)	(0.840)
ln(% Active MF ownership)	-0.042	-0.020	-0.019	-0.028	0.035	0.005	0.009	-0.001	-0.000
	[0.028]	[0.020]	[0.020]	[0.025]	[0.011]	[0.012]	[0.011]	[0.014]	[0.013]
	(0.138)	(0.312)	(0.344)	(0.268)	(0.001)	(0.676)	(0.402)	(0.930)	(0.983)
ln(% Unclassified MF ownership)	0.045	0.020	0.021	0.037	-0.022	-0.013	-0.010	-0.007	-0.007
	[0.023]	[0.019]	[0.019]	[0.025]	[0.017]	[0.016]	[0.013]	[0.020]	[0.017]
	(0.053)	(0.289)	(0.262)	(0.141)	(0.188)	(0.397)	(0.433)	(0.736)	(0.684)
ln(% Non-MF institutional ownership)	0.216	0.127	0.117	0.108	-0.016	0.042	0.084	0.050	0.103
	[0.034]	[0.033]	[0.033]	[0.037]	[0.014]	[0.024]	[0.021]	[0.031]	[0.026]
	(0.000)	(0.000)	(0.000)	(0.004)	(0.254)	(0.077)	(0.000)	(0.107)	(0.000)
Product market competition		0.223	0.260	0.064		-0.028	-0.014	-0.107	-0.120
		[0.227]	[0.228]	[0.071]		[0.047]	[0.046]	[0.055]	[0.051]
		(0.326)	(0.253)	(0.368)		(0.550)	(0.758)	(0.051)	(0.019)
ln(Industry sales average)		0.135	0.116	0.099		-0.207	-0.104	-0.302	-0.194
		[0.062]	[0.060]	[0.068]		[0.039]	[0.029]	[0.061]	[0.044]
		(0.031)	(0.054)	(0.145)		(0.000)	(0.000)	(0.000)	(0.000)
ln(% Pure index MF ownership) * Tech.-intensive			0.132						
			[0.051]						
			(0.010)						
ln(% Other index MF ownership) * Tech-intensive			0.088						
			[0.054]						
			(0.102)						
Time	0.007	0.087	0.104	0.138	-0.119	-0.037	-0.050	0.012	-0.038
	[0.031]	[0.037]	[0.036]	[0.044]	[0.015]	[0.020]	[0.017]	[0.027]	[0.024]
	(0.836)	(0.020)	(0.003)	(0.002)	(0.000)	(0.067)	(0.004)	(0.656)	(0.124)
Patent control	N/A	N/A	N/A	N/A	No	No	Yes	No	Yes
Industry FE	Yes	No	No	No	Yes	No	No	No	No
Firm FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Adjusted R-squared	0.751	0.295	0.297	0.363	0.653	0.065	0.504	0.069	0.496
Wald test two-sided p-value †	0.001	0.065	0.594	0.037	0.000	0.000	0.000	0.003	0.004
Number of firms	1,680	1,680	1,680	1,067	1,680	1,680	1,456	1,067	912
Number of observations	16,185	16,185	16,185	9,478	16,185	16,185	11,649	9,478	6,819

Note: Robust standard errors clustered by firm are reported in brackets, followed by two-sided p values in parentheses. There are six additional controls included in each regression: ln(Analyst coverage), ln(Patent stock), ln(Sales), Cash flow per share, ln(Capital to labor ratio), ln(Market capitalization). In columns (5)-(9), ln(R&D stock) is also included as a control. Patent control refers to the inclusion of ln(# patents),t+2 in the model.

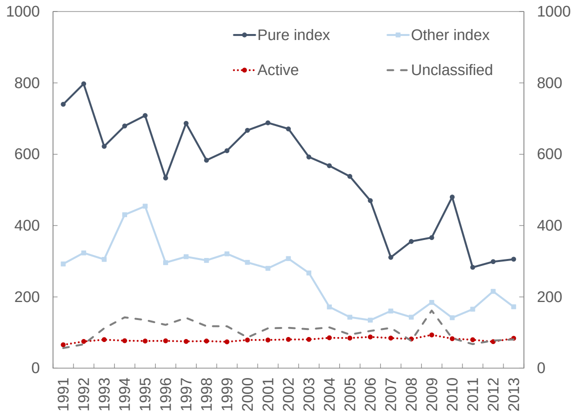
† p-value from Wald test of equality. The null hypothesis is that the coefficient on pure index mutual fund ownership is the same as other index mutual fund ownership. In column 3, the null hypothesis is that the interaction between pure index mutual fund ownership and R&D-intensive industry is the same as the interaction between other index mutual fund ownership and R&D-intensive industry.

Table 4. Additional Analyses Addressing Measurement Error and Selection

	DV: ln(R&D), t+1		DV: ln(1 + # Explor. Patents), t+2		DV: ln(R&D), t+1	DV: ln(% Pure index own.)	DV: ln(R&D), t+1	DV: ln(1 + # Explor. Patents), t+2	DV: ln(% Pure index own.)	DV: ln(1 + # Explor. Patents), t+2
	Full Sample	Tech.-intensive	Full Sample	Tech.-intensive	Naïve 2SLS Full	1st Stage 2SLS Full	2nd Stage 2SLS Full	Naïve 2SLS Full	1st Stage 2SLS Full	2nd Stage 2SLS Full
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Pure index MF assets (Trillion $)						1.705			1.512	
						[0.066]			[0.075]	
						(0.000)			(0.000)	
Weighted average expense ratio	-0.017	0.037	-0.164	-0.126						
	[0.040]	[0.044]	[0.029]	[0.033]						
	(0.674)	(0.402)	(0.000)	(0.000)						
ln(% MF ownership)	-0.114	-0.381	0.721	0.470						
	[0.118]	[0.128]	[0.081]	[0.095]						
	(0.333)	(0.003)	(0.000)	(0.000)						
Weighted avg. exp. ratio * ln(% MF ownership)	-0.025	-0.084	0.153	0.097						
	[0.026]	[0.027]	[0.017]	[0.021]						
	(0.344)	(0.002)	(0.000)	(0.000)						
ln(% Pure index ownership)					0.078		0.408	-0.027		-0.196
					[0.043]		[0.076]	[0.021]		[0.059]
					(0.069)		(0.000)	(0.205)		(0.001)
ln(% Other index ownership)					-0.026	0.064	-0.054	0.074	0.101	0.102
					[0.032]	[0.013]	[0.034]	[0.021]	[0.016]	[0.023]
					(0.426)	(0.000)	(0.111)	(0.000)	(0.000)	(0.000)
ln(% Active MF ownership)					-0.006	0.044	-0.030	-0.013	0.045	0.002
					[0.022]	[0.007]	[0.022]	[0.011]	[0.008]	[0.011]
					(0.786)	(0.000)	(0.168)	(0.210)	(0.000)	(0.843)
ln(% Unclassified MF ownership)	0.029	0.050	-0.038	-0.040	0.019	0.030	0.007	-0.007	0.012	0.009
	[0.019]	[0.024]	[0.014]	[0.019]	[0.021]	[0.009]	[0.022]	[0.013]	[0.012]	[0.013]
	(0.125)	(0.034)	(0.008)	(0.031)	(0.360)	(0.001)	(0.749)	(0.618)	(0.294)	(0.484)
ln(% Non-MF institutional ownership)	0.119	0.100	0.191	0.219	0.128	0.045	0.110	0.069	0.036	0.079
	[0.031]	[0.034]	[0.021]	[0.026]	[0.040]	[0.012]	[0.039]	[0.020]	[0.016]	[0.021]
	(0.000)	(0.004)	(0.000)	(0.000)	(0.002)	(0.000)	(0.005)	(0.001)	(0.020)	(0.000)
Time	0.082	0.120	-0.094	-0.050	0.084	0.102	0.024	-0.009	0.017	0.033
	[0.033]	[0.024]	[0.017]	[0.025]	[0.035]	[0.011]	[0.031]	[0.016]	[0.015]	[0.019]
	(0.013)	(0.000)	(0.000)	(0.043)	(0.016)	(0.000)	(0.438)	(0.586)	(0.241)	(0.083)
Patent offset	N/A	N/A	Yes	Yes	N/A	N/A	N/A	Yes	Yes	Yes
Industry FE	No	No	No	No	No	No	No	No	No	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.312	0.405	0.508	0.499	0.304	0.640	0.197	0.526	0.677	0.513
Kleibergen-Paap rk Wald F statistic							660.09			406.52
Number of firms	1,677	1,065	1,449	908	1,459	1,459	1,459	1,161	1,161	1,161
Number of observations	15,948	9,324	11,518	6,729	12, 821	12, 821	12, 821	9,078	9,078	9,078

