Common Owners as Active Monitors: A Theory of Rational Neglect

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Abstract

I propose a novel mechanism of how common ownership affects product market competition. Internalization of shareholders' portfolio interests into managers' objective functions is no longer necessary if owners can provide active monitoring that affects firms' ability to compete. Whenever product market externalities cause common owners to neglect monitoring, firms are less competitive compared to a counterfactual where shareholder interests are aligned with firm value maximization. I formally prove this intuition in a static model of active monitoring with common ownership that allows for heterogeneous firms and portfolio allocations. Based on the game's unique Nash equilibrium, I derive empirical predictions that link unobserved active monitoring to observed product market outcomes. I conclude with a brief analysis of two policy interventions aimed at curbing the anti-competitive effects of common ownership.

Keywords:

Common ownership, corporate governance, industrial organization, product markets

JEL: G34, L13

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1. Introduction

"Although proxy voting at shareholder meetings is important, ... We believe that engaging in direct discussions with the leaders and directors of the companies in which the Vanguard funds invest is a particularly effective way for us to advocate for our views. During our conversations with corporate leaders and board members, we strive to provide constructive input that will better position companies to deliver sustainable value over the long term for all investors." - Vanguard proxy voting guidelines, cited in Rock and Rubinfeld (2018) p. 43.

...

"One should therefore not expect large diversified mutual fund families to actively push for more aggressive product market behavior between portfolio firms, given that doing so would not only be costly, but also go against incentives to maximize the value of the family's total portfolio." - Azar et al. (2018) p. 1552.

A recent and controversially discussed strand of empirical literature investigates the product market effects of common ownership of natural competitors by large, diversified shareholders.[2] The central hypothesis of this literature is that the rise of institutional ownership[3] is causally linked to a decline in product market competition in the U.S. and thereby a loss in consumer surplus. Azar et al. (2018) propose that *doing nothing* on the part of institutional investors is a sufficient mechanism to reduce competition among portfolio firms because managers prefer a quiet life and competing aggressively is personally costly. This proposition however is at odds with the self-reported source of value creation by institutional investors as well as a long standing literature that studies active monitoring and intervention by large shareholders both theoretically and empirically.[4] The present paper bridges the gap in these literatures and reconciles these divergent views in a theoretical framework.

I propose a model of common ownership founded on the first principle of self-interested agents. That is, instead of assuming that firms' managers voluntarily internalize the portfolio interests of their shareholders, internalization arises endogenously through investors' strategic decisions. To this end, I build on the literature on active monitoring. Rather than confining investors to an entirely passive role, they can exert privately costly effort to enhance the competitive characteristics of the firms in their portfolio and thus increase the expected return from holding their shares. For instance, shareholders might push managers to develop higher quality products that better meet the requirements of the product market or they might prevent the consumption of costly perks such as private jets in order to reduce the cost per unit of production in the firm.

Intuitively, some amount of active monitoring always seems beneficial on a firm-by-firm basis. This is

[2]See Schmalz (2018) for a comprehensive review.

[3]Gilje et al. (2020) estimate that while nearly 80% of possible combinations of U.S. public firm pairs had no institutional common owner in 1980 this number has shrunk to less than 10% in 2012. Using sample data for 1,240 U.S. firms, Edmans and Manso (2011) estimate that about 88% of sample firms had at least one institutional investor holding more than 5% of shares in 2001.

[4]See Edmans (2014) for a comprehensive review.

no longer guaranteed to be the case when investors have ownership stakes in multiple firms in the same industry who compete imperfectly with one another. Suppose an investor holds shares in two firms competing in a duopoly and that she correctly anticipates the strategic decisions of the managers controlling these firms. Assume for simplicity that managers' incentives are perfectly aligned with the maximization of their respective firms' value. Then, simply matching marginal costs and marginal benefits of active monitoring for each firm is sub-optimal for the investor because, given the investor's monitoring effort, both managers compete more aggressively which imposes a negative externality on competitor's profits and thereby the investor's portfolio.

Figure 1 illustrates the decreasing optimal active monitoring efforts of an investor whose $1/N$-portfolio spans an increasing number of identical firms competing in the same product market. Here, a *common owner* is an investor that correctly internalizes the between firm externalities from imperfect competition whereas a *concentrated owner* simply matches marginal costs and marginal benefits on the level of individual firms. As suggested above, the active monitoring efforts of a concentrated owner consistently dominate the monitoring by a common owner.

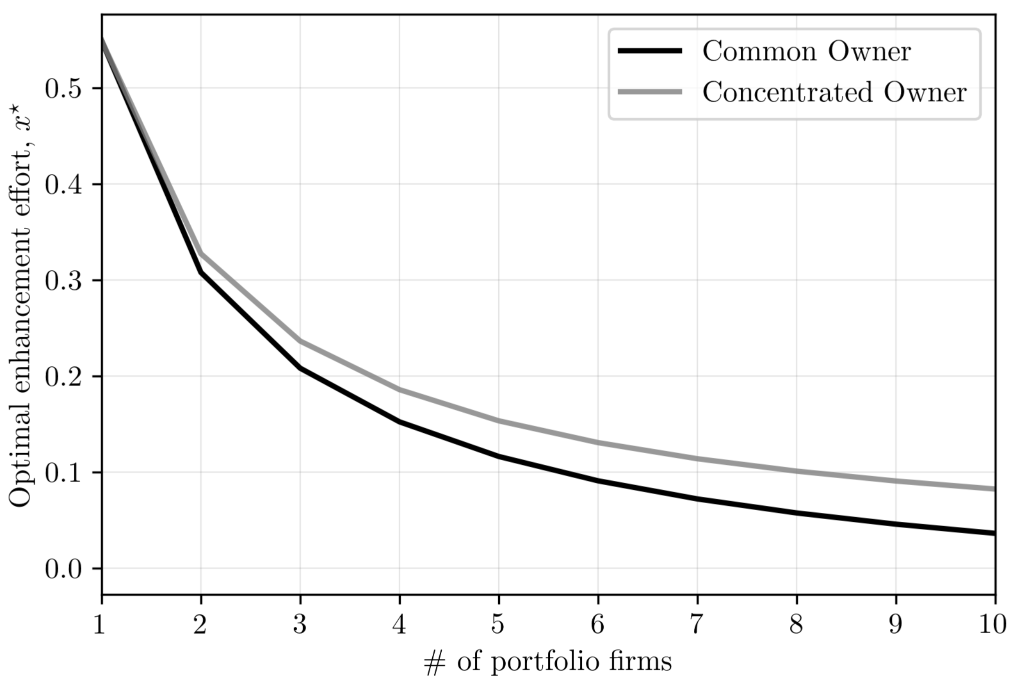

Figure 1: *Optimal active monitoring effort for concentrated and common owners of a* $1/N$ *portfolio.* This figure depicts the decreasing optimal active monitoring efforts of an investor whose portfolio is successively split into equal-sized holdings $\alpha = 1/N$ in otherwise identical firms. The black line indicates the effort choices of such an investor who is a common owner. The grey line indicates the counterfactual effort choices of a group of N concentrated owners where each holds α shares in exactly one firm and invest $(1-\alpha)$ of her endowment in the risk-free asset. Firms are symmetric with parameters $u = c = 1$ and the number of firms competing in the industry is equal to 10 for all points on the x-axis. Active monitoring efforts under common and concentrated ownership exhibit increasing differences as the investor becomes more and more thinly spread.

The main part of this paper formally proves the intuition of these examples in a general setting. I show that, within the model framework, the active monitoring decisions of a common owner are characterized by a unique Nash equilibrium which is robust to heterogeneous portfolio allocations and ex-ante firm-level parameters as well as modes of competition among firms in the product market. This property is important for two reasons. First, it allows a much needed departure from the literature's standard building block of a fully symmetric game. Common ownership is not evenly distributed among publicly listed firms in the U.S. and it is therefore unlikely that all managers wish to soften product market competition uniformly.[5] Canonical models of common ownership are not built to accommodate such industry structures. Second, uniqueness of a Nash equilibrium in pure strategies is advantageous from an empirical point of view because the model lends itself well to implementation in a structural estimation for arbitrary combinations of parameters. This may help to overcome some of the inherent endogeneity concerns in common ownership research.

Furthermore, I relate the investor's unobserved active monitoring choices to observable, firm-level product market outcomes and to consumer surplus. I show that, within the model, firms' markup ratios and share of total consumer demand are monotonically increasing in the investor's active monitoring of the firm. Therefore these characteristics are fully revealing of the investor's monitoring effort, ceteris paribus. Since these are equilibrium properties, they are furthermore strictly positively associated with consumer surplus. This is not generally the case for product prices and market shares that depend on them. This is because when product prices depend on both, utility of consumption and cost of production, and the investor can choose to enhance either, then the comparative statics are only well defined if the chosen technology is observed by the econometrician. This may be partially possibly but it is highly unlikely to retrospectively observe this data over decades in a broad sample of industries. Hence product prices and other measures that do not take possible changes in production costs into account are unsuitable to identify changes in investors' active monitoring of firms.

Finally, I conduct brief analysis of two potential policy interventions based on the burgeoning anti-trust debate surrounding common ownership. Specifically, I study the equilibrium change in the investor's active monitoring from imposing an upper bound on ownership stakes or encouraging more concentrated portfolios within the industry in a simple setting. On the one hand, imposing upper bounds on ownership while maintaining within-industry diversification further reduces the investor's incentive to exert privately costly effort and thus amplifies the adverse effects associated with common ownership. I expect such a measure to have a strictly negative impact on consumer surplus. On the other hand, encouraging more concentrated portfolio allocations within the industry (or reducing the internalization of product market externalities) strictly increases effort provision by the investor in equilibrium. Hence I expect such a measure to have a strictly positive impact on consumer surplus. This is, of course, without consideration of the welfare losses due to reduced portfolio diversification. Taken together, these policy experiments suggest that regulators should refrain from hasty intervention to curb common ownership

[5] See Gilje et al. (2020) for the determinants of common ownership and Backus et al. (2020) for equilibrium strategies in the presence of maverick firms.

until a clear mechanism of harm is identified and empirically confirmed.

My paper contributes to two distinct streams of literature. On the one hand, this paper extends the literature studying the product market effects of common ownership (Rotemberg (1984]), Reynolds and Snapp (1986) Hansen and Lott (1996), Salop and O'Brien (2000), Matvos and Ostrovsky (2008), He and Huang (2017), O'Brien and Waehrer (2017) Azar et al. (2018), Dennis et al. (2021), Brooks et al. (2018), Backus et al. (2020), Gilje et al. (2020), Koch et al. (2021), Ederer and Pellegrino (2022), Saidi and Streitz (2021), Lewellen and Lowry (2021) and many others). The large majority of this literature builds on Rotemberg (1984]) and *assumes* that managers internalize the portfolio interests of their shareholders when making their strategic decisions. Product market outcomes result from these strategic decisions in equilibrium, while product characteristics are considered exogenous. Notable exceptions within this literature that share similarities with this paper include the contributions of López and Vives (2019) and Antón et al. (2022). In both papers, managers have the opportunity to exert costly effort to reduce marginal costs of production which is also one of two possible enhancement technologies proposed in this paper. Moreover, Antón et al. (2022) propose a mechanism, management incentive contracts, through which a *majority* shareholder can influence the firm objective function such that management unknowingly incorporates her portfolio interests. The present paper differs from these contributions because the mechanism of harm does not rely on the presence of a majority owner. Therefore it avoids the potential coordination problem when multiple shareholders with different portfolio objectives are present.[6] In addition, this paper considers an alternative channel, utility of consumption or quality, by which owners can affect firm primitives and thereby product market outcomes. I show that in particular product prices can exhibit opposite dynamic w.r.t. enhancement efforts in utility of consumption or cost of production and that other observable product market outcomes are much better suited for empirical investigation.

On the other hand, my work is closely related to the well established literature on active monitoring of firms by owners of large blocks of shares (Shleifer and Vishny (1986), Burkart et al. (1997), Bolton and Von Thadden (1998), Maug (1998), Carleton et al. (1998), Brav et al. (2008), Cronqvist and Fahlenbrach (2009), Edmans and Manso (2011) Appel et al. (2016), McCahery et al. (2016), Fos (2017), Lewellen and Lewellen (2022), Albuquerque et al. (2022) and many others). Most contributions in this literature study the interaction of a single firm and one or several of its shareholders. Firms' product market environment is typically taken as given or entirely abstracted from. The present paper shares similarities with the contributions of Admati et al. (1994) and Edmans et al. (2019), whose theoretical models generally include multiple links between firms and shareholders. Admati et al. (1994) is the first paper to analyze the active monitoring efforts of a single investor with ownership stakes in multiple firms. My paper differs from the contribution of these authors because their emphasis is on securities trading in an asset pricing equilibrium and abstracts from product market competition. Conversely, I allow for imperfect competition among firms and focus on product market effects when an investor holds shares of multiple firms

[6]While the model features only one institutional investor that has the capability to exert costly effort, extensions to multiple shareholders are straightforward so long as the perfect information assumption is maintained.

in the same industry. Notably, Admati et al. (1994) anticipate the effects of common ownership on the investor's incentive to actively enhance firms in their concluding remarks. Yet, the gap in the literature has remained until the advent of the present paper.

Edmans et al. (2019) provide a counterexample to the common wisdom that diversification weakens corporate governance by spreading investors too thinly. The authors show that common ownership can strengthen governance if an investor has discretion about which firms' shares to sell in the event of a liquidity shock. Importantly, common ownership in Edmans et al. (2019) spans a set of unrelated firms whose strategic decisions do not impose externalities on one another. This is different in my paper. When portfolio firms are product market competitors, common ownership amplifies the negative effect of having stakes across multiple firms on the investors' monitoring decision. Figure 1 illustrates this effect for a $1/N$ portfolio comprised of an increasing number of identical firms in the same industry. As a result, despite the standard assumptions in the formulation of the model, it may be optimal for the investor to do nothing at all. The proof of this intuition lends formal support to a conjecture of Azar et al. (2018) that neglecting active monitoring is a sufficient channel through which common ownership can reduce product market competition and consumer surplus.