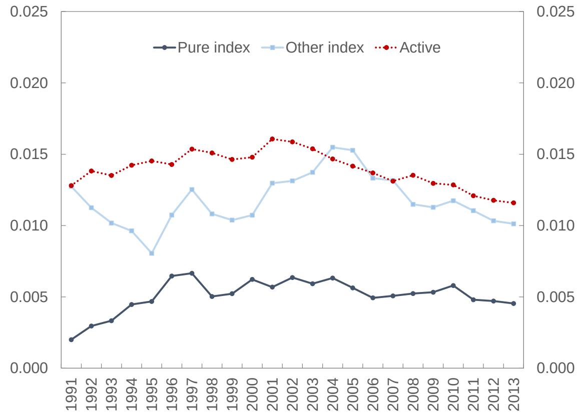
Note: Robust standard errors clustered by firm are reported in brackets, followed by two-sided p values in parentheses. There are eight additional controls included in each regression: ln(Analyst coverage), ln(Patent stock), ln(Sales), Cash flow per share, ln(Capital to labor ratio), ln(Market capitalization). ln(R&D stock) is also included as a control in columns (3), (4), (8)-(10). Columns (5)-(10) also include GDP growth and indicator variables for membership in the S&P 500, 400, 600, and Russell 1000, 2000 indices. Patent offset refers to the inclusion of ln(# patents),t+2 in the model where the coefficient is constrained to 1. The Kleibergen-Paap rk Wald F statistic provides information about the weakness of the instrument. It is over 400 for both R&D and exploratory estimated models, far exceeding the Stock and Yogo (2005) critical values ranging between 5.53 and 16.38. The weakness of the instrument is rejected.

Figure 1: Mean # Firms Held by Mutual Funds



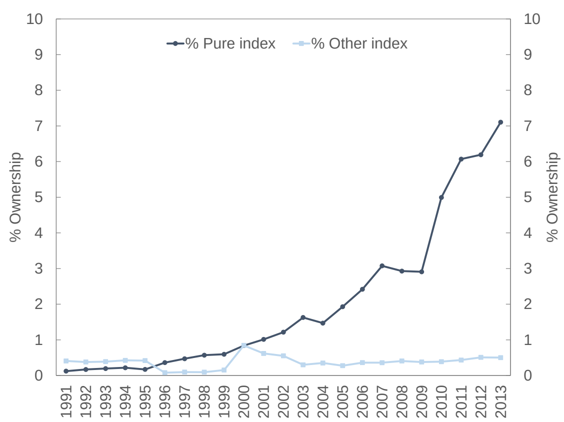
Source: CRSP and S12

Figure 2: Mean Expense Ratios for Mutual Funds



Source: CRSP and S12

Figure 3: Mean % Shares of Public Firms



Source: CRSP and S12

Figure 4: % Change in R&D given 1 Basis Point Increase in Expense Ratio

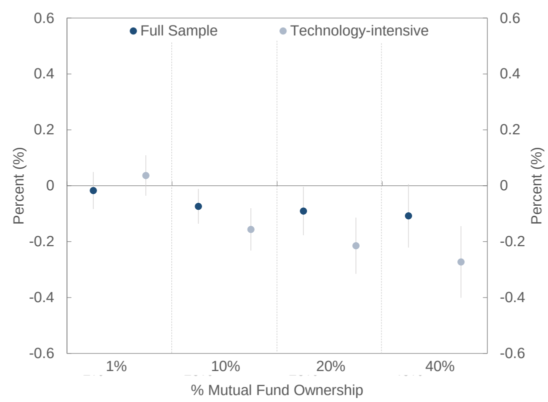
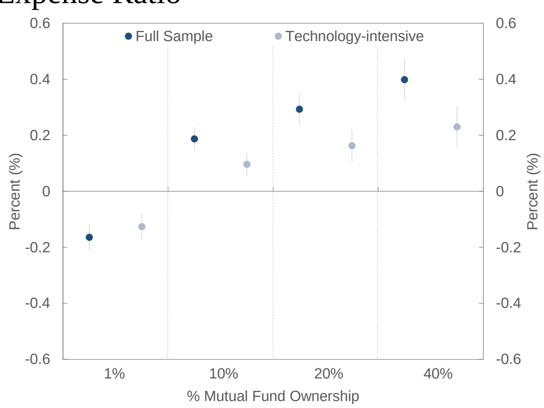


Figure 5: % Change in Rate of Exploratory Patenting given 1 Basis Point Increase in Expense Ratio



Appendix A. Alternative Lag Structures

We use a two-year lag structure in our main analyses. Table A estimates with one-, three-, and four-year lag structures in columns (1)-(12). The coefficient on pure index ownership is consistently negative and consistent with p-values less than 0.01 except for column (12) (p=0.072). However, to more carefully explore how the effect of an increase in pure index ownership might unfold over time and to address the possibility that we have not sufficiently accounted for time trends in the data, we also estimated distributed lag models with the lagged year-to-year changes in pure index ownership in columns (13)-(16).[13] We include the lagged changes in other index ownership as well since we view other index ownership as a placebo test.

$$\ln(1 + \#\, Exploratory\ Patents) = \boldsymbol{\beta_j} \sum_{j=1}^{4}(\Delta\,\%\, Pure\ index\ ownership_{it-j} + \Delta\,\%\, Pure\ other\ ownership_{it-j}) + \boldsymbol{\phi x}_{it} + \delta_i + \epsilon \quad (2)$$

where

$$\Delta\,\%\, Pure\ index\ ownership_t = \%\, Pure\ index\ MF\ ownership_t - \%\, Pure\ index\ MF\ ownership_{t-1}$$

$$\Delta\,\%\, Pure\ other\ ownership_t = \%\, Pure\ other\ MF\ ownership_t - \%\, Pure\ other\ MF\ ownership_{t-1}$$

The regression coefficients on the distributed lags can be summed to obtain the overall effect of an increase in pure index ownership. In the full sample, a one percentage point increase in pure index ownership is associated with an overall 11.3% decrease (p=0.000) in exploratory patenting and a 13.3% decrease (p=0.000) in exploratory patenting relative to overall patenting. Looking at the individual lags, the effect size increases over time. In the technology-intensive subsample, a one percentage point increase in pure index ownership is associated with an overall 11.4% decrease (p=0.000) in exploratory patenting and a 12.1% (p=0.000) decrease in exploratory patenting relative to overall patenting. In contrast, a one percentage point increase in other index ownership is associated with an overall 11.6% increase (p=0.005) in exploratory patenting and a

[13] Furthermore, the percent of pure index ownership is highly correlated from year to year—for example, $\%\, pure\ index\ ownership_{t-1}$ and $\%\, pure\ index\ ownership_{t-2}$ have a correlation of 0.89—which introduces significant multicollinearity to the model. It is common practice to estimate a distributed lag model with the first differences of pure index ownership instead.

11.6% increase (p=0.005) in exploratory patenting relative to overall patenting. Similarly, in the technology-intensive subsample, a one percentage point increase in other index ownership is associated with an overall 8.5% increase (p=0.011) in exploratory patenting and a 7.8% (p=0.047) increase in exploratory patenting relative to overall patenting. The difference between the overall effect of changes in pure index ownership and the overall effect of changes in other index ownership is significant with p=0.000 for each model. Thus, both in the main analyses and in supplemental analyses, the observed effect of pure index ownership on R&D continues to be consistent with our predictions while the effect of other index ownership is inconsistent.

Table A. Estimated Effect of Pure Index MF Ownership on Exploratory Patents, Alternative Lag Structures

	DV: ln(1 + # Exploratory Patents), t+1				DV: ln(1 + # Exploratory Patents), t+3				DV: ln(1 + # Exploratory Patents), t+4				DV: ln(1 + # Exploratory Patents)			
	Full Sample		Technology-intensive		Full Sample		Technology-intensive		Full Sample		Technology-intensive		Full Sample		Technology-intensive	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
ln(% Pure index MF ownership)	-0.149	-0.127	-0.134	-0.111	-0.158	-0.103	-0.122	-0.062	-0.150	-0.106	-0.101	-0.049				
	[0.019]	[0.017]	[0.024]	[0.022]	[0.023]	[0.019]	[0.029]	[0.025]	[0.025]	[0.021]	[0.032]	[0.027]				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.013)	(0.000)	(0.000)	(0.002)	(0.072)				
ln(% Other index ownership)	0.002	0.006	0.000	0.027	-0.049	-0.012	-0.045	0.001	-0.096	-0.052	-0.072	-0.042				
	[0.020]	[0.021]	[0.027]	[0.026]	[0.021]	[0.021]	[0.028]	[0.028]	[0.022]	[0.022]	[0.028]	[0.030]				
	(0.928)	(0.786)	(0.991)	(0.307)	(0.020)	(0.559)	(0.109)	(0.970)	(0.000)	(0.018)	(0.010)	(0.161)				
Δ % Pure index MF ownership, t-1													-0.013	-0.027	-0.014	-0.027
													[0.005]	[0.005]	[0.007]	[0.006]
													(0.013)	(0.000)	(0.043)	(0.000)
Δ % Pure index MF ownership, t-2													-0.024	-0.032	-0.021	-0.027
													[0.007]	[0.006]	[0.010]	[0.008]
													(0.001)	(0.000)	(0.028)	(0.001)
Δ % Pure index MF ownership, t-3													-0.040	-0.041	-0.042	-0.037
													[0.008]	[0.006]	[0.010]	[0.009]
													(0.000)	(0.000)	(0.000)	(0.000)
Δ % Pure index MF ownership, t-4													-0.043	-0.042	-0.043	-0.038
													[0.008]	[0.007]	[0.011]	[0.009]
													(0.000)	(0.000)	(0.000)	(0.000)
Δ % Other index MF ownership, t-1													0.028	0.025	0.031	0.025
													[0.010]	[0.009]	[0.013]	[0.013]
													(0.005)	(0.010)	(0.015)	(0.057)
Δ % Other index MF ownership, t-2													0.036	0.028	0.040	0.025
													[0.011]	[0.010]	[0.014]	[0.013]
													(0.001)	(0.005)	(0.003)	(0.063)
Δ % Other index MF ownership, t-3													0.030	0.025	0.026	0.023
													[0.011]	[0.011]	[0.014]	[0.013]
													(0.005)	(0.027)	(0.060)	(0.072)
Δ % Other index MF ownership, t-4													0.015	0.004	0.012	0.002
													[0.009]	[0.011]	[0.012]	[0.011]
													(0.111)	(0.703)	(0.306)	(0.877)
ln(% Active MF ownership)	0.008	0.019	-0.000	0.002	0.004	-0.002	0.001	-0.008	-0.009	-0.007	-0.008	-0.013	0.000	0.018	-0.011	0.005
	[0.011]	[0.011]	[0.014]	[0.013]	[0.012]	[0.011]	[0.015]	[0.015]	[0.013]	[0.012]	[0.016]	[0.015]	[0.013]	[0.013]	[0.017]	[0.017]
	(0.473)	(0.075)	(0.975)	(0.865)	(0.760)	(0.885)	(0.928)	(0.574)	(0.486)	(0.576)	(0.638)	(0.369)	(0.995)	(0.180)	(0.528)	(0.774)
ln(% Unclassified MF ownership)	0.017	0.011	0.019	0.008	-0.006	0.012	0.005	0.021	0.006	0.024	0.003	0.028	0.020	0.017	0.010	0.003
	[0.015]	[0.013]	[0.019]	[0.017]	[0.016]	[0.014]	[0.021]	[0.018]	[0.017]	[0.015]	[0.020]	[0.019]	[0.017]	[0.015]	[0.023]	[0.021]
	(0.249)	(0.399)	(0.317)	(0.658)	(0.731)	(0.395)	(0.798)	(0.243)	(0.697)	(0.119)	(0.883)	(0.151)	(0.230)	(0.261)	(0.672)	(0.891)
ln(% Non-MF institutional ownersl	0.027	0.065	0.032	0.084	0.041	0.106	0.058	0.141	0.047	0.119	0.062	0.144	0.035	0.082	0.053	0.092
	[0.023]	[0.021]	[0.030]	[0.025]	[0.025]	[0.023]	[0.033]	[0.028]	[0.022]	[0.022]	[0.028]	[0.026]	[0.034]	[0.028]	[0.045]	[0.034]
	(0.234)	(0.002)	(0.283)	(0.001)	(0.102)	(0.000)	(0.085)	(0.000)	(0.035)	(0.000)	(0.027)	(0.000)	(0.302)	(0.003)	(0.240)	(0.007)
Time	-0.063	-0.052	-0.037	-0.047	-0.053	-0.052	0.006	-0.028	-0.072	-0.045	-0.020	-0.024	-0.074	-0.074	-0.037	-0.069
	[0.019]	[0.017]	[0.026]	[0.024]	[0.021]	[0.018]	[0.027]	[0.025]	[0.022]	[0.018]	[0.028]	[0.027]	[0.019]	[0.017]	[0.028]	[0.025]
	(0.001)	(0.002)	(0.151)	(0.050)	(0.013)	(0.004)	(0.823)	(0.270)	(0.001)	(0.013)	(0.476)	(0.372)	(0.000)	(0.000)	(0.189)	(0.005)
Patent control	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Industry FE	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.073	0.497	0.073	0.483	0.065	0.500	0.071	0.494	0.073	0.507	0.080	0.499	0.087	0.476	0.096	0.457
Wald test two-sided p-value †	0.000	0.000	0.001	0.000	0.001	0.003	0.063	0.110	0.109	0.095	0.491	0.853	0.000	0.000	0.000	0.000
Number of firms	1,785	1,570	1,152	1,002	1,572	1,350	991	840	1,469	1,247	919	764	1,395	1,240	873	771
Number of observations	17,620	12,658	10,413	7,467	14,574	10,617	8,571	6,174	13,438	9,690	7,756	5,607	11,671	8,896	6,751	5,242