The rest of this paper is organized as follows. In section 2, I introduce the setting of the theoretical model including players, information, moves and payoffs as well as the technologies through which the investors' active monitoring decisions affect product market outcomes. I analyze the model in section 3. In subsection 3.1, I prove that product market competition is characterized by a unique Nash equilibrium and I derive comparative statics of product market outcomes w.r.t. active monitoring effort. In subsection 3.2, I establish that an investor's monitoring effort is uniquely determined by a fixed point in a single dimension and I analyze the equilibrium effects of two potential policy interventions related to recent proposals in the anti-trust literature. Section 4 concludes the main part of the paper. I demonstrate that the model extends to an alternate mode of competition in Appendix A and verify the robustness of my predictions in a simulation study in Appendix B.

2. Model

2.1. Setting

This model demonstrates a potential conflict of interest that arises between a large, diversified institutional investor (a blockholder) and the managers running the firms in her portfolio, even though managers are trying to maximize their respective firm's value. In the model, I consider a game, denoted $\mathcal{G}$, that consists of a mass 1 of consumers, N firms engaged in imperfect competition in a single industry, and a singular institutional investor. The game is played in three stages designated as investment stage, enhancement stage and competition stage. Let $\mathcal{G}_1$, $\mathcal{G}_2$ and $\mathcal{G}_3$ denote the subgames associated with these stages respectively.[7] Information is perfect at all stages of the game. The timeline of the game is depicted in figure 2.

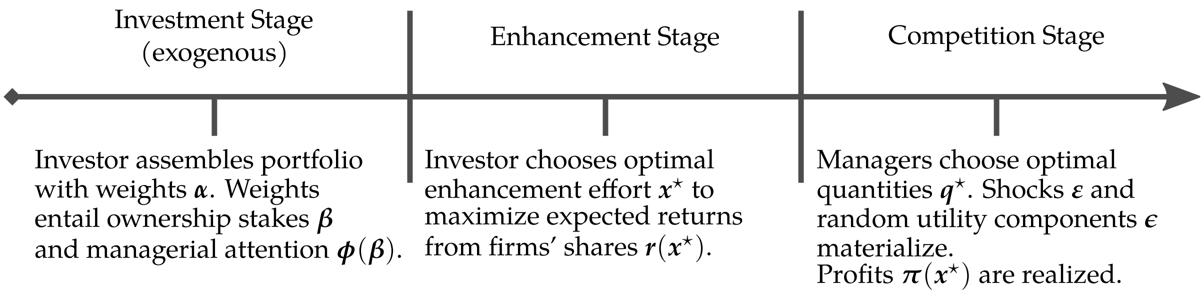

Figure 2: *Timeline of the model.* In the investment stage the investor forms a portfolio characterized by the vector of weights $\boldsymbol{\alpha}$. Taking her portfolio as given, in the enhancement stage, she then optimally chooses monitoring effort associated with portfolio firms to maximize her expected return from holding the shares. After monitoring efforts are made to enhance firms' competitiveness, consumers learn their preferred products through random utility and firms' managers choose output quantities optimally to maximize profits in the competition stage.

2.1.1. Investment stage

Portfolio formation. In the first stage of the game, the institutional investor forms a portfolio that may consist of the N firms' shares and a risk-free outside alternative, such as a treasury bond. I assume the outcome of this stage to be exogenously given and I do not formulate the underlying economic optimization problem.[8] The N firms operating in the industry are all-equity financed with a single share outstanding and any combination of firms can be considered to form the portfolio.[9] Let ν_j denote the ex-ante log value of firm j's share.[10] I assume that the institutional investor has an initial endowment equal to 1. After the investor has chosen her portfolio allocation, represented by the vector $\boldsymbol{\alpha}$, this initial endowment and the vector of ex-ante log values $\boldsymbol{\nu}$ fully determine the ownership stakes in each firm. Let $\boldsymbol{\beta}$ denote this vector of resulting ownership stakes. I assume that the investor is short-sale constrained and that each firm is assigned a weakly positive portfolio weight such that the total sum of weights in the industry is less than or equal to one, i.e.

$$\mathbf{1}'\boldsymbol{\alpha} \leq 1, \quad \text{and} \quad \alpha_j \geq 0 \quad \forall j \in N \tag{1}$$

Any remaining funds of the investor are invested in risk-free asset. Furthermore, I assume that all remaining fractional shares of the N firms are held by a diffuse mass of marginal shareholders. These marginal

[7] Naturally, the subgame associated with the investment stage, $\mathcal{G}_1$, is the full game, $\mathcal{G}$.

[8] In the simplest case, the investor is the manager of a mutual fund that physically replicates a given index like the S&P500 or the Russell 1000. In this case her investment decisions are fully determined by the portfolio weights of the index and the savings and withdrawal decisions of the fund's investors. Since the fund manager is rewarded based on management fees proportional to assets-under-management at the end of the game, her optimization problem is fully described by the subgame beginning in the enhancement stage.

[9] Importantly, this allows that the shares of some firms are not part of the portfolio.

[10] The specification of an initial value is a technical assumption needed to characterize the return from holding firms' shares as ex-post log profit minus ex-ante log value. This paper does not attempt to price firms' assets in a financial market equilibrium.

owners are assumed passive and will not engage in any monitoring efforts or governance activities for the remainder of the game.

Managerial attention. Each firm is run by a manager. These managers observe the ownership stakes in their respective firm and decide how much *attention* to pay to each individual owner. In the context of the model, attention refers to the managers' willingness to spend time and privately costly effort to engage and cooperate with owners who wish to monitor the firm. Since manager may have the opportunity to work with a multitude of shareholders, attention is a reduced form representation of a coordination problem among shareholders and managers. Economically, attention acts a limiting factor for individual investor's attempts to improve the firm through costly effort provision. I assume that managers are endowed with an attention budget equal to 1 and that they allocate attention non-strategically,[11] in a manner that is weakly increasing in ownership stakes, i.e.

$$\phi_j(\beta_j = 0) = 0, \quad \text{and} \quad \phi_j(\beta_j = 1) = 1, \quad \text{and} \quad \frac{\partial \phi_j}{\partial \beta_j} \geq 0 \quad \forall j \in N \tag{2}$$

After the portfolios of the investor and the marginal shareholders are formed and managers have decided their willingness to pay attention, the game proceeds to the next stage.

2.1.2. Enhancement stage

Conflict of interest. The modeling of this stage is the central innovation of this paper. Between portfolio formation and the realization of returns, in the second stage, the investor has the option to exert costly effort to actively monitor the managers of the firms in her portfolio. I assume that monitoring can take a variety of forms but that it is always positively related to firms' competitiveness in the product market and the subsequent expected returns from holding shares.[12] For instance, the investor could engage in costly market research to better understand the needs of potential customers and advise the manager how to best meet these requirements and create more desirable products. Alternatively, the investor could direct her efforts to preventing managerial perk consumption, thus lowering the total cost of operations in the firm. To encompass all these forms of active ownership, I model active monitoring in reduced form as continuously differentiable effort choice by the investor. Therefore, irrespective of specific goal of monitoring, the institutional investor always trades off the private cost of effort against the increased expected return of her portfolio optimally. Yet, this trade-off may be subject to an externality in the presence of common ownership when portfolio firms are engaged in imperfect competition. A conflict of interest emerges, in spite of managers attempting to maximize firm value.

[11] In this paper there is only one investor with the means to exert costly effort to enhance the firm. In the absence of a moral hazard problem a strategic manager should allocate all attention to this investor. If multiple such investors with different ownership stakes and portfolios are present, a strategic manager might choose to allocate most attention to the investor whose interests are best aligned with her own incentives.

[12] This is consistent with Lewellen and Lewellen (2022) who study institutional investors' incentives and find that they should be willing to bear a private cost of 236,300$ in order to engage with management and realize a one-time 1% increase in firm value.

Returns. I begin the definition of the investor's problem with a specification of returns from holding firms' shares. Let $\boldsymbol{\pi}$ denote the vector of firms' log profits from competing in the industry and let $\boldsymbol{\varepsilon}$ represent a vector of multivariate normal innovations with covariance matrix $\boldsymbol{\Sigma}$ that captures risks unrelated to product market competition. I assume that monitoring effort affect firms' profits and establish the micro-founded relationship below. Let $\boldsymbol{x}$ denote the vector of monitoring efforts exerted by the institutional investor. I require that each element x_j in the vector of effort choices satisfies $x_j \geq 0$, i.e. the investor cannot take action to distract a manager or otherwise hamper a firm's competitiveness directly. Finally, I assume that firms' assets are liquidated with a scrap value of zero at the end of the game. Taken together with the vector of firms' ex-ante log valuations, $\boldsymbol{\nu}$, the vector of log returns from holding firms' shares, denoted $\boldsymbol{r}$, is thus defined as

$$\boldsymbol{r}(\boldsymbol{x}) = \boldsymbol{\pi}(\boldsymbol{x}) - \boldsymbol{\nu} + \boldsymbol{\varepsilon} = \boldsymbol{\mu}(\boldsymbol{x}) + \boldsymbol{\varepsilon} \tag{3}$$

where $\boldsymbol{\mu}$ represents the vector of expected log returns given the investor's effort choices. Considering that the portfolio allocation was fixed in the investment stage, optimally choosing this vector is of sole interest to the institutional investor in the subgame $\mathcal{G}_2$.

Investor's problem. I assume that the investor is risk-neutral and that her optimization problem in the enhancement stage is fully characterized by equation 4, where she trades off the benefit of an increased expectation of her portfolio log return, denoted $\overline{r}(\boldsymbol{x})$, against the private cost of exerting effort.

$$\max_{\boldsymbol{x}} \Omega(\boldsymbol{x}) = \max_{\boldsymbol{x}} \left[\mathbb{E}[\overline{r}(\boldsymbol{x})] - \frac{1}{2}\boldsymbol{x}'\boldsymbol{x} \right] \tag{4}$$

I follow Campbell and Viceira (2002) and Dahlquist et al. (2017) who approximate the expected log return of a portfolio of log normally distributed returns as

$$\mathbb{E}[\overline{r}(\boldsymbol{x})] = \overline{\mu}(\boldsymbol{x}) \approx r_0 + \boldsymbol{\alpha}' \left(\boldsymbol{\mu}(\boldsymbol{x}) - r_0 \mathbf{1} + \frac{1}{2}\boldsymbol{\sigma}^2 \right) - \frac{1}{2}\boldsymbol{\alpha}'\boldsymbol{\Sigma}\boldsymbol{\alpha} \tag{5}$$

where r_0 is the return on the risk-less asset, $\mathbf{1}$ is a vector of ones and $\boldsymbol{\sigma}^2$ is a vector containing the diagonal entries of the covariance matrix $\boldsymbol{\Sigma}$. Plugging the approximation of the expected portfolio log return from equation 5 into the investor's objective function in equation 4 and collecting all terms unaffected by effort into a constant C, I obtain the central optimization problem of this paper given by

$$\max_{\boldsymbol{x}} \Omega(\boldsymbol{x}) \approx \max_{\boldsymbol{x}} \left[\boldsymbol{\alpha}'\boldsymbol{\pi}(\boldsymbol{x}) - \frac{1}{2}\boldsymbol{x}'\boldsymbol{x} + C \right] \tag{6}$$

whereas the primary innovation comes from the assumption of imperfect competition among portfolio constituent firms. In the analysis, I show that this assumption leads to a situation where the monitoring effort in one firm can adversely affect the returns on the stocks of competing firms, which in turn reduces the optimal level of active monitoring.

Enhancement technology. Before discussing the competition stage, it remains to specify the technology that transforms monitoring effort by the investor into tangible improvements of firms' competitiveness. I assume that each firm produces and sells a single, differentiated good and that two distinct technologies for firm enhancement exist. I designate these technologies as *utility enhancement* and *cost reduction*. To represent both, I introduce three parameter vectors denoted $\boldsymbol{u}^\star$, $\boldsymbol{c}^\star$ and $\boldsymbol{\delta}$, whereas the full mapping of these parameters into (log) profits and hence returns is discussed in section 2.1.3.

Let δ_j be a typical element of $\boldsymbol{\delta}$ associated with any given firm j. I assume δ_j denotes the known realization of a Bernoulli random variable with $\delta_j \in \{0, 1\}$. If $\delta_j = 0$, the utility enhancement technology is exogenously assigned to firm j. Otherwise, the cost reduction technology is employed to enhance firm j. Intuitively, this variable represents the manifestation of some form of untapped potential inherent in the firm's business model or management that can be overcome with the aid of an outside party. Within the framework of the model, this outside party is the investor who engages in active monitoring.

Let $u_j^\star$ be a typical element of $\boldsymbol{u}^\star$ that represents the ex-ante expected utility of consumption associated with firm j's product.[13] I assume that the expected utility is adjusted in relation to the possibility of consuming an outside alternative and that it may therefore take any real value, i.e. $u_j^\star \in \mathbb{R}$. Given the technology selection, δ_j, and the monitoring effort exerted by the investor, x_j, I define the ex-post expected utility from consuming firm j's good as

$$u_j(x_j, \delta_j) = \begin{cases} u_j^\star + \ln(1 + \phi_j x_j), & \text{if } \delta_j = 0 \\ u_j^\star, & \text{otherwise.} \end{cases} \tag{7}$$

where ϕ_j is a shorthand for the willingness of j's manager to cooperate with the institutional investor, $\phi_j(\beta_j)$.