Note: Robust standard errors clustered by firm are reported in brackets, followed by two-sided p values in parentheses. There are seven additional controls included in each regression: ln(Analyst coverage), ln(Patent stock), ln(R&D stock), ln(Sales), Cash flow per share, ln(Capital to labor ratio), ln(Market capitalization). Patent control refers to the inclusion of ln(# patents) in the model.

† p-value from Wald test of equality. The null hypothesis is that the coefficient on pure index mutual fund ownership is the same as other index mutual fund ownership. In columns 13-16, the null hypothesis is that the sum of the coefficients for the lagged difference in percent pure index mutual fund ownership is the same as the sum of the coefficients for the lagged difference in percent other index mutual fund ownership.

Appendix B. Negative Binomial Specification

All models presented in the main results of this paper use an OLS specification. The OLS specification holds advantages, especially when including firm fixed effects, but it is also common to use count models for count measures of innovation (e.g., Aghion et al., 2013; Blundell et al., 1999). For robustness, we include estimates of negative binomial models in Table B. We estimated negative binomial models rather than Poisson models because each dependent variable is over-dispersed.

We estimated these models with and without firm fixed effects. We estimate fixed effects by including a set of firm dummy variables. This approach traditionally raises concerns about incidental parameter bias. However, Greene (2004) shows that this bias generally begins to drop off quite rapidly for panel lengths of 3 or more, and he demonstrates that it is inappropriate to assume that the bias documented for probit and logit models necessarily extends to other nonlinear models like the tobit or negative binomial. Allison and Waterman (2002) find that even for panels of length 2, there is little evidence of bias in negative binomial estimates with fixed effects. Therefore, we estimate negative binomial models with firm fixed effects, but as a precaution we require a minimum panel length of 5 years.

Columns (1)-(4) display the estimates for the full sample, and Columns (5)-(8) display the estimates for the technology-intensive subsample. As in our main findings, we consistently find a negative relationship between pure index mutual fund ownership and exploratory patenting. Column (2) displays the estimates for the fixed effects model with retail ownership as the baseline. A one-standard deviation increase in pure index mutual fund ownership relative to retail ownership (2.81 percentage points) is associated with a 21.7 percent decrease in the number of exploratory patents. Figure A.1 illustrates the mean predicted number of exploratory patents at different levels of pure index mutual fund ownership. In this sample, the mean percent pure index mutual fund ownership is 2.21%.

Column (4) displays the estimates for the same model but with the inclusion of a total patents offset variable. A one-standard deviation increase in pure index mutual fund ownership is associated with a 16.4 percent decrease in the rate of exploratory patenting given the total number of patents. Figure A.2 illustrates the mean predicted number of exploratory patents at different levels of pure index mutual fund ownership when the total number of patents is 3, 10, 40, and 140, representing the 25th, 50th, 75th, and 90th percentiles for total patents for this sample.

For the technology-intensive subsample, Column (6) indicates that a one-standard deviation increase in pure index mutual fund ownership relative to retail ownership is associated with an 18.5 percent decrease in the number of exploratory patents. Column (8) indicates that a one-standard deviation increase in pure index mutual fund ownership is associated with a 14.3 percent decrease in the rate of exploratory patenting given the total number of patents.

Table B. Estimated Effect of Pure Index MF Ownership on Distant Search in R&D (Negative Binomial)