Likewise, let $c_j^\star$ be a typical element of $\boldsymbol{c}^\star$ that represents the strictly positive ex-ante marginal cost of production of firm j's good, i.e. $c_j^\star > 0$. Given the technology selection, δ_j, and the monitoring effort exerted by the investor, x_j, I define the ex-post marginal cost of producing firm j's good as

$$c_j(x_j, \delta_j) = \begin{cases} c_j^\star, & \text{if } \delta_j = 0 \\ \ln\left[\frac{\exp(c_j^\star) + \phi_j x_j}{1 + \phi_j x_j}\right], & \text{otherwise.} \end{cases} \tag{8}$$

where the chosen functional form ensures that the resulting marginal cost of production will always remain strictly positive so long as the provided effort is finite.[14]

[13] Notice that all agents agree on the value of $u_j^\star$. This is a specific case of the more general class of random utility models. See Train (2009) for further reference.

[14] Naturally, this expression collapses to the ex-ante marginal cost of production if the institutional investor decides to not exert any monitoring effort.

I demonstrate below that either technology in itself is sufficient to increase firms' expected profits and is thus broadly consistent with the ideas expressed in Edmans and Manso (2011) where shareholders can provide costly effort to increase the value of the firm. The necessity for two distinct technologies arises from the observation that products are not generally perfect substitutes in all industries and that enhancements in expected utility and marginal cost have different effects on firms' observable characteristics in the product market equilibrium. For instance, suppose that an increase in expected utility of a given good entails an increased equilibrium output price since costumers are willing to pay a higher markup to consume that product, compared to a no-monitoring counterfactual. By contrast, the observed equilibrium price could be lower than the counterfactual price if the same amount of effort was exerted to reduce marginal costs instead. This is because managers choose output quantities (or prices) optimally to maximize the expected profits from operating the firm. This optimization problem is at the core of the final stage of the game.

2.1.3. *Competition stage*

Imperfect competition. In the final stage of the game, the competition stage, managers choose optimal output quantities to maximize their respective firm's profit.[15] I assume that managers are risk neutral and that competition in the industry is imperfect such that one manager's decision impose an externality on competing firms' outcome. Whereas the assumptions of risk neutrality and imperfect competition are standard in the common ownership literature, assuming firm value maximization constitutes a departure from the canonical theory of common ownership. Rather than *assuming* that managers internalize the portfolio interests of their owners and tacitly soften competition, I show that common ownership can adversely affect competition even if managers act under the value maximization paradigm.[16] By contrast, the theoretical literature on active monitoring usually treats the maximization of firm value in isolation of competitive forces between firms and focuses on the interrelation of investors and managers or financial markets instead.

Demand for goods. I begin the formal definition of the competition stage by specifying a suitable demand system that allows for an arbitrary number of horizontally and potentially vertically differentiated products without becoming analytically intractable.[17] The multinomial logit model developed by McFadden (1974) is a random utility demand system that satisfies this requirement.[18] Following e.g. Anderson and

[15] I consider a modification of the model to competition in prices in the appendix and find that the predictions concerning observable characteristics and monitoring effort are qualitatively identical. That is, all partial derivatives with empirical relevance have the same sign but may differ in magnitude.

[16] Notice that the canonical theory of common ownership can be nested within this model for a cumulative effect of monitoring neglect and internalization of portfolio interests. See Rötzer (2021) for an model of the competition stage in the canonical setting without effort choice.

[17] I think of horizontal differentiation as properties where consumers have no strict ordering of preferences e.g. the packaging or color of a given good. In contrast, by vertical differentiation I mean a characteristic that is preferred by all consumers given they were offered at the same price, e.g. first class seats versus second class seats.

[18] See e.g. Greene (2014) for a standard introduction of the model and its econometric properties.

de Palma (1992) or Train (2009), I assume that each marginal consumer i is presented with a menu of $N+1$ alternatives consisting of the N firms' products and a single outside good that acts as numeraire. The outside good's representative utility is normalized to zero and I assume that the same normalization is already implied in the ex-ante expected utility of consumption of the N inside goods.[19] Each consumer observes a vector of i.i.d. mean zero random innovations denoted $\boldsymbol{\epsilon}_i$ whereas each element $\epsilon_{i,j}$ is associated with one of the $N+1$ alternatives. This random vector captures non-systematic variations in preferences for product properties and thus choices across consumers and products. Upon observing expected utility of consumption, output prices and random innovations, each consumer i computes her idiosyncratic random utility for each alternative according to

$$v_{i,j} = u_j(x_j, \delta_j) - p_j(\boldsymbol{x}, \boldsymbol{\delta}) + \epsilon_{i,j} \quad \forall j \in N, \quad \text{and} \quad v_{i,0} = \epsilon_{i,0} \tag{9}$$

where index 0 denotes the outside good. Upon observing the realizations of random utility each marginal consumer purchases the option that maximizes her net utility of consumption.

McFadden (1974) shows that if a Gumbel distribution with a scale of 1 is assumed for the random utility components of individual choice, then idiosyncratic risk integrates out and the demand system entails choice probabilities and therefore demand shares[20] equal to

$$q_j(\boldsymbol{p}) = \frac{e^{u_j - p_j}}{1 + \sum_{n=1}^{N} e^{u_n - p_n}} \quad \forall j \in N, \quad \text{and} \quad q_0(\boldsymbol{p}) = 1 - \mathbf{1}'\boldsymbol{q}(\boldsymbol{p}) = \frac{1}{1 + \sum_{n=1}^{N} e^{u_n - p_n}} \tag{10}$$

where $\boldsymbol{p}$ is the vector of output prices demanded by firms in exchange for their goods. The function arguments $\boldsymbol{x}$ and $\boldsymbol{\delta}$ are omitted for brevity.

More recently, Li and Huh (2011) as well as Berry et al. (2013) and Berry and Haile (2014) prove that the multinomial logit demand system entails a one-to-one correspondence between prices and demand shares. This implies the above system of equations is invertible and the inverse demand function of inside goods can be stated as

$$p_j(\boldsymbol{q}) = u_j(x_j, \delta_j) - \ln q_j(\boldsymbol{x}, \boldsymbol{\delta}) + \ln q_0(\boldsymbol{x}, \boldsymbol{\delta}) \qquad \forall j \in N \tag{11}$$

This inverse demand function has a number of analytical advantages relative to the direct demand function and it allows me to consider competition á la Cournot as the primary theoretical model whereas the more challenging competition in prices is treated separately in the appendix.

[19]Note that expected utility itself is a reduced form representation of a (monotonic function of a linear) combination of product properties. See e.g. Brathwaite and Walker (2018).

[20]Demand shares express quantities as a fraction of total demand in the product market with the latter being equal to one by assumption of a mass 1 of consumers.

Managers' problem. Managers are risk neutral and maximize the expected profits of their respective firm by optimally choosing the share of total demand supplied to the product market. Their decisions take monitoring effort and technology assignments in all competing firms into account and they understand the inverse demand function and the probabilities underlying consumer choice. Let $\Pi_j = \exp(\pi_j)$ denote firm j's profit from competing in the product market. Then the manager's objective function is given by

$$\max_{q_j} \left[\Pi_j(\boldsymbol{q}|\boldsymbol{x},\boldsymbol{\delta})\right] = \max_{q_j} \left[q_j \left(p_j(\boldsymbol{q}|\boldsymbol{x},\boldsymbol{\delta}) - c_j(x_j,\delta_j)\right)\right] \quad \forall j \in N \tag{12}$$

where q_j is the fraction of total demand supplied by the firm, p_j is the resulting equilibrium price, c_j is the ex-post constant marginal cost of production of firm j's output. Upon making their output decision, managers have to consider the coupled constraint required by market clearing. That is, the demand shares supplied by all firms competing in the industry must satisfy

$$\mathbf{1}'\boldsymbol{q} \leq 1, \quad \text{and} \quad q_j \geq 0 \quad \forall j \in N \tag{13}$$

such that both, the product markets can clear and the inverse demand relationship holds.

Li and Huh (2011) demonstrate existence of a Nash equilibrium in pure strategies and provide a semi-closed form solution that satisfies this requirement. That is, the equilibrium play of the subgame $\mathcal{G}_3$ entails a strictly positive demand share for all goods available to consumers. I prove below that the fixed point described by this Nash equilibrium is also unique. Since rational managers will always play this unique equilibrium for a given set of parameters $\{\boldsymbol{u}(\boldsymbol{x},\boldsymbol{\delta}), \boldsymbol{c}(\boldsymbol{x},\boldsymbol{\delta})\}$, this result allows me to formulate robust testable hypothesis for empirical research.

This concludes the model description. Next, I analyze the equilibrium of the game by backward induction.

3. Analysis

3.1. Competition stage

3.1.1. Nash Equilibrium

First-order-conditions. To apply backward induction as solution concept, I take the active monitoring efforts $\boldsymbol{x}$ of the investor as given. For a given vector $\boldsymbol{x}$, let $\boldsymbol{q}^\star$ denote a vector of output choices that solves firms' first-order-conditions which are given by

$$\frac{\partial \Pi_j}{\partial q_j} = (u_j(x_j,\delta_j) - \ln q_j + \ln q_0) - c_j(x_j,\delta_j) - \left(1 + \frac{q_j}{q_0}\right) = 0 \qquad \forall j \in N \tag{14}$$

Li and Huh (2011) provide a semi-closed form solution to this system of non-linear equations and prove existence of a Nash equilibrium for the subgame $\mathcal{G}_3$ by demonstrating concavity of firms' objective functions. To build on these results, I require the definition of the following mathematical objects and quantities. Definitions 1 and 2 are used in Li and Huh (2011) and their necessity arises naturally from the set of first-order-conditions. Definition 3 is novel and allows me to prove uniqueness of the Nash equilibrium in pure strategies for the subgame $\mathcal{G}_3$.

Definition 1 (Lambert W function)**.** *The Lambert W function over the positive reals is a monotonically increasing, concave function whose unique solution $w = W(z)$ satisfies*

$$w \cdot \exp(w) = z \tag{15}$$

Definition 2 (Cost-adjusted-attractiveness)**.** *Cost-adjusted-attractiveness is a strictly positive index that relates the expected utility of a good to its marginal cost of production. It is defined as*

$$\bar{a}_j(x_j, \delta_j) = \exp\left(u_j(x_j, \delta_j) - c_j(x_j, \delta_j) - 1\right) \tag{16}$$

Definition 3 (Industry & competitor supply)**.** *Industry supply, Q, is the fraction of demand supplied by firms competing in the industry, assuming the constraints in equation 13 are non-binding. That is*

$$Q = \mathbf{1}'\boldsymbol{q} = 1 - q_0 \tag{17}$$

Likewise, competitor supply, Q_j, is the fraction of demand supplied by firm j's competitors excluding the outside good and under the same constraint as above. It is given by

$$Q_j = \mathbf{1}'\boldsymbol{q} - q_j = Q - q_j \tag{18}$$

With these necessary definitions in place, I can summarize the contribution of Li and Huh (2011) relevant to this paper in the following proposition.

Proposition 1 (Existence and solution)**.** *The subgame $\mathcal{G}_3$ associated with the competition stage has at least one Nash equilibrium in pure strategies. Let $\boldsymbol{q}^\star(\boldsymbol{x}, \boldsymbol{\delta})$ denote a vector of demand shares that satisfies managers' first- and second-order-conditions. Its entries are given by*

$$q_j^\star(\boldsymbol{x}, \boldsymbol{\delta}) = \frac{W(\bar{a}_j(x_j, \delta_j))}{1 + \sum_{k=1}^{N} W(\bar{a}_k(x_k, \delta_k))} \quad \forall j \in N \tag{19}$$

The corresponding equilibrium prices are given by

$$p_j^\star(x_j, \delta_j) = 1 + W(\bar{a}_j(x_j, \delta_j)) + c_j(x_j, \delta_j) \quad \forall j \in N \tag{20}$$

Proof. See Li and Huh (2011) section 2.3.1. □

The solution of Li and Huh (2011) is both analytically elegant and economically intuitive. First, it assigns a strictly positive demand share to every good available in the choice set of consumers. This is consistent with the underlying idea that any product offering in the industry, regardless how inferior its cost-adjusted-attractiveness, will generate some amount of fringe demand due to the variety of consumer tastes represented by the random utility component. Furthermore, it captures the notion that no single firm is able to fully seize the market unless it is willing to heavily (infinitely) subsidize the distribution of its product. Second, the solution demonstrates that, if firms compete in quantities, managers will always adjust their output decisions to maintain an optimal profit margin given their product parameters.[21] This result is appealing from an empirical perspective because it implies that econometric models using prices and margins as dependent variable do not requirea strict definition of firms' competitive environment.

What Li and Huh (2011) omit, however, is a proof that ensures that the comparative statics of the model behave in a predictable way at all times. This could be achieved, among other ways, through demonstrating that the model's comparative statics are monotone (Milgrom and Roberts (1990), Milgrom and Shannon (1994)), by application of the implicit function theorem or by proving uniqueness of the Nash equilibrium which implies that the solution vectors' comparative statics are sufficient, ceteris paribus. In what follows, I provide a proof for the latter case which, to the best of my knowledge, is novel in the industrial organization literature.

Let $\boldsymbol{H}_\Pi(\boldsymbol{q})$ denote the Hessian matrix associated with managers' objective functions evaluated for some candidate vector of demand shares, $\boldsymbol{q}$. Theorem 7 in Cachon and Netessine (2006) requires that

$$(-1)^N \det(\boldsymbol{H}_\Pi(\boldsymbol{q}^\star)) > 0, \quad \text{s.t.} \quad \left.\frac{\partial \Pi_j}{\partial q_j}\right|_{\boldsymbol{q}^\star} = 0 \quad \forall j \in N \tag{21}$$

to assert uniqueness of a Nash equilibrium in pure strategies. Therefore, this so-called index theory approach which is based on the Poincaré-Hopf theorem[22] requires a certain sign of the Hessian matrix' determinant, but this needs to hold only at the equilibrium candidate, $\boldsymbol{q}^\star$. As such, the requirement is weaker than many other concepts of uniqueness but also more challenging to prove. However, the requirement on the determinant is trivially satisfied if $\boldsymbol{H}_\Pi(\boldsymbol{q}^\star)$ is negative definite since negative defineteness implies that all eigenvalues of the Hessian are strictly negative and the determinant is the product of those eigenvalues. With the strict positivity and interiority of the equilibrium candidate vector $\boldsymbol{q}^\star$ proven by Li and Huh (2011) in proposition 1, it remains to demonstrate negative definiteness of the Hessian matrix for this candidate vector.

Proposition 2 (Uniqueness)**.** *The subgame $\mathcal{G}_3$ associated with the competition stage has a unique Nash equilibrium in pure strategies.*

Proof. I establish the uniqueness property in a series of steps. I begin by substituting $1 - Q = 1 - q_j - Q_j$ in place of q_0 in the system of first-order-conditions that defines the Nash equilibrium. In what follows

[21] I show in the appendix that this is not the case when firms compete in prices because managers need to reconsider their pricing decisions when a competitor becomes more or less competitive.

[22] See also Guillemin and Pollack (1974) for a rigorous treatment in differential topology.

all quantities are understood as equilibrium quantities, i.e. $q_j = q_j^\star$, $Q_j = Q_j^\star$ and $Q = Q^\star$.

Diagonal entries of the Hessian matrix. Taking the derivative of managers' first-order-conditions w.r.t. their own firm's demand share, q_j, yields the diagonal entries of the Hessian matrix, $\boldsymbol{H}_\Pi(\boldsymbol{q}^\star)$. These elements are given by

$$\frac{\partial^2 \Pi_j}{\partial q_j^2} = -\frac{\left(1 - Q_j\right)^2}{q_j\left(1 - q_j - Q_j\right)^2} < 0 \qquad \forall j \in N \tag{22}$$

For any firm j, given the proposed equilibrium vector of production decisions, this expression is strictly negative because industry supply is strictly below aggregate demand but strictly above competitor supply, i.e., $Q_j < q_j + Q_j = Q < 1$.

Off-Diagonal entries of the Hessian matrix. The off-diagonal entries of the Hessian matrix obtained from taking cross-derivatives of managers' first-order-conditions are given by

$$\frac{\partial^2 \Pi_j}{\partial q_j \partial q_k} = -\frac{1 - Q_j}{\left(1 - q_j - Q_j\right)^2} \leq 0 \qquad \forall j \in N, \forall k \in N \setminus j \tag{23}$$

As above, these entries are strictly negative given the proposed equilibrium vector, $\boldsymbol{q}^\star$.

The Hessian matrix of profit functions. With the mathematical expressions for its entries established I state the Hessian matrix of profit functions at the equilibrium vector, $\boldsymbol{H}_\Pi(\boldsymbol{q}^\star)$, as

$$\boldsymbol{H}_\Pi(\boldsymbol{q}^\star) = \begin{vmatrix} -\frac{(1-Q_1)^2}{q_1(1-q_1-Q_1)^2} & -\frac{1-Q_1}{(1-q_1-Q_1)^2} & \cdots & -\frac{1-Q_1}{(1-q_1-Q_1)^2} \\ -\frac{1-Q_2}{(1-q_2-Q_2)^2} & -\frac{(1-Q_2)^2}{q_2(1-q_2-Q_2)^2} & \cdots & -\frac{1-Q_2}{(1-q_2-Q_2)^2} \\ \vdots & \vdots & \ddots & \vdots \\ -\frac{1-Q_N}{(1-q_N-Q_N)^2} & -\frac{1-Q_N}{(1-q_N-Q_N)^2} & \cdots & -\frac{(1-Q_N)^2}{q_N(1-q_N-Q_N)^2} \end{vmatrix} \tag{24}$$

Notice that all entries of this matrix share a strictly positive common factor in their denominator since $1 - q_j - Q_j = 1 - Q > 0 \; \forall j \in N$ when the Hessian matrix is evaluated at the equilibrium vector.

Definiteness of the Hessian matrix. Recall that a symmetric matrix $\boldsymbol{M}$ is negative definite if and only if $-\boldsymbol{M}$ is positive definite (PD). The symmetric matrix $-\boldsymbol{M}$ is PD if and only if all of its eigenvalues are positive. Furthermore a positive semi-definite (PSD) matrix is positive definite if and only if it is invertible.

I proceed to prove uniqueness by establishing positive definiteness of $-\boldsymbol{H}_\pi(\boldsymbol{q}^\star)$. Pulling out the positive common factor in the denominator of matrix entries since it does not affect positive definiteness and simultaneously adding and subtracting the difference of aggregate demand and competitor supply in each row, we obtain

$$-\boldsymbol{H}_\pi(\boldsymbol{q}^\star) = \frac{1}{(1-Q)^2} \cdot \begin{vmatrix} \frac{(1-Q_1)^2}{q_1} & 1-Q_1 & \dots & 1-Q_1 \\ 1-Q_2 & \frac{(1-Q_2)^2}{q_2} & \dots & 1-Q_2 \\ \vdots & \vdots & \ddots & \vdots \\ 1-Q_N & 1-Q_N & \dots & \frac{(1-Q_N)^2}{q_N} \end{vmatrix} =$$

$$\frac{1}{(1-Q)^2} \cdot \left(\begin{vmatrix} \frac{q_0}{q_1}(1-Q_1) & 0 & \dots & 0 \\ 0 & \frac{q_0}{q_2}(1-Q_2) & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \frac{q_0}{q_N}(1-Q_N) \end{vmatrix} + \begin{vmatrix} 1-Q_1 & 1-Q_1 & \dots & 1-Q_1 \\ 1-Q_2 & 1-Q_2 & \dots & 1-Q_2 \\ \vdots & \vdots & \ddots & \vdots \\ 1-Q_N & 1-Q_N & \dots & 1-Q_N \end{vmatrix} \right) =$$

$$= \frac{1}{(1-Q)^2} \cdot (\boldsymbol{H}_0 + \boldsymbol{H}_1) \tag{25}$$

That is, the negative Hessian matrix evaluated at the equilibrium vector is equivalent to the sum of a diagonal matrix and a rank-1 matrix, both multiplied by strictly positive coefficient.

Diagonal matrix $\boldsymbol{H}_0$. The matrix $\boldsymbol{H}_0$ is a diagonal matrix with typical element $h^0_{jj} > 0$ since interiority of the candidate vector $\boldsymbol{q}^\star$ implies $q_0 > 0 \wedge q_j > 0 \; \forall j \in N$ which in turn implies $Q_j < q_j + Q_j = Q < 1$ $\forall j \in N$.

Therefore $\boldsymbol{H}_0$ is positive definite (PD) since

$$\boldsymbol{z}'\boldsymbol{H}_0\boldsymbol{z} = \sum_{j=1}^{N} z_j^2 h^0_{jj} > 0, \quad \forall \boldsymbol{z} \neq \boldsymbol{0} \tag{26}$$

Rank-1 matrix $\boldsymbol{H}_1$. The matrix $\boldsymbol{H}_1$ can be represented as outer product of two vectors, one of which is a vector of ones, such that

$$\boldsymbol{H}_1 = \boldsymbol{h}_1 \boldsymbol{1}' = \begin{vmatrix} 1-Q_1 \\ 1-Q_2 \\ \vdots \\ 1-Q_N \end{vmatrix} \begin{vmatrix} 1 & 1 & \dots & 1 \end{vmatrix} \tag{27}$$

This implies that $\boldsymbol{H}_1$ is of rank 1 and, by the *Rank-Nullity Theorem* (see e.g. Horn and Johnson (2013), has exactly one non-zero eigenvalue. This singular non-zero eigenvalue, λ, is given by the trace of the matrix, i.e the sum of its diagonal elements, since the trace of a matrix is equal to the sum of its eigenvalues (see e.g. Horn and Johnson (2013)). Therefore

$$\lambda = \lambda + \sum_{j=1}^{N-1} 0 = \text{tr}(\boldsymbol{H}_1) = \sum_{j=1}^{N} h_{jj}^1 = \sum_{j=1}^{N}(1 - Q_j) > 0 \tag{28}$$

which makes $\boldsymbol{H}_1$ a positive semi-definite (PSD) matrix.

Conclusion. Since $\boldsymbol{H}_0$ is PD and $\boldsymbol{H}_1$ is PSD it follows that $\boldsymbol{H}_0 + \boldsymbol{H}_1$ is PD (see Horn and Johnson (2013), observation 7.1.3.) which implies that $-\boldsymbol{H}_\Pi$ is PD since scaling of $\boldsymbol{H}_0 + \boldsymbol{H}_1$ with a positive coefficient does not change definiteness. Taken together these observations satisfy the requirement of Theorem 7 in Cachon and Netessine (2006) and therefore guarantee uniqueness of the Nash equilibrium in pure strategies.

This completes the proof. □

Having established uniqueness of the Nash equilibrium associated with the competition stage, I proceed to analyze the relationship of active monitoring efforts and firm-level product market outcomes.

3.1.2. Product market outcomes and active monitoring

Counterfactual ownership structures. Azar et al. (2018) argue that doing nothing on the part of common owners of large blocks of shares is sufficient to soften product market competition if competing aggressively is privately costly for the manager. This paper omits modeling the exact interaction of managers and the investor and proposes a reduced form model where investors' active monitoring directly affects firm competitiveness. To put the following comparative statics analysis into context it is important to gauge how common ownership affects the investor's incentive for costly effort provision. To this end, I define two counterfactual ownership structures that will serve as benchmarks for the common owner's active monitoring.

For the first case, maintaining the above assumption that investors cannot distract the value maximizing manager or otherwise sabotage the firm, I prove in section 3.2.1 that common ownership in my model works through a channel of institutional neglect, i.e. the investor eschews monitoring effort that would be exerted for an otherwise identical firm if common ownership were not present. As such, it must be that the active monitoring effort of a common owner associated with any given firm is bounded below by doing nothing and bounded above by a concentrated owner with a similar stake in the firm.

Since, by assumption, marginal investors do not produce any active monitoring efforts, I define the first counterfactual benchmark as an ownership structure that is composed entirely of such marginal shareholders. I refer to this counterfactual as *diffuse ownership*. Intuitively, given the size of these shareholders, their private cost of exerting effort is to high in relation to the public increase in expected return. A free rider problem emerges and therefore their optimal effort policy is always equal to zero. Let x_j^- denote the effort provision associated with any given firm j under diffuse ownership.

For the second case, I treat the investor's decision to engage in active monitoring as if she ignored the externality on portfolio returns that arises from her common ownership. Therefore, her active monitoring reflects the effort choices of a series of concentrated investors where each holds a portfolio comprised of shares from a single firm in the industry and the risk free asset. By assumption, the latter is unaffected by monitoring efforts or product market competition. I refer to this counterfactual as *concentrated ownership*. I demonstrate in section 3.2.1 that such an ownership structure is always associated with a strictly positive effort provision for all firms whose shares are held by an institutional investor. This is because, for a concentrated owner, the marginal net benefit of exerting effort is always positive at the lower bound of doing nothing. Let x_j^+ denote the effort provision associated with any given firm j under concentrated ownership.

From these arguments, it is evident that common ownership never arises in isolation but as a side effect of diversified institutional ownership. Since the conjectured effects of increased common or concentrated ownership stakes on the investor's incentive to actively monitor are exactly opposite, any meaningful empirical analysis must aim to disentangle these two channels. Concluding this discussion, equation 29 relates the predictions from these counterfactual cases to the actual monitoring effort provision under common ownership, denoted $x_j^\star$.

$$x_j^- = 0 \leq x_j^\star \leq x_j^+ \qquad \forall j \in N \tag{29}$$

Notice that, by construction, one of these inequalities must be strict for all firms with positive institutional ownership, i.e. $\alpha_j > 0$.

Comparative statics. It is now time to investigate the relationship of active monitoring and observable product market outcomes on a firm-level. The solution concept of Li and Huh (2011) employs the Lambert W function and a quantity denoted cost-adjusted-attractiveness. I begin by stating the derivative of this expression w.r.t. active monitoring effort by the investor. Let $w_j(x_j)$ be a shorthand for $w_j(x_j) = W(\overline{a}_j(x_j, \delta_j))$, i.e. the Lambert W function of a product's ex-post cost-adjusted-attractiveness. I refer to this object as *output ratio* since it is exactly the quotient of firm j's demand share and the demand share of the outside good in equilibrium. Then any given firm's output ratio is strictly increasing in the investor's monitoring effort, x_j, since[23]

$$\frac{\partial w_j}{\partial x_j} = \frac{w_j(x_j)}{(1 + w_j(x_j))} \frac{1}{\overline{a}_j(x_j, \delta_j)} \frac{\partial \overline{a}_j}{\partial x_j} > 0 \qquad \forall j \in N \tag{30}$$

[23]It is furthermore straightforward to prove that the slope is strictly below 1 and downward curving i.e. concave.

From an empirical perspective, it is desirable to isolate the economic channel under investigation as well as possible from any confounding factors. The equilibrium outcome of the product market game stated in proposition 1 suggest that market prices depend exclusively on the monitoring effort associated with the firm in question, whereas equilibrium demand shares do not. This suggests that product prices are an excellent starting point for studying the effects of common ownership on product market competition. This is precisely the approach taken by Azar et al. (2018).