	DV: # Exploratory Patents, t+2							
	Full Sample				Technology-Intensive			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% Pure index MF ownership	-0.128	-0.087	-0.061	-0.067	-0.127	-0.075	-0.067	-0.059
	[0.007]	[0.008]	[0.005]	[0.006]	[0.010]	[0.011]	[0.006]	[0.008]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
% Other index MF ownership	0.007	0.027	0.035	0.018	0.021	0.047	0.042	0.029
	[0.020]	[0.017]	[0.015]	[0.013]	[0.026]	[0.024]	[0.019]	[0.015]
	(0.744)	(0.126)	(0.023)	(0.172)	(0.416)	(0.048)	(0.030)	(0.059)
% Active MF ownership	0.006	0.005	0.000	0.002	0.005	0.002	-0.000	0.001
	[0.003]	[0.003]	[0.002]	[0.002]	[0.004]	[0.003]	[0.003]	[0.002]
	(0.036)	(0.079)	(0.957)	(0.282)	(0.220)	(0.641)	(0.906)	(0.738)
% Unclassified MF ownership	0.011	-0.001	-0.000	0.004	0.011	-0.004	0.002	0.005
	[0.010]	[0.007]	[0.005]	[0.005]	[0.015]	[0.010]	[0.007]	[0.007]
	(0.293)	(0.839)	(0.934)	(0.368)	(0.453)	(0.715)	(0.825)	(0.424)
% Non-MF institutional ownership	0.002	-0.001	-0.003	-0.003	0.003	-0.003	-0.003	-0.004
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]
	(0.036)	(0.492)	(0.000)	(0.000)	(0.047)	(0.068)	(0.003)	(0.000)
Time		-0.074		-0.031		-0.079		-0.037
		[0.030]		[0.020]		[0.040]		[0.028]
		(0.014)		(0.119)		(0.049)		(0.192)
Patent offset	No	No	Yes	Yes	No	No	Yes	Yes
Industry FE	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes	No	Yes
Pseudo R-squared	0.146	0.220	0.086	0.143	0.147	0.229	0.080	0.150
Number of firms	859	859	859	859	520	520	520	520
Number of observations	10,293	10,293	10,293	10,293	5,933	5,933	5,933	5,933

Note: Robust standard errors clustered by firm are reported in brackets, followed by two-sided p values in parentheses. There are nine additional controls included in each regression: ln(Analyst coverage), ln(Patent stock), ln(R&D stock), ln(Sales), Cash flow per share, ln(Capital to labor ratio), ln(Market capitalization), Product market competition, ln(Industry sales average). Patent offset refers to the inclusion of ln(# patents),t+2 in the model where the coefficient is constrained to 1.

Figure A.1 Mean Predicted # Exploratory Patents (with Firm FE)

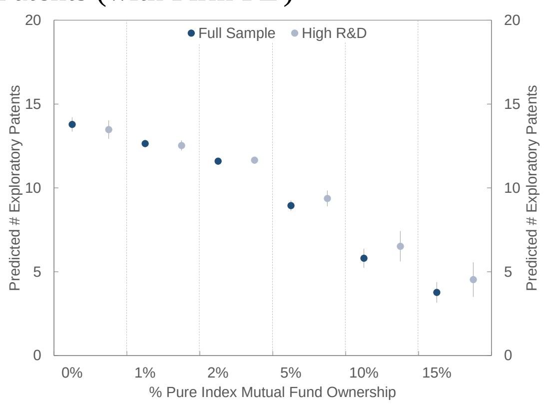
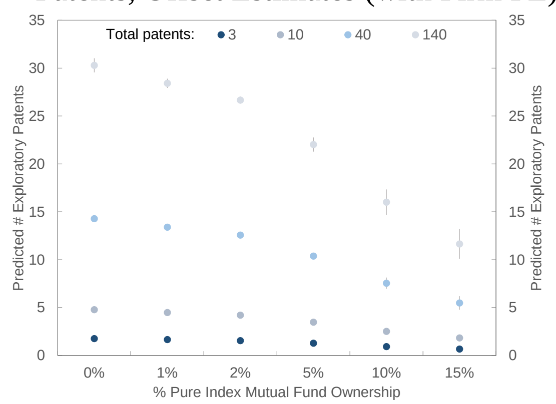


Figure A.2 Mean Predicted # Exploratory Patents, Offset Estimates (with Firm FE)



Appendix C. Estimated Effect of Pure Index Ownership on the Number of Exploitative Patents

In the main analyses, we examine a shift toward less distant search processes in R&D by examining the relationship between pure index mutual fund ownership and exploratory patents. The models with a total patents offset variable allow us to estimate the effect of pure index mutual fund ownership on the rate of exploratory patenting given total patents. In this appendix, we provide additional analyses illustrating the shift toward less distant search in R&D.

Table C presents estimates for two dependent variables: *number of exploitative patents* and *percent exploratory patents*. Exploitative patents are all patents that are not potentially radical and do not cite either unfamiliar technology or emerging technology. Columns (1)-(5) display the estimates for number of exploitative patents. For the full sample, Column (2) indicates that a one standard deviation increase above the mean in pure index mutual fund ownership is associated with a 5.0 percent decrease in exploitative patents (p=0.007). This is still consistent with pure index mutual fund ownership leading to a more short-term approach to R&D, as fewer patents overall may reflect a shift toward exploiting existing inventions. By this logic, we would expect a smaller decrease in exploitative patents in technology-intensive industries where new invention is both competitively and normatively more important. Indeed, although the coefficient for the technology-intensive subsample in column (4) is also negative, it is smaller in magnitude and not significantly different from zero (p=0.191).

Moreover, once a total patents control variable is included in column (3), we find that a one standard deviation increase above the mean in pure index mutual fund ownership relative ownership is associated with a 4.9 percent *increase* in the rate of exploitative patents given total patents (p=0.000). In the technology-intensive subsample in (5), we again find a positive relationship between pure index mutual fund ownership and the rate of exploitative patenting given total patents. Providing further evidence of the shift away from exploratory R&D,

Columns (6)-(10) display the estimates for percent exploratory patents, defined as $(1 - \#Exploitative\ patents)/(Total\ patents) * 100$. We again consistently find a negative relationship between exploratory patenting and pure index mutual fund ownership, with p-values equal to 0.000.

In sum, without controlling for total patents, both exploitative and exploratory patenting decrease (reflecting in an overall decrease in patenting), but the decrease is smaller for exploitative than exploratory patenting. We also consistently find that the percentage of total patents that are exploitative increases (the percent of exploratory patents decrease). Thus, the pattern of results is consistent with our main prediction that an increase in pure index ownership results in less exploratory R&D. The reduction in overall patenting is also consistent with our theorizing. While patents are more visible and measurable than how exploratory an R&D project or approach is, they are not required to be reported nor is there a standard way to evaluate their quality and value—e.g., they are not as "spreadsheet-able" as R&D expenditures. Furthermore, an overall decrease in patenting while R&D expenditures increase is also consistent with shifting R&D resources away from exploring and creating new knowledge toward exploiting existing knowledge.