However, there is a caveat. In the present model, equation 31 demonstrates that the effect of monitoring effort on equilibrium output prices can have either a positive or a negative sign, depending on which enhancement technology is assigned to the firm in question at the beginning of the game.

$$\frac{\partial p_j^\star}{\partial x_j} = \begin{cases} \frac{\partial w_j}{\partial x_j} & > 0, \quad \text{if } \delta_j = 0 \\ \frac{\partial w_j}{\partial x_j} + \frac{\partial c_j}{\partial x_j} & < 0, \quad \text{otherwise.} \end{cases} \tag{31}$$

However, this enhancement technology is generally not observed by researchers investigating product market outcomes. Indeterminacy of the vector of technology parameters, $\boldsymbol{\delta}$, and the corresponding divergent comparative statics of market prices lead to a situation where industry-level aggregation or strong identification assumptions may entail falsely negative or biased results.

For the case of Azar et al. (2018), since common ownership reduces the investor's incentive to undertake privately costly efforts, output prices under common ownership can only consistently increase if all firms are assigned the cost reduction technology. Conversely, researchers should expect market prices to fall, as consumers will be unwilling to pay for products with lower utility if all companies use the technology to increase utility. In between these extremes, little can be said about a systematic relationship of common ownership and equilibrium prices since neither portfolio shares, and thus the investor's incentives, nor products' expected utility of consumption or cost of production are ex-ante identical among all firms. I refer to this phenomenon as *price-effort indeterminacy*.

One possible solution to avoid this price-effort indeterminacy is to study the effect of monitoring efforts on firms' markup ratios instead. Assuming constant marginal cost of production, the markup ratio of any firm j's good is defined as the ratio of equilibrium output price over marginal cost, i.e. $m_j^\star(x_j, \delta_j) = p_j^\star(x_j, \delta_j)/c_j(x_j, \delta_j)$. This measure has been used, among others, in the industry-level study on common ownership and product market competition by Koch et al. (2021). The definition of markup ratios entails that firm j's equilibrium markup ratio responds to increased monitoring effort according to

$$\frac{\partial m_j^\star}{\partial x_j} = \frac{1}{c_j(x_j, \delta_j)} \frac{\partial w_j}{\partial x_j} - \frac{(1 + w_j(x_j))}{c_j^2(x_j, \delta_j)} \frac{\partial c_j}{\partial x_j} > 0 \qquad \forall j \in N \tag{32}$$

which indicates a monotonically increasing relationship between firms' markup ratios and the active monitoring effort of the institutional investor. Intuitively, when the investor engages in active monitoring to reduce marginal costs, market prices never decrease as much as costs, whereas when she enhances utility only the margin component of market prices increases.

Does this imply that Koch et al. (2021)'s report of no significant effect of common ownership on markups settles the issue for academics and policy makers? Not necessarily. Since the authors aggregate markups on an industry-level and institutional ownership of large blocks of shares is by far not evenly distributed among publicly listed firms, investors' active monitoring efforts may differ strongly in the cross-section. Rötzer (2021) shows in a simulation study that with such an ownership structure, even a modest amount of unexplained idiosyncratic variation in firms' markups is sufficient to fully conceal an existing effect of common ownership.

I proceed to investigate the comparative statics of demand shares in equilibrium. Managers' optimal output decision is strictly increasing in the investor's active monitoring efforts since regardless of the type of enhancement technology, the product becomes unanimously more desirable for consumers. That is

$$\frac{\partial q_j^\star}{\partial x_j} = \frac{q_j^\star(\boldsymbol{x},\boldsymbol{\delta})(1-q_j^\star(\boldsymbol{x},\boldsymbol{\delta}))}{w_j(x_j)}\frac{\partial w_j}{\partial x_j} > 0 \tag{33}$$

Contrary to prices and markups, demand shares are linked to the full vector of monitoring effort choices, $\boldsymbol{x}$. This implies that the demand shares of the outside good and all competing firms' products move according to

$$\frac{\partial q_0^\star}{\partial x_j} = -\frac{q_0^\star(\boldsymbol{x},\boldsymbol{\delta})q_j^\star(\boldsymbol{x},\boldsymbol{\delta})}{w_j(x_j)}\frac{\partial w_j}{\partial x_j} < 0 \quad \text{and} \quad \frac{\partial q_k^\star}{\partial x_j} = -\frac{q_k^\star(\boldsymbol{x},\boldsymbol{\delta})q_j^\star(\boldsymbol{x},\boldsymbol{\delta})}{w_j(x_j)}\frac{\partial w_j}{\partial x_j} < 0 \quad \forall k \in N \setminus j \tag{34}$$

The fact that equilibrium demand shares are linked to the active monitoring of all firms' in the industry is challenging from an empirical point of view, even if enhancement technologies were guaranteed to be identical within an industry. This is because a reduced demand for firm j's product can stem from either, a reduced monitoring effort in that firm or increased active monitoring in a competitor. An empirical specification that does not control for rival ownership on top of common ownership should be expected to result in biased estimates. This class of models includes empirical approaches employing market shares as dependent variable as seen in e.g. He and Huang (2017), since market shares, by definition, depend on prices and quantities of all firms in the industry.

Last, I examine the effect of active monitoring on consumer surplus in product market equilibrium. I build on de Jong et al. (2007), who relate the net expected utility of marginal consumer i (as expectation of equation 9) to her expected consumer surplus as given by

$$\mathbb{E}[CS_i] = \ln\left(1+\sum_{n=1}^{N}\exp(u_j(x_j,\delta_j)-p_j(\boldsymbol{x},\boldsymbol{\delta}))\right)+K = \ln\left(\frac{1}{q_0^\star(\boldsymbol{x},\boldsymbol{\delta})}\right)+K \tag{35}$$

where K denotes a constant value of utility that is unobserved. Since, given multinomial logit demand, all marginal consumers share the same log sum expression and the expression in logs is nothing else than the reciprocal of the outside good's demand share in product market equilibrium, the comparative statics of any consumer i's surplus w.r.t. active monitoring effort are given by

$$\frac{\partial}{\partial x_j}\mathbb{E}[CS_i] = -\frac{1}{q_0^\star(\boldsymbol{x},\boldsymbol{\delta})}\frac{\partial q_0^\star}{\partial x_j} > 0 \tag{36}$$

Therefore any additional active monitoring effort by the investor not only enhances competition in the product market but is also strictly welfare increasing for consumers. Conversely, if common ownership reduces the incentives to engage in active monitoring, it's associated consumer surplus is strictly dominated by the consumer surplus of an equivalent concentrated ownership structure.

3.2. *Enhancement Stage*

3.2.1. *Nash equilibrium*

The investor's objective function and first-order-conditions. I commence the analysis of the investor's optimal active monitoring effort by substituting the general term for expected log profits with the solutions of the competition stage. Following proposition 1, a typical element of the vector of expected log profits is given by

$$\pi_j(\boldsymbol{x}) = \ln q_j^\star(\boldsymbol{x},\boldsymbol{\delta}) + \ln(p_j^\star(x_j,\delta_j) - c_j(x_j,\delta_j)) \qquad \forall j \in N \tag{37}$$

Inserting these elements into the investor's objective function yields

$$\max_{\boldsymbol{x}} \Omega(\boldsymbol{x}) \approx \max_{\boldsymbol{x}} \left[\boldsymbol{\alpha}'\boldsymbol{\pi}(\boldsymbol{x}) - \frac{1}{2}\boldsymbol{x}'\boldsymbol{x} + C\right] =$$

$$= \max_{\boldsymbol{x}} \left[\sum_{j=1}^{N} \alpha_j \underbrace{\left(\ln w_j(x_j) - \ln\left[1 + w_j(x_j) + \sum_{n\neq j}^{N} w_n(x_n)\right] + \ln\left[1 + w_j(x_j)\right]\right)}_{\text{Expected log profit of firm } j} - \underbrace{\frac{1}{2}\sum_{j=1}^{N} x_j^2}_{\text{Cost}} + \underbrace{C}_{\text{Constant}}\right] \tag{38}$$

Equation 38 consists of three components. First, a sum over the large expression in brackets that corresponds to firms' expected log profits given the investor's active monitoring. Second, the sum of squared x_j's that captures the private cost of effort associated with each portfolio firm. Third, a constant C that collects all remaining terms that are independent of the investor's monitoring effort.

Taking the first derivative of this objective function w.r.t. monitoring effort x_j for all portfolio firms, $j \in N$, yields the vector of first-order-conditions of optimality associated with each firm's contribution to the investor's portfolio return. A typical element of the vector of first-order-conditions is given by[24]

$$\frac{\partial \Omega}{\partial x_j} = \underbrace{\left[\frac{\alpha_j}{w_j(x_j)} - \frac{\alpha_j}{1+\sum_{n=1}^{N} w_n(x_n)} + \frac{\alpha_j}{1+w_j(x_j)}\right]\frac{\partial w_j}{\partial x_j}}_{\Delta\text{Expected benefit of active monitoring}} - \underbrace{x_j}_{\Delta\text{Cost}} - \underbrace{\frac{\sum_{n\neq j}^{N}\alpha_k}{1+\sum_{n=1}^{N} w_n(x_n)}\frac{\partial w_j}{\partial x_j}}_{\Delta\text{Common ownership externalities}} = 0 \qquad \forall j \in N \tag{39}$$

Equation 39 shows that the investor's first-order-conditions associated with any given firm j also contains into three components. First, Δ*Benefit of active monitoring* captures the marginal increase in product market competitiveness of the particular firm being monitored. It is trivial to verify that this expression is strictly positive for any vector of effort choices, $\boldsymbol{x}$. Thus, active monitoring always increases the expected return from holding firm j's share, though these increases may have decreasing marginal benefits. Second, Δ*Cost* captures the marginal increasing in private costs of active monitoring borne by the investor. Notice that the difference of benefits and costs of effort provision is always strictly positive at the lower effort bound, i.e. $x_j = 0$. Therefore, a concentrated owner will never find it optimal to do nothing and will always engage in a strictly positive amount of active monitoring. This statement is no longer guaranteed to be true when Δ*Common ownership externalities* are taken into account. Consideration of these externalities in the investor's active monitoring problem is the central innovation of this paper. In the presence of common ownership externalities an institutional investor may find it optimal to not exert any effort to enhance firm j's product market competitiveness. In such cases, the conjecture of Azar et al. (2018) comes true: The institutional investor does nothing.

This mathematical structure of the first-order-conditions has important consequences for the equilibrium monitoring efforts associated with any given firm j. As will become apparent in the analysis below, depending on the particular set of parameters, the subgame $\mathcal{G}_2$ contains up to three different groups of first-order-conditions as characterized by their best response correspondence. The ownership stakes in the first group are always associated with a strictly positive best responses i.e. monitoring effort $x_j^\star$, irrespective of the amount of active monitoring in their competitors. The ownership stakes in the second group are never associated with strictly positive best responses, irrespective of the amount of monitoring in the industry. This is because the portfolio externalities from enhancing these firms are so severe that the investor considers it optimal to do nothing at all. The third and final group of ownership stakes is associated with conditionally positive best responses, depending on the investor's enhancement effort in other firms. That is, it may be optimal to engage in active monitoring in these firms but only if other firms have already undergone a substantial amount of monitoring. Since this behavior creates discontinuities in the investor's best response correspondence and the presence of this third group can not be ruled out for general, non-symmetric model calibrations, the equilibrium analysis of this model poses a formidable technical challenge.

[24]Notice that any differences related to firms' exogenously assigned enhancement technology are captured by the partial derivative of that firm's output ratio, $\partial w_j / \partial x_j$.

A potential remedy comes from the observation of another feature of equation 39. The output ratios of firm j's competitors and the associated active monitoring efforts never appear individually in the first-order-conditions but always as a sum over all firms in the industry. In what follows, I show that the subgame $\mathcal{G}_2$ associated with the enhancement stage has an equivalent subgame $\mathcal{G}_2^\star$ that is fully aggregative in the sense of Cornes and Hartley (2012).[25] In turn, this equivalence allows me to prove that the Nash equilibrium of the subgame is unique in pure strategies which eventually entails that active monitoring efforts are strictly decreasing with an increasing degree of common ownership in an industry.

A fully aggregative game. Let $\mathcal{G}_2^\star$ be a $N \geq 2$ player game[26] of perfect information where each player j chooses $x_j \in \mathbb{R}_{\geq 0}$ to maximize an objective function given by

$$\max_{x_j} \Gamma_j(x_j, t(\boldsymbol{x})) = \max_{x_j} \left[\alpha_j \left(\ln w_j(x_j) + \ln(1 + w_j(x_j)) \right) - \frac{1}{2}x_j^2 - \sum_{n=1}^{N} \alpha_n \ln t(\boldsymbol{x}) \right] \tag{40}$$

where I refer to the function $t(.)$ as the *aggregator*. It is defined according to

Definition 4 (Aggregator)**.** *The aggregator function of any given vector of active monitoring efforts, $\boldsymbol{x} \in \mathbb{R}^N_{\geq 0}$, is given by*

$$t(\boldsymbol{x}) = 1 + \sum_{n=1}^{N} w_n(x_n) \tag{41}$$

Therefore, any admissible value of the aggregator, $\tau = t(\boldsymbol{x})$, satisfies

$$\tau \in T = \left\{ \tau \in \mathbb{R} | \tau \geq \overline{\tau} = 1 + \sum_{n=1}^{N} w_n(0) \right\} \tag{42}$$

Clearly, the first-order-conditions of the game $\mathcal{G}_2^\star$, denoted $\partial\Gamma_j/\partial x_j$, are the exact same ones as those of the investor choosing optimal active monitoring efforts in the original subgame $\mathcal{G}_2$ given in equation 39.[27] This is true for any vector $\boldsymbol{x} \in \mathbb{R}^N_{\geq 0}$. Therefore, it must be that any solution vector $\boldsymbol{x}^\star$ that constitutes a Nash equilibrium in pure strategies for the game $\mathcal{G}_2^\star$ is also a solution to the investor's problem.

Furthermore, notice that the aggregator $t(.)$ satisfies the requirements of definition 1 and proposition 1 in Cornes and Hartley (2012) for all $N \geq 3$. If $N = 2$, it is straightforward to prove that the chosen aggregator has a derivative $\partial t/\partial x_j$ that is a function of x_j alone and thus does not lead to a contradiction of the assumptions on the players' strategy space and the existence assumptions underlying equation 1 in Cornes and Hartley (2012).[28] Hence, I propose the following lemma.

[25] See also Cornes and Hartley (2005), Jensen (2010) or Nocke and Schutz (2018) as a non-exhaustive reference to the literature on aggregative games.

[26] I omit the $N = 1$ player case because its analysis is trivial and common ownership is not possible under such an industry structure.

[27] This furthermore implies that both games share the same second-order-conditions and Hessian matrix.

[28] Specifically for any $\tau = t(x)$ this aggregator entails $H(\tau) = \tau - 1$ and $F_j(x_j) = w_j(x_j)$.

Lemma 1. *The game $\mathcal{G}_2^\star$ is fully aggregative for all $N \geq 2$. If a pure strategy Nash equilibrium, denoted $\boldsymbol{x}^\star$, exists, it is identical to the solution of the investor's optimal active monitoring problem, $\mathcal{G}_2$.*

The observation that the investor's problem can be treated as a fully aggregative game conveys two strong analytical advantages compared to a regular game of N players. First, it entails that every player in this game has a replacement correspondence that assigns a set of best responses to any given value of the aggregator $\tau = t(\boldsymbol{x} \in \mathbb{R}^N_{\geq 0})$. Second, if players' best responses are singletons and a pure strategy equilibrium, $\boldsymbol{x}^\star$ exists, Cornes and Hartley (2012) assure that the Nash equilibrium of the game $\mathcal{G}_2^\star$ is characterized by a fixed point in only one dimension. Since these properties greatly simplify the analysis, I proceed as follows. I first prove that the implicitly defined best responses of any player j are singletons and strictly increasing in the value of the aggregator. Using this result, I define two types of pure strategy Nash equilibria and demonstrate that, for any set of parameters, a pure strategy Nash equilibrium of the game $\mathcal{G}_2^\star$ exists and is furthermore unique. In turn, this implies that the two types of equilibria are mutually exclusive.

Implicit best responses. Intuitively, the implicit best response of player j in the game $\mathcal{G}_2^\star$ is determined by the equality of marginal benefit and marginal costs of active monitoring. However marginal benefits are not guaranteed to be non-negative in all cases after externalities from common ownership are considered. Hence the analysis of best responses and the game's Nash equilibrium is more involved compared to a model that has strictly interior solutions by construction. To facilitate the analysis of players' best responses, I define the following object.

Definition 5 (Ownership-adjusted marginal benefit)**.** *For any vector of active monitoring efforts $\boldsymbol{x} \in \mathbb{R}^N_{\geq 0}$, let $b_j(x_j, t(\boldsymbol{x})) \in \mathbb{R}$ denote player j's ownership-adjusted marginal benefit of active monitoring given by*

$$b_j(x_j, t(\boldsymbol{x})) = \left[\frac{\alpha_j}{w_j(x_j)} + \frac{\alpha_j}{1 + w_j(x_j)} - \frac{\sum_{n=1}^N \alpha_k}{t(\boldsymbol{x})}\right] \frac{\partial w_j}{\partial x_j} \tag{43}$$

Notice that the sign of this *ownership-adjusted marginal benefit* is determined exclusively by the expression inside the square brackets which is strictly increasing in t and strictly decreasing in x_j. This has important consequences for the investor's optimal choice of active monitoring efforts. In particular, there may exist aggregator values such that no admissible amount of active monitoring in firm j entails a strictly positive marginal benefit. In such cases the investor is best advised to do nothing. In all other cases, there may be one, none or multiple best responses in terms of active monitoring. I prove in the following proposition that players' best responses are characterized by a player-specific *activity threshold* and either take on a value of zero or a strictly positive value which has a one-to-one correspondence to the value of the aggregator τ.

Proposition 3 (Activity threshold & best response)**.** *For any player j, let $\tau_j^+ \in \mathbb{R}_{\geq 0}$ denote her activity threshold that is the unique solution to*

$$b_j(0, \tau_j^+) = 0 \tag{44}$$

For any admissible value of the aggregator $\tau \in T$, player j's best response, $x_j^\star(\tau)$, is the unique solution to

$$x_j^\star = \begin{cases} b_j(x_j^\star, \tau) & \text{if} \quad \tau \geq \tau_j^+ \\ 0 & \text{otherwise.} \end{cases} \tag{45}$$

This best response is strictly increasing in τ if $\tau \geq \tau_j^+$ and constant otherwise.

Proof. I prove proposition 3 in four steps.

Activity threshold. Recall that player j's first-order-condition is given by

$$\frac{\partial \Gamma_j}{\partial x_j} = b_j(x_j, t(\boldsymbol{x})) - x_j = 0 \qquad \forall j \in N \tag{46}$$

Substitute τ for all instances of $t(\boldsymbol{x})$ on the left-hand-side of players' first-order-conditions. Given τ, this transforms the system of N non-linear equations in N unknowns into a set of N non-linear equations of one unknown each. These modified first-order-conditions are given by

$$g_j(x_j, \tau) = b_j(x_j, \tau) - x_j = 0 \qquad \forall j \in N \tag{47}$$

Remember that these are necessary conditions for optimality of player j's active monitoring effort. To satisfy these conditions for a given τ, it must be that $\exists x_j \in \mathbb{R}_{\geq 0} : b_j(x_j, \tau) \geq 0$. Otherwise, there is no best response that satisfies the first-order-conditions i.e. $\nexists x_j \in \mathbb{R}_{\geq 0} : g_j(x_j, \tau) = 0$.

For any player j, determine the derivative of that player's modified first-order-condition w.r.t the aggregator value τ. It is given by

$$\frac{\partial g_j}{\partial \tau} = \frac{\partial b_j}{\partial \tau} = \frac{\sum_{n=1}^{N} \alpha_n}{\tau^2} \frac{\partial w_j}{\partial x_j} > 0 \qquad \forall j \in N \tag{48}$$

Since $\partial g_j / \partial \tau$ is strictly positive, there exists a unique $\tau_j^+ \in \mathbb{R}_{\geq 0}$ such that equation 44 holds. Furthermore, since $\partial t / \partial x$ is also strictly positive, equation 48 implies supermodularity of the game $\mathcal{G}_2^\star$. I distinguish two cases.

Doing nothing. If $\tau < \tau_j^+$, then player j's necessary condition cannot be fulfilled since

$$\nexists x_j \in \mathbb{R}_{\geq 0} : b_j(x_j, \tau) \geq 0 \implies g_j(x_j, \tau) < 0 \quad \forall x_j \in \mathbb{R}_{\geq 0} \tag{49}$$

Therefore, player j's unique best response below the activity threshold is to do nothing, i.e. $x_j^\star(\tau) = 0$.

Active monitoring. If $\tau \geq \tau_j^+$, supermodularity of player j's objective function implies existence of at least one pure strategy best response, $x_j^\star(\tau)$, such that the necessary condition in equation 47 holds.

Let $x_j^\star(\tau) \geq 0$ denote that player's best response given $\tau \geq \tau_j^+$. Determine the derivative of that player's modified first-order-condition w.r.t active monitoring, x_j, and evaluate it at the parameter values $\{x_j^\star(\tau), \tau\}$. The derivative is *equivalent* to[29]

$$\frac{\partial g_j}{\partial x_j}\bigg|_{x_j^\star|\delta_j\in\{0,1\}} \equiv -\frac{\phi_j}{1+\phi_j x_j^\star}\left[\frac{1}{\exp(c_j^\star)+\phi_j x_j^\star}\right]^{\delta_j}\left(b_j(x_j^\star,\tau)\left[1+2\phi_j x_j^\star+\exp(c_j^\star)\right]^{\delta_j}+\dots\right.$$
$$\left.\dots+\left(\frac{2\alpha_j w_j(x_j^\star)}{(1+w_j(x_j^\star))^3}+\frac{\sum_{n=1}^N \alpha_n}{\tau(1+w_j(x_j^\star))^2}\right)\frac{\partial w_j}{\partial x_j}\bigg|_{x_j^\star|\delta_j\in\{0,1\}}\right)-1<0 \tag{50}$$

The strict inequality on the right-hand-side arises from the facts that

$$\tau \geq \tau_j^+ \implies \exists x_j \in \mathbb{R}_{\geq 0} : b_j(x_j,\tau) \geq 0 \tag{51}$$

and

$$g_j(x_j^\star(\tau),\tau) = 0 \implies b_j(x_j^\star(\tau),\tau) \geq 0 \tag{52}$$

By continuity of player j's objective function, the statements above establish a single crossing property of the modified first-order-condition in equation 47 given $\tau \geq \tau_j^+$. Therefore, player j's best response is unique given aggregator values at or above the activity threshold.

Taken together with the *doing nothing* case, this result establishes equation 45.

Increasing best response. It remains to prove that best responses are strictly increasing in τ for all $\tau \geq \tau_j^+$. By application of the implicit function theorem, the correspondence relationship of player j's best response and the aggregator is given by

$$\frac{\partial x_j^\star}{\partial \tau} = \begin{cases} -\frac{\partial g_j/\partial \tau}{\partial g_j/\partial x_j^\star}\big|_{x_j^\star} > 0 & \text{if} \quad \tau \geq \tau_j^+ \\ 0 & \text{otherwise.} \end{cases} \tag{53}$$

This completes the proof. □

Proposition 3 proves that whether or not a given firm j is actively monitored by the investor depends exclusively on a the aggregator function. This is because the aggregator captures the competitive situation in the product market in a singular value. Intuitively, if ex-ante competition is low, corresponding to a small value of τ, active monitoring may not be optimal for a common owner because in equilibrium the

[29] Here, I use the term *equivalent* to signify that the power δ_j exponents of the expressions in square brackets do not arise from the derivation. Instead, by engineering these and substituting the correct parameter value $\delta_j \in \{0,1\}$ the given expression collapses to the correct second derivative given player j's exogenously assigned enhancement technology.

negative side effects in other portfolio firms outweigh the benefit in the firm being monitored.[30] Conversely, if ex-ante competition is high, corresponding to a large value of τ, the negative externality of active monitoring on other portfolio firms may be negligible such that the benefit in the monitored firm dominates in equilibrium. This intuition is captured by the proposed *activity threshold*, τ_j^+, as well as by the increasing best response in active monitoring associated with the value of the aggregator.

Earlier in this section, I suggest that the game $\mathcal{G}_2^\star$ contains up to three different groups of first-order-conditions as characterized by their best response dynamic. Given the activity thresholds derived in proposition 3 this statement receives formal support.

First, or any firm j, suppose its activity threshold satisfies $\tau_j^+ \leq \overline{\tau}$ where $\overline{\tau}$ represents the lower bound on the admissible values of the aggregator. In this case, if an equilibrium exists, it must be that the investor always actively monitors firm j because the benefits of enhancement outweigh the externalities of common ownership for any degree of competition in the industry. Hence, firm j belongs to the first group.

Next, for another firm k, assume its activity threshold satisfies $\tau_j^+ \geq \widehat{\tau} = t(\boldsymbol{x}^\star(\infty))$ where $\widehat{\tau}$ represents an economically motivated upper bound on the admissible values of the aggregator.[31] Hence, if an equilibrium exists and firm k's activity threshold exceeds the upper bound, it must be that the investor never actively monitors that firm because the benefits are always dominated by the common ownership externality and the private cost of exerting effort. Thus, firm k belongs to the second group.

Last, for a firm l, suppose its activity threshold lies in between the lower and upper bound, i.e. $\overline{\tau} \leq \tau_j^+ \leq \widehat{\tau}$. If an equilibrium exists, whether or not firm l is monitored by the investor depends on the realized equilibrium itself. Due to increasing best responses, monitoring firm l may not be optimal if competition is low but it could be optimal once other firms receive a sufficient amount of active monitoring by the investor. Therefore, firm l belongs to the third group.

This assortment of firms into groups based on their respective activity threshold hinges on the existence of a Nash equilibrium in pure strategies. For any set of model parameters, I prove existence and uniqueness of a Nash equilibrium in the next step.

Equilibrium analysis. Following Cornes and Hartley (2012), uniqueness of players' best responses implies that any Nash equilibrium of the game $\mathcal{G}_2^\star$ in pure strategies is fully determined by a fixed point in one dimension. Formally, I define

[30] Recall that active monitoring is always optimal for an investor with concentrated ownership stake.

[31] Indeed, regardless of parameters, there exists no model setup or firm for which an infinite amount of monitoring can satisfy the necessary conditions given in equation 47.

Definition 6 (Equilibrium condition)**.** *Let $\tau^\star \in T$ be an aggregator value that solves*

$$t(\boldsymbol{x}^\star(\tau^\star)) - \tau^\star = 0 \tag{54}$$

where $\boldsymbol{x}^\star(\tau)$ represents the vector of best responses defined in proposition 3 and $t(.)$ represents the aggregator function given in definition 4. Then $\tau^\star$ determines a Nash equilibrium of the game $\mathcal{G}_2^\star$ in pure strategies.