Table C. Estimated Effect of Pure Index MF Ownership on Exploitative Patents and % Exploratory Patents

	DV: ln(1 + Exploitative Patents)					DV: % Exploratory Patents				
	Full Sample			Tech.-intensive		Full Sample			Tech.-intensive	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(% Pure index ownership)	-0.088	-0.058	0.055	-0.039	0.062	-3.126	-3.789	-3.958	-4.115	-4.249
	[0.020]	[0.022]	[0.01]	[0.030]	[0.014]	[0.713]	[0.842]	[0.842]	[1.123]	[1.119]
	(0.000)	(0.007)	(0.000)	(0.191)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln(% Other index ownership)	-0.017	-0.024	-0.001	-0.042	-0.008	5.835	3.080	3.096	3.711	3.770
	[0.025]	[0.021]	[0.013]	[0.030]	[0.017]	[1.175]	[1.162]	[1.155]	[1.423]	[1.412]
	(0.511)	(0.256)	(0.920)	(0.168)	(0.618)	(0.000)	(0.008)	(0.007)	(0.009)	(0.008)
ln(% Active MF ownership)	0.022	-0.005	-0.010	-0.007	-0.020	-0.318	0.047	0.060	-0.471	-0.474
	[0.012]	[0.012]	[0.007]	[0.016]	[0.008]	[0.446]	[0.533]	[0.532]	[0.641]	[0.637]
	(0.058)	(0.678)	(0.140)	(0.654)	(0.016)	(0.477)	(0.930)	(0.910)	(0.462)	(0.457)
ln(% Unclassified MF ownership)	-0.026	-0.017	-0.004	-0.018	-0.014	0.547	0.459	0.431	1.043	1.011
	[0.018]	[0.016]	[0.009]	[0.021]	[0.011]	[0.662]	[0.711]	[0.712]	[0.933]	[0.936]
	(0.142)	(0.292)	(0.669)	(0.380)	(0.216)	(0.409)	(0.519)	(0.545)	(0.264)	(0.280)
ln(% Non-MF institutional ownership)	-0.091	-0.048	0.036	-0.048	0.044	0.213	-0.615	-0.658	-0.279	-0.309
	[0.016]	[0.025]	[0.013]	[0.033]	[0.016]	[0.723]	[1.025]	[1.026]	[1.222]	[1.225]
	(0.000)	(0.050)	(0.006)	(0.140)	(0.006)	(0.768)	(0.548)	(0.522)	(0.819)	(0.801)
Product market competition		-0.036	0.051	-0.054	0.036		1.555	1.456	-1.472	-1.673
		[0.051]	[0.026]	[0.061]	[0.028]		[2.257]	[2.253]	[2.632]	[2.624]
		(0.481)	(0.048)	(0.377)	(0.208)		(0.491)	(0.518)	(0.576)	(0.524)
ln(Industry sales average)		-0.107	-0.012	-0.143	0.006		-1.060	-1.258	-1.306	-1.628
		[0.039]	[0.017]	[0.064]	[0.024]		[1.208]	[1.206]	[1.734]	[1.736]
		(0.006)	(0.479)	(0.026)	(0.81)		(0.380)	(0.297)	(0.451)	(0.349)
Time	-0.027	-0.005	0.030	0.015	0.021	-0.795	-0.532	-0.547	-0.368	-0.375
	[0.016]	[0.020]	[0.011]	[0.029]	[0.014]	[0.652]	[0.845]	[0.845]	[1.178]	[1.176]
	(0.098)	(0.811)	(0.007)	(0.603)	(0.134)	(0.223)	(0.529)	(0.517)	(0.755)	(0.750)
ln(# Patents), t+2								-1.557		-1.843
								[0.503]		[0.602]
								(0.002)		(0.002)
Patent offset	No	No	Yes	No	Yes	N/A	N/A	N/A	N/A	N/A
Industry FE	Yes	No	No	No	No	Yes	No	No	No	No
Firm FE	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Adjusted R-squared	0.810	0.119	0.7708	0.116	0.7928	0.231	0.037	0.038	0.041	0.043
Number of firms	1,680	1,680	1,456	1,067	912	1,456	1,456	1,456	912	912
Number of observations	16,185	16,185	11,649	9,478	6,819	11,649	11,649	11,649	6,819	6,819

Note: Robust standard errors clustered by firm are reported in brackets, followed by two-sided p values in parentheses. There are seven additional controls included in each regression: ln(Analyst coverage), ln(Patent stock), ln(R&D stock), ln(Sales), Cash flow per share, ln(Capital to labor ratio), ln(Market capitalization). Patent offset refers to the inclusion of ln(# patents),t+2 in the model where the coefficient is constrained to 1.

Appendix D. Types of Distant Search

Each column includes firm fixed effects and a total patent output offset variable. In the technology-intensive subsample estimates in Columns (2), (4), and (6), we find that a one-standard deviation increase in pure index mutual fund ownership above the mean is associated with a 7.5 percent decrease in potentially radical patents relative to total patents ($p=0.003$), a 5.6 percent decrease in patents citing unfamiliar technology ($p=0.013$), and a 2.1 percent increase in patents citing emerging technology ($p=0.339$).

The size and direction of the effect of pure index mutual fund ownership on patents citing emerging technology was initially surprising. However, further reflection and empirical analysis provide some context. First, patents citing emerging technology are those for which the average age of patents cited by the focal patent is less than two years. This is rather stringent criteria, resulting in far fewer such patents than potentially radical patents or patents citing unfamiliar technology. By virtue of a smaller baseline, even small absolute changes will translate into larger percent-changes. Second, with respect to the direction of the effect, patents citing emerging technology may be a relatively noisy indicator of distant search because distance between the emerging technology that is being cited and a firm's existing knowledge and capability base may vary quite a bit. Moreover, in supplementary analyses, we find that the relationship between pure index mutual fund ownership and patents citing emerging technology becomes more negative as firm size increases. This raises the intriguing possibility that building on emerging technologies is relatively more exploratory for larger firms than smaller firms. Exploring this relationship, however, goes beyond the scope of the current paper.

Table D. Estimated Effect of Index Ownership on Types of Exploration (OLS)

	DV: ln(1 + # Potentially Radical Patents), t+2		DV: ln(1 + # Patents Citing Unfamiliar Technology), t+2		DV: ln(1 + # Patents Citing New Technology), t+2	
	Full Sample	Technology-intensive	Full Sample	Technology-intensive	Full Sample	Technology-intensive
	(1)	(2)	(3)	(4)	(5)	(6)
ln(% Pure index ownership)	-0.143	-0.089	-0.081	-0.066	0.004	0.024
	[0.022]	[0.030]	[0.019]	[0.026]	[0.016]	[0.025]
	(0.000)	(0.003)	(0.000)	(0.013)	(0.826)	(0.339)
ln(% Other index ownership)	-0.019	-0.010	0.003	0.002	-0.008	-0.015
	[0.021]	[0.027]	[0.019]	[0.026]	[0.012]	[0.019]
	(0.348)	(0.704)	(0.885)	(0.938)	(0.516)	(0.448)
ln(% Active MF ownership)	0.018	0.007	0.003	-0.001	-0.011	-0.023
	[0.012]	[0.015]	[0.010]	[0.013]	[0.008]	[0.011]
	(0.133)	(0.649)	(0.800)	(0.951)	(0.145)	(0.034)
ln(% Unclassified MF ownership)	-0.016	-0.013	0.001	0.008	-0.026	-0.032
	[0.015]	[0.019]	[0.012]	[0.016]	[0.010]	[0.014]
	(0.263)	(0.485)	(0.905)	(0.634)	(0.011)	(0.024)
ln(% Non-MF institutional ownership)	0.131	0.124	0.053	0.075	0.037	0.053
	[0.024]	[0.028]	[0.018]	[0.022]	[0.023]	[0.029]
	(0.000)	(0.000)	(0.004)	(0.001)	(0.097)	(0.070)
Time	-0.104	-0.085	-0.010	0.010	-0.035	-0.049
	[0.019]	[0.027]	[0.016]	[0.023]	[0.011]	[0.018]
	(0.000)	(0.002)	(0.544)	(0.660)	(0.002)	(0.006)
Patent control	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	No	No	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.273	0.289	0.418	0.389	0.117	0.153
Number of firms	1,456	912	1,456	912	1,456	912
Number of observations	11,649	6,819	11,649	6,819	11,649	6,819