Furthermore, given best response dynamics established above, I distinguish two types of Nash equilibria in pure strategies. These capture the notion that the investor either engages in active monitoring or remains entirely passive because the externalities from common ownership fully erode any incentive for costly effort provision. Formally, I define

Definition 7 (Equilibrium types)**.** *If $\tau^\star$ exists and the maximum norm of players' corresponding best response vector is lesser equal zero, i.e. $||\boldsymbol{x}^\star(\tau^\star)||_\infty \leq 0$, I call $\boldsymbol{x}^\star(\tau^\star)$ a passive equilibrium. Otherwise, if $\tau^\star$ exists and $||\boldsymbol{x}^\star(\tau^\star)||_\infty > 0$, then I refer to $\boldsymbol{x}^\star(\tau^\star)$ as an active equilibrium.*

In the proposition that follows, I show that these equilibria can never coexist because the game $\mathcal{G}_2^\star$ always has exactly one Nash equilibrium in pure strategies. From this observation and the best response dynamics established above, I derive a simple testable conditions that determines which type of equilibrium is played for any given set of model parameters. Because both games, $\mathcal{G}_2$ and $\mathcal{G}_2^\star$, share the same set of first-order-conditions, $\boldsymbol{x}^\star(\tau^\star)$ is the unique vector of active monitoring efforts that solves the investors problem of choosing optimal active monitoring efforts. Building on definitions 6 and 7, I propose

Proposition 4 (Nash equilibrium)**.** *The game $\mathcal{G}_2^\star$ has exactly one Nash equilibrium in pure strategies. That is*

$$\exists! \tau^\star \in T : t(\boldsymbol{x}^\star(\tau^\star)) - \tau^\star = 0 \tag{55}$$

This implies that passive and active equilibria are mutually exclusive given the model's parameters. A necessary and sufficient condition for the presence of an active equilibrium is given by

$$\exists j : \tau_j^+ < \overline{\tau} \tag{56}$$

Proof. Recall that players' best responses are bounded below by zero. Hence, for an aggregator value equal to $\overline{\tau}$, the equilibrium condition in equation 54 becomes an inequality given by

$$t(\boldsymbol{x}^\star(\overline{\tau})) - \overline{\tau} \geq 0 \tag{57}$$

Because, for any j, $\partial t / \partial x_j > 0$, this inequality is strict if at least one player's best response to $\overline{\tau}$ is to actively monitor the associated firm. Otherwise, if $\boldsymbol{x}^\star(\overline{\tau}) = \boldsymbol{0}$, the left- and right-hand-side of the inequality are exactly equal.

By continuity in τ, the weakly positive value of the equilibrium condition on the lower bound of T implies that a sufficient condition for existence and uniqueness of $\tau^\star$ is given by

$$\sum_{j=1}^{N}\left(\frac{\partial t}{\partial x_j}\frac{\partial x_j^\star}{\partial \tau}\right)-1<0 \impliedby \sum_{j=1}^{N}\left(\frac{\partial t}{\partial x_j}\frac{\partial x_j^\star}{\partial \tau}\right)\leq \sum_{j=1}^{N}\frac{w_j(x_j^\star(\tau))}{\tau} \impliedby \frac{\partial t}{\partial x_j}\frac{\partial x_j^\star}{\partial \tau}\leq \frac{w_j(x_j^\star(\tau))}{\tau} \quad \forall j\in N \tag{58}$$

Hence, to establish existence and uniqueness of a Nash equilibrium in pure strategies it remains to prove the inequality on the right-hand-side of equation 58 is true for any $j \in N$.

Recall that any player j's best response dynamics are given by

$$\frac{\partial x_j^\star}{\partial \tau}=\begin{cases}-\frac{\partial g_j/\partial \tau}{\partial g_j/\partial x_j^\star}\big|_{x_j^\star}>0 & \text{if} \quad \tau\geq \tau_j^+\\ 0 & \text{otherwise.}\end{cases} \tag{59}$$

Therefore, player j's inequality is trivially satisfied if $\tau < \tau_j^+$.

Conversely, if $\tau \geq \tau_j^+$, recall that

$$\frac{\partial t}{\partial x_j}=\frac{\partial w_j}{\partial x_j}\leq 1 < -\frac{\partial g_j}{x_j^\star}\bigg|_{x_j^\star|\delta_j\in\{0,1\}} \tag{60}$$

Since furthermore $\partial w_j/\partial x_j < w_j(x_j)$, $\sum_{n=1}^{N}\alpha_n \leq 1$ and $\tau > 1$, it follows that

$$\frac{\partial t}{\partial x_j}\frac{\partial x_j^\star}{\partial \tau}<\frac{w_j(x_j^\star(\tau))}{\tau} \Leftrightarrow \frac{1}{w_j(x_j^\star(\tau))}\frac{\sum_{n=1}^{N}\alpha_n}{\tau}\left(\frac{\partial w_j}{\partial x_j}\right)^2 < -\frac{\partial g_j}{x_j^\star} \tag{61}$$

Thus, player j's sufficient condition is satisfied with strict inequality for any $\tau \in T$. Therefore, taken together with the statements above

$$\exists!\tau^\star \in T : t(\boldsymbol{x}^\star(\tau^\star))-\tau^\star=0 \tag{62}$$

which implies existence and uniqueness of a Nash equilibrium in pure strategies.

Uniqueness of $\tau^\star$ entails that the equilibrium play of the game involves either a passive or an active equilibrium but it cannot involve both. Hence, passive and active equilibria are mutually exclusive.

This establishes equation 55 and the first part of proposition 4. It remains to prove that the condition on players' activity threshold, τ_j^+, is necessary and sufficient to obtain an active equilibrium.

For sufficiency, recall that if $\exists j \in N : \tau_j^+ < \overline{\tau}$ the game must have an active equilibrium because

$$x_j^\star(\tau)>0 \quad \forall \tau\in T \implies ||\boldsymbol{x}^\star(\tau^\star)||_\infty > 0 \tag{63}$$

Thus the condition is sufficient.

For necessity, assume that $\nexists j \in N : \tau_j^+ < \overline{\tau}$ and that $\tau^\star > \overline{\tau}$ is an equilibrium of the game. This however contradicts the proven uniqueness of the game's Nash equilibrium because players' best responses imply that the first and only equilibrium is determined by

$$t(\boldsymbol{x}^\star(\overline{\tau})) - \overline{\tau} = t(\mathbf{0}) - \overline{\tau} = 0 \implies ||\boldsymbol{x}^\star(\overline{\tau})||_\infty = 0 \tag{64}$$

Since $\overline{\tau}$ implies a passive equilibrium and no other equilibrium value $\tau^\star > \overline{\tau}$ can exist unless $\exists j \in N : \tau_j^+ < \overline{\tau}$, the condition is also necessary.

Taken together, the condition given in equation 56 is thus necessary and sufficient for the presence of an active equilibrium. This completes the proof. □

3.2.2. Policy interventions and equilibrium response

In the previous section, I establish that the investor's problem of choosing optimal active monitoring efforts has a unique solution. I find that, depending on the structure of her portfolio, the degree of common ownership externalities and the ex-ante competitiveness of the firms issuing shares, the investor may find it optimal to exert no effort at all. Whereas the micro-foundation based on the active monitoring of portfolio firms is novel in the literature, I am not the first to study the economic relationship of common ownership and product market outcomes.

Following the publication of Azar et al. (2018)'s empirical findings that support an anti-competitive effect of common ownership in the airline industry, some legal scholars and anti-trust experts have argued in favor of curbing common ownership. This is despite the fact that the very existence of a statistically significant relationship between common ownership and product market outcomes remains a contentious issue among researchers. For instance, Elhauge (2016) proposes legal pursuit of institutional common owners suspected of orchestrating or condoning anti-competitive conduct by private and public plaintiffs under the Clayton act §7. Doing so he argues that the sweeping language of the act allows legal action far beyond its typical application to actual horizontal mergers in concentrated industries. In a similar vein, Posner et al. (2017) demand that *"no institutional investor or individual holding shares of more than a single effective firm in an oligopoly may ultimately own more than 1% of the market share unless unless the entity holding shares is a free-standing index fund that commits to being purely passive"*. This proposal comes with the principle goal to either limit common ownership in magnitude or force institutional owners into more concentrated portfolios, a diffuse (and thereby costlier) fund structure or a mirror voting approach to corporate governance. The need to take policy action, however, is not unanimously recognized. Among others, Rock and Rubinfeld (2018), Patel (2018) and Lambert and Sykuta (2019) have rejected the proposed policies in light of the well-known anticipated welfare losses from imposing limits on diversification and index investing and the current indeterminacy of results in empirical common ownership research.

In this section, I analyse the investor's equilibrium response to the implementation of two policies that are loosely based on the proposals of Posner et al. (2017). Specifically, I investigate the investor's response to policies that limit ownership stakes or encourage (active monitoring that is similar to) concentrated portfolios, ceteris paribus.

Limiting ownership stakes. Consider the following policy experiment. Regulators implement a policy that imposes an upper bound $\overline{\beta} \in [0,1]$ on the investor's ownership stake in any given firm. Furthermore the investor's endowment and the ex-ante valuation of all firms' shares remain unchanged. Compared to the counterfactual case with no regulation, a single ownership stake in firm j is in violation of the new policy. All else equal, $\beta_j > \overline{\beta}$ implies that the investor must reduce the share of firm j's stock in her portfolio to meet the regulatory requirement. For simplicity, I assume that all funds in excess of the maximum admissible ownership stake are redistributed to the risk free asset and that managerial attention ϕ_j remains unchanged, irrespective of the tightness of the regulatory constraint.

Let $\kappa(\overline{\beta})$ denote a policy transmission function that captures the effect of the ownership constraint $\overline{\beta}$ on the weight of firm j in the investor's portfolio α_j such that

$$\kappa(\overline{\beta} = 0) = 0, \quad \text{and} \quad \kappa(\overline{\beta} = 1) = 1, \quad \text{and} \quad \frac{\partial \kappa}{\partial \overline{\beta}} \geq 0 \tag{65}$$

Then the investor's necessary condition for optimal active monitoring under the policy constraint can be expressed as

$$\frac{\partial \Omega_\kappa}{\partial x_j} = \kappa(\overline{\beta}) \left[\frac{\alpha_j}{w_j(x_j)} - \frac{\alpha_j}{1 + \sum_{n=1}^{N} w_n(x_n)} + \frac{\alpha_j}{1 + w_j(x_j)} \right] \frac{\partial w_j}{\partial x_j} - x_j - \frac{\sum_{n \neq j}^{N} \alpha_k}{1 + \sum_{n=1}^{N} w_n(x_n)} \frac{\partial w_j}{\partial x_j} = 0 \tag{66}$$

The left-hand-side of equation 67 shows that the derivative of this policy constrained first-order-condition w.r.t. $\overline{\beta}$ is strictly positive. Together with the supermodularity property of the game $\mathcal{G}_2$, theorem 5 in Milgrom and Roberts (1990) implies that the investor's active monitoring efforts in *all firms* in the industry are non-decreasing in the policy parameter $\overline{\beta}$.[32] That is

$$\frac{\partial^2 \Omega_\kappa}{\partial x_j \partial \overline{\beta}} = \frac{\partial \kappa}{\partial \overline{\beta}} \left[\frac{\alpha_j}{w_j(x_j)} - \frac{\alpha_j}{1 + \sum_{n=1}^{N} w_n(x_n)} + \frac{\alpha_j}{1 + w_j(x_j)} \right] \frac{\partial w_j}{\partial x_j} \geq 0 \implies \frac{\partial x_n^\star}{\partial \overline{\beta}} \geq 0 \qquad \forall n \in N \tag{67}$$

While this seems like good news at first glance, there is an important caveat. Given the nature of the policy constraint, the counterfactual scenario with no regulation corresponds to a policy parameter $\overline{\beta} = 1$. The tighter the policy that bounds ownership stakes from above, $\overline{\beta}$, the smaller the value of the associated policy function $\kappa(\overline{\beta})$ becomes. Therefore, imposing an upper bound on the investor's ownership in any given firm erodes her incentive to actively monitor and thus amplifies the common ownership externality in relative terms. Within the scope of the model, this policy of limiting ownership stakes is, at best, welfare

[32] See also Milgrom and Shannon (1994). See Cachon and Netessine (2006) and Amir (2005) for less rigorous introductions of the same concept.

neutral but most likely strictly welfare reducing.

Encouraging concentrated ownership. Consider next an alternative policy experiment. Regulators implement a policy that encourages the formation of concentrated portfolio within any given industry. For any existing portfolios, this regulation gradually shifts investors' incentives and encourages them to act as if they were concentrated owners depending on the relative strength of the policy. For instance, the policy could require the investor to delegate monitoring to competing fund managers that engage with firms' management in her stead. Once every firm is managed by a distinct fund manager, the incentives of owners and firms are fully aligned as in the concentrated ownership counterfactual. Let $\lambda \in [1, \infty)$ denote a policy parameter that represents the relative strength of this regulation. Then the investor's necessary condition for optimal active monitoring under the policy constraint can be expressed as

$$\frac{\partial \Omega_\lambda}{\partial x_j} = \left[\frac{\alpha_j}{w_j(x_j)} - \frac{\alpha_j}{1 + \sum_{n=1}^N w_n(x_n)} + \frac{\alpha_j}{1 + w_j(x_j)} \right] \frac{\partial w_j}{\partial x_j} - x_j - \frac{1}{\lambda} \frac{\sum_{n \neq j}^N \alpha_k}{1 + \sum_{n=1}^N w_n(x_n)} \frac{\partial w_j}{\partial x_j} = 0 \tag{68}$$

The left-hand-side of equation 69 shows that the derivative of this policy constrained first-order-condition w.r.t. λ is strictly positive. Together with the supermodularity property of the game $\mathcal{G}_2$, theorem 5 in Milgrom and Roberts (1990) implies that the investor's active monitoring efforts in *all firms* in the industry are non-decreasing in the policy parameter λ. That is

$$\frac{\partial^2 \Omega_\lambda}{\partial x_j \partial \lambda} = \frac{1}{\lambda^2} \frac{\sum_{n \neq j}^N \alpha_k}{1 + \sum_{n=1}^N w_n(x_n)} \frac{\partial w_j}{\partial x_j} \geq 0 \implies \frac{\partial x_n^\star}{\partial \lambda} \geq 0 \qquad \forall n \in N \tag{69}$$

Since the policy parameter $\lambda = 1$ obtains in the counterfactual scenario with no regulation and stronger regulatory incentives increase the parameter value, encouraging (active monitoring that is similar to) concentrated ownership seems suitable to curb downsides of common ownership related to monitoring. Therefore, within the scope of the model and so long as costs of implementation are ignored, this policy is likely to be strictly welfare increasing. Notice however that this welfare statement is exclusively with respect to consumers in the product market and any potential welfare losses resulting from a reduction in portfolio diversification are not taken into account.