Note: Robust standard errors clustered by firm are reported in brackets, followed by two-sided p values in parentheses. There are nine additional controls included in each regression: ln(Analyst coverage), ln(Patent stock), ln(R&D stock), ln(Sales), Cash flow per share, ln(Capital to labor ratio), ln(Market capitalization), Product market competition, ln(Industry sales average). Patent offset refers to the inclusion of ln(# patents),t+2 in the model where the coefficient is constrained to 1.

Appendix E: Additional 2SLS Analyses

In this section, we include additional analyses using assets under the management (AUM) of pure index mutual funds as an instrument for pure index mutual fund ownership. More specifically, for each firm, we calculate the assets under management of pure index mutual funds whose benchmark indices include that firm. This means there is both within-firm variation in the AUM measure over time and across-firm variation within a given year. Figure D.1 illustrates differences in assets under by management by pure index funds tracking the S&P 500 versus other key indices. To calculate this AUM measure, we first calculated the sum of assets under the management of pure index mutual funds tracking indices that include at least some U.S. firms. This data come from the Thomson Reuters s12 filings. Next, for all firms that are not included in the S&P 500 at a given point in time, we subtracted assets under the management of pure index funds with benchmark index S&P 500 or any subset of the S&P 500 (e.g., S&P 500 sector indices) from the total AUM. We identified pure index mutual funds tracking the S&P 500 by flagging funds based on fund names or holding about 500 firms in their portfolios, followed by manual verification.

By similar methods, we subtracted assets under the management of pure index funds with benchmark index S&P 400 or any subset of the S&P 400 from the total AUM for all firms outside the S&P 400. We subtracted assets under the management of pure index funds with benchmark index S&P 600 or any subset of the S&P 600 from the total AUM for all firms outside the S&P 600. We subtracted assets under the management of pure index funds with benchmark index S&P 1500 or any subset of the S&P 1500 from the total AUM for all firms outside the S&P 1500. We subtracted assets under the management of pure index funds with benchmark index Russell 1000 or any subset of the Russell 1000 from the total AUM for all firms outside the Russell 1000. We subtracted assets under the management of pure index funds with benchmark index Russell 2000 or any subset of the Russell 2000 from the total AUM for all firms outside the Russell 2000. We subtracted assets under the management of pure index funds with benchmark index Russell 3000 or any subset of the Russell 3000 from the total AUM for all firms outside the Russell 3000. We limited this exercise to the S&P and Russell indices because we were unable to obtain sufficient historical constituent information for other indices, but these are popular sets of indices for pure index mutual funds to track and represent a significant portion of the variation in assets under management during our sample period. We shorten our sample to cover the years 1991-2001, 2003-2009 because asset data was incomplete in 2002 and beyond 2009.

Figure D.1 Assets Under the Management of Pure Index Mutual Funds

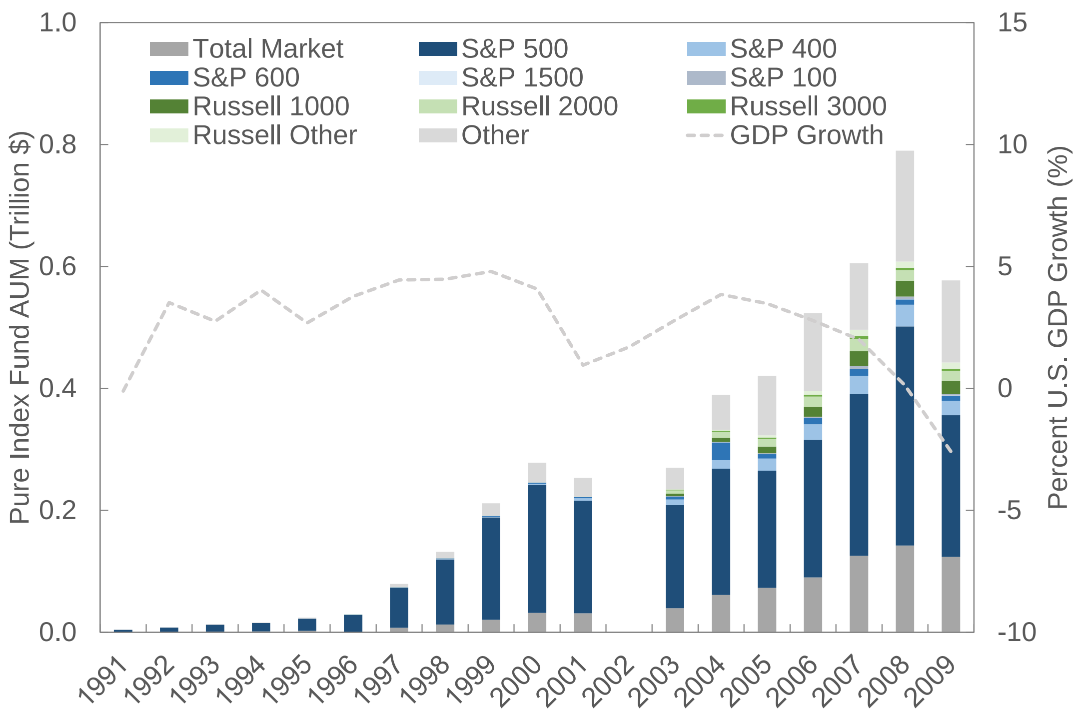
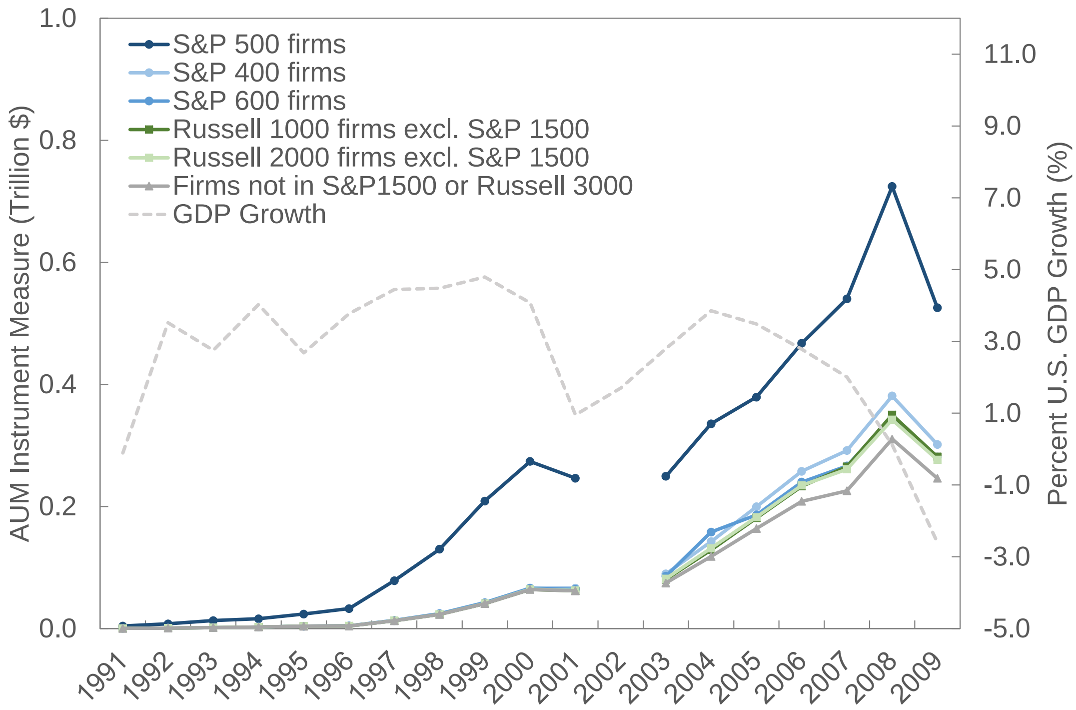


Figure D.2 illustrates some of the variation this measure can produce. The chart shows that in a given year, a firm in the S&P 500 is going to have a higher AUM instrument value that a firm outside the S&P 500. Firms that are outside of all the S&P and Russell indices consistently have the lowest AUM instrument value.

Figure D.2 AUM Instrument for Firms in Various Key Indices



The main results of the 2SLS analyses using the AUM measure as an instrument for the percent of pure index mutual fund ownership are displayed in Table 5 and discussed in the main text. Table E displays 2SLS estimates for R&D expenditures and exploratory patenting, as well as exploitative patenting for the technology-intensive subsample. For R&D expenditures and exploratory patenting, the direction of effects is the same as in the main analysis, but coefficients are larger and p-values lower. Notably, the p=0.021 for the effect pure index ownership on exploratory patenting in the naïve regression in Column (4). The naïve estimate on pure index ownership for exploitative patenting is positive but the 2LS estimate is negative.

Table E. Estimated Effect of Index Ownership on R&D Investment (2SLS)

	DV: ln(R&D), t+1	DV: ln(% Pure index own.)	DV: ln(R&D), t+1	DV: ln(1 + # Explor. Patents), t+2	DV: ln(% Pure index own.)	DV: ln(1 + # Explor. Patents), t+2	DV: ln(1 + # Exploit. Patents), t+2	DV: ln(% Pure index own.)	DV: ln(1 + # Exploit. Patents), t+2
	Naïve	1st Stage	2nd Stage	Naïve	1st Stage	2nd Stage	Naïve	1st Stage	2nd Stage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pure index MF assets (Trillion $)		1.617			1.401			1.401	
		[0.091]			[0.105]			[0.105]	
		(0.000)			(0.000)			(0.000)	
ln(% Pure index ownership)	0.113		0.801	-0.066		-0.527	0.031		-0.051
	[0.059]		[0.117]	[0.029]		[0.107]	[0.017]		[0.057]
	(0.056)		(0.000)	(0.021)		(0.000)	(0.077)		(0.376)
ln(% Other index ownership)	0.013	0.067	-0.044	0.121	0.088	0.172	-0.019	0.088	-0.011
	[0.044]	[0.017]	[0.048]	[0.026]	[0.020]	[0.030]	[0.020]	[0.020]	[0.021]
	(0.764)	(0.000)	(0.365)	(0.000)	(0.000)	(0.000)	(0.339)	(0.000)	(0.595)
ln(% Active MF ownership)	-0.024	0.029	-0.054	-0.007	0.029	0.019	-0.023	0.029	-0.020
	[0.030]	[0.009]	[0.030]	[0.014]	[0.011]	[0.015]	[0.010]	[0.011]	[0.010]
	(0.432)	(0.001)	(0.073)	(0.584)	(0.006)	(0.215)	(0.017)	(0.006)	(0.045)
ln(% Unclassified MF ownership)	0.035	0.034	0.012	0.018	0.011	0.040	-0.001	0.011	0.000
	[0.030]	[0.011]	[0.032]	[0.017]	[0.015]	[0.018]	[0.012]	[0.015]	[0.012]
	(0.240)	(0.003)	(0.708)	(0.301)	(0.443)	(0.024)	(0.933)	(0.443)	(0.979)
ln(% Non-MF institutional ownership)	0.135	0.048	0.096	0.092	0.036	0.112	0.020	0.036	0.025
	[0.051]	[0.013]	[0.049]	[0.024]	[0.018]	[0.027]	[0.016]	[0.018]	[0.016]
	(0.008)	(0.000)	(0.050)	(0.000)	(0.045)	(0.000)	(0.206)	(0.045)	(0.125)
Time	0.110	0.044	0.064	-0.005	-0.066	0.028	-0.004	-0.066	-0.005
	[0.044]	[0.014]	[0.040]	[0.023]	[0.018]	[0.025]	[0.016]	[0.018]	[0.016]
	(0.012)	(0.002)	(0.114)	(0.824)	(0.000)	(0.255)	(0.805)	(0.000)	(0.763)
Patent offset				Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	No	No	No	No	No	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.328	0.629	0.170	0.511	0.666	0.474	0.779	0.666	0.779
Kleibergen-Paap rk Wald F statistic			317.347			176.63			176.63
Number of firms	917	917	917	721	721	721	721	721	721
Number of observations	7,511	7,511	7,511	5,261	5,261	5,261	5,261	5,261	5,261

Note: Robust standard errors clustered by firm are reported in brackets, followed by two-sided p values in parentheses. There are additional controls included in each regression: ln(Analyst coverage), ln(Patent stock), ln(Sales), Cash flow per share, ln(Capital to labor ratio), ln(Market capitalization), include GDP growth and indicator variables for membership in the S&P 500, 400, 600, and Russell 1000, 2000 indices. ln(R&D stock) is also included as a control in columns (4)-(9). Patent offset refers to the inclusion of ln(# patents),t+2 in the model where the coefficient is constrained to 1.