In closing, these two policy experiments loosely based on the suggestions of Posner et al. (2017) highlight the importance of incentive compatible regulation. If investors' active monitoring of portfolio firms constitutes a valuable input to firm competitiveness and consumer surplus and an ill-advised policy implementation curbs investors' incentives to exert the necessary costly effort, then a regulation aimed at remedying the anti-competitive effects of common ownership may itself turn out to be welfare destroying. In my model, I assume that active monitoring and the investor's incentives are the only channel by which ownership structure affects product market outcomes. If the only real-world channel of owner influence was indeed the provision of costly effort, then imposing upper bounds on holdings in any given firm is likely to have an adverse effect because it erodes investor's incentives to exert effort in the first place.

Therefore, I would urge in favor of a more cautious approach as proposed by Lambert and Sykuta (2019). At least until empirical research has succeeded in carefully disentangling the benefits and costs of institutional and common ownership and more concrete welfare statements concerning policy intervention are possible.

4. Conclusion

In this paper I propose a novel mechanism of how common ownership affects product market competition. The key insight is that internalization of owners' portfolio interests into managers' objective functions is not a necessary condition if investors' themselves can provide, or withhold, an input factor that translates into tangible improvements of firms' ability to compete. I build on the well established theoretical literature on active monitoring[33] to develop a model where common owners have the means but possibly not the incentive to exert privately costly effort to increase the expected returns from their portfolio firms' shares. This is because firms' strategic decisions in the product market impose negative externalities on each others profits such that an investor may find it optimal to do nothing at even if monitoring is unequivocally profitable on the level of individual firms. In the framework of my theory, this results holds irrespective of industry structure, portfolio allocation or mode of competition.[34]

To arrive at this conclusion, I formulate a three stage model of active monitoring where, following an exogenous portfolio assignment, a single investor chooses privately costly monitoring efforts to enhance portfolio firms before the latter compete imperfectly in a single product market. In this market, goods are differentiated and managers compete by choosing optimal output quantities. In my analysis, I prove that both, the competition stage and the enhancement stage, have a unique Nash equilibrium in pure strategies and that the investor's optimal monitoring is characterized by a fixed point in a single dimension. In the appendix, I verify by means of a simulation study that uniqueness of the game's Nash equilibrium and the associated comparative statics extend to settings where firms compete in market prices instead of output quantities.

Uniqueness of the game's Nash equilibrium under arbitrary industry structures and portfolio allocations conveys several key advantages compared to other models of common ownership that typically rely on the conjecture of a symmetric Nash equilibrium. First, real world industries are characterized by the presence of mavericks and clustering of common ownership in certain firms that are often part of an equity index.[35] These asymmetries however entail that firms do not soften competition uniformly which implies that, to benefit the common owners' portfolio, some firms leave money on the table compared to a counterfactual scenario without common ownership. Contrary to the arguments put forth in Schmalz

[33] See e.g. Shleifer and Vishny (1986), Admati et al. (1994), Edmans and Manso (2011), Edmans et al. (2019).

[34] The model presented allows for an arbitrary number of ex-ante heterogeneous firms and arbitrary portfolio allocation by a single investor. Extensions to multiple investors are straightforward so long as perfect information is maintained.

[35] See Gilje et al. (2020) for a study of the determinants of common ownership.

(2018), it is unlikely the concentrated shareholders in the set of losing firms will endorse such changes of competitive conduct. Hence softening of competition as a mechanism of common ownership only works if incentives reasonably symmetric. This is not the case in my model. A commonly-held firm will never compete less than under diffuse ownership and sometimes it may find itself being monitored with the same intensity as under concentrated ownership.[36] Together with the one-to-one relationship of monitoring effort, margins, demand shares and consumer surplus, this entails well defined predictions for empirical research. Second, the computationally simple equilibrium conditions and the fact that firms' markup ratios only depend on the investor's monitoring effort and that particular firm's set of parameters provides an attractive opportunity for structural estimation methods. Structural estimation may not only resolve some endogeneity concern inherent in common ownership research but also lend itself to perform counterfactual and policy experiments. Third, uniqueness of the Nash equilibrium coupled with the monotone comparative statics property of the model ensures that the only rational play of the game reacts predictably to changes in parameters which should be beneficial for further theoretical research. For instance, I analyze two possible policy interventions aimed to curb the potential anti-competitive effects of common ownership and find that encouraging concentrated ownership stakes should be strictly welfare increasing whereas imposing upper bounds on ownership stakes may achieve the opposite effect. Furthermore, I demonstrate that market prices and consequentially market shares are ill-suited for empirical research because, unless the precise nature of the investor's monitoring technology is observed, their association with active monitoring and thus the owner's incentives is indeterminate.

In my model, the effect of common ownership is a byproduct of the institutional ownership of large blocks of shares in multiple firms in the same industry. The role of institutional investors as active owners who engage with firms' management is well supported by a long literature of empirical and theoretical contributions.[37] Recently, Lewellen and Lewellen (2022) study the incentives of institutional investors to be engaged with portfolio firms. They find that on average institutions should be willing to bear a private cost of up to 236,300$ in exchange for a one-time 1% increase in value of one of their portfolio firms. The authors furthermore find that incentives associated with corporate actions that increase value at the expense of rivals are considerably smaller. Such actions are on average 30% less valuable for average institutions and 73% less valuable for the top five suppliers of index funds. Viewed from the framework of my theory, these findings lend strong support to doing nothing as a mechanism by which common ownership affects product markets.

I conclude with limitations of the theory and a perspective for future research. One important restriction is that, for the sake of tractability, I dispense of the hypothesized anti-competitive conduct that is standard in the common ownership literature. This is important because this softening of competition is typically

[36]The firm may still achieve an inferior outcome because competing firms are subject to more active monitoring. Nevertheless concentrated shareholders will unanimously support management's policies because they are optimal for firm value maximization.

[37]See e.g. Cronqvist and Fahlenbrach (2009), Appel et al. (2016) or Albuquerque et al. (2022) for empirical contributions or Edmans (2014) for a comprehensive review of both empirical and theoretical literature.

associated with rising markups whereas my model predicts that markups decrease as a consequence of the investor's withholding of active monitoring effort compared to a concentrated ownership counterfactual. If both mechanisms are present simultaneously, it is not impossible for an empirical study to find a coefficient on common ownership that is statistically indistinguishable from zero despite two strong economic effects, both of which are welfare reducing. Coincidentally, Koch et al. (2021) study the effect of common ownership on markup ratios on an industry-level and conclude that common ownership does not appear to have any effect on industry markups. Further, minor concerns are related to the assumptions that information is perfect, managers' interests are perfectly aligned with firm value maximization and the patterns of substitution inherent in a multinomial logit demand system. For the context of this paper, I consider these limitations to be minor.

In summary, this paper predicts that institutional investor who are common owners have a reduced incentive to actively monitor and engage with managers of the firms in their portfolio compared to a counterfactual where no common ownership externality exists. The paper furthermore presents comparative statics results that relate product market outcomes to the portfolio interests of institutional investors and their distortion by common ownership of firms competing in the same industry. These results are well suited for investigation in empirical settings which I leave as an opportunity for future research.

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Appendix A. Modification to Competition in Prices

In this section I modify the model presented in the main text such that firms compete in the product market by choosing market prices instead of output quantities. Relative to product market competition in quantities, a large body of literature[38] analyzes product market competition in prices in conjunction with a multinomial logit demand system to answer questions of industrial organization, consumer welfare, corporate finance or plainly econometric identification.

As in the main text, I analyze the modified model by backward induction beginning with a presentation of results for the competition stage for given active monitoring choices. These results are the contributions of Milgrom and Roberts (1990) and Li and Huh (2011) respectively and kept to a minimum necessary to follow the argument. I then present investor's problem of choosing optimal active monitoring efforts to maximize her expected portfolio return. I derive a proof for the existence of a Nash equilibrium in pure strategies for the concentrated ownership counterfactual but do not find further analytical proofs under a common ownership structure. Therefore, in section Appendix B, I conduct a simulation study to verify that the central predictions of model in the main text continue to hold when firms compete in prices. I find that, similar to the unmodified model, the investor's choice to actively monitor is pinned down in a unique Nash equilibrium in pure strategies. Compared to the diffuse and concentrated ownership counterfactuals, this entails predictable changes in the investor's monitoring effort which manifests in firm-level product market outcomes.

Appendix A.1. Competition Stage

Objective function and first-order-conditions. Let $\mathcal{G}_3^B$ denote the subgame associated with the competition stage when firms' managers choose market prices instead of output quantities. I maintain all other assumption for this stage as in the main text. Thus the objective function of firm j's manager becomes

$$\max_{p_j} \left[\Pi_j(\boldsymbol{p}|\boldsymbol{x},\boldsymbol{\delta})\right] = \max_{p_j} \left[q_j(\boldsymbol{p}|\boldsymbol{x},\boldsymbol{\delta}) \left(p_j - c_j(x_j,\delta_j)\right)\right] \quad \forall j \in N \tag{A.1}$$

Determining the first derivative of this objective function and factoring out common positive coefficients yields a gradient vector $\boldsymbol{g}(\boldsymbol{p}|\boldsymbol{x},\boldsymbol{\delta})$ whose elements satisfy

$$g_j(\boldsymbol{p}|\boldsymbol{x},\boldsymbol{\delta}) = -(1 - q_j(\boldsymbol{p}|\boldsymbol{x},\boldsymbol{\delta}))(p_j - c_j(x_j,\delta_j)) + 1 \quad \propto \quad \frac{\partial \Pi_j}{\partial p_j} \qquad \forall j \in N \tag{A.2}$$

The gradient vector $\boldsymbol{g}(\boldsymbol{p}|\boldsymbol{x},\boldsymbol{\delta})$ will serve as the set of managers' first-order-conditions of optimality for the remainder of the analysis.

[38] See e.g. Anderson and de Palma (1992), Berry et al. (1995), (Berry et al., 2013), Berry and Haile (2014), Li and Huh (2011), Kennedy et al. (2017)

Nash equilibrium. The first-order-conditions above are not generally concave over managers' full strategy space. However, existence and uniqueness of a Nash equilibrium of the subgame $\mathcal{G}_3^B$ can be motivated and proven using the theory of supermodular games.[39] The following result has been proven in the literature.

Proposition 5 (Existence & uniqueness)**.** *The subgame $\mathcal{G}_3^B$ associated with the competition stage has exactly one Nash equilibrium in pure strategies.*

Proof. See Milgrom and Roberts (1990) section 4 example 2. □

For the purpose of this article, a more applicable almost-closed form solution has been proposed by Li and Huh (2011). To apply their result, I require the following definition.

Definition 8 (The V function)**.** *The V function over the positive reals is a monotonically increasing, concave function whose unique solution $v = V(z)$ satisfies*

$$v \cdot \exp\left(\frac{v}{1-v}\right) = z \tag{A.3}$$

Together with definition 2 from the main text, this allows the to restate the solution concept for the $\mathcal{G}_3^B$.

Proposition 6 (Solution)**.** *Let $q_0^\star \in [0,1]$ denote the unique solution of the product market clearing condition given by*

$$q_0 + \sum_{n=1}^{N} V(q_0 \overline{a}_j(x_j, \delta_j)) - 1 = 0 \tag{A.4}$$

Then $\boldsymbol{p}^\star(\boldsymbol{x}, \boldsymbol{\delta})$ denotes a vector of market prices that satisfies managers' first-order-conditions of optimality. Its entries are given by

$$p_j^\star(\boldsymbol{x}, \boldsymbol{\delta}) = \frac{1}{(1 - V(q_0^\star(\boldsymbol{x}, \boldsymbol{\delta})\overline{a}_j(x_j, \delta_j))} + c_j(x_j, \delta_j) \quad \forall j \in N \tag{A.5}$$

The corresponding equilibrium demand shares are given by

$$q_j^\star(\boldsymbol{x}, \boldsymbol{\delta}) = V(q_0^\star(\boldsymbol{x}, \boldsymbol{\delta})\overline{a}_j(x_j, \delta_j)) \tag{A.6}$$

Proof. See Li and Huh (2011) section 2.3.2. □

Comparative statics. A fundamental difference between price and quantity competition is that in price competition, both the equilibrium price and the equilibrium demand share depend on the investor's active monitoring in all firms. This is because both are functionally dependent on the solution of the market

[39]See Topkis (1978) and Topkis (1979) for the foundational contributions of this literature.

market-clearing condition. Here I derive the comparative statics of observable product market outcomes ceteris paribus, i.e. holding the vector of monitoring efforts in rivals, $\boldsymbol{x}_{-j}$ constant. The following definition allows me to simplify mathematical expressions more aggressively.

Definition 9 (Cost-adjusted expected utility)**.** *Cost-adjusted expected utility relates the expected utility of a good to its marginal cost of production. It is defined as*

$$f_j(x_j, \delta_j) = u_j(x_j, \delta_j) - c_j(x_j, \delta_j) \tag{A.7}$$

This allows me to rewrite *cost-adjusted-attractiveness* and its derivative as

$$\bar{a}_j(x_j, \delta_j) = \bar{a}_j(f_j(x_j, \delta_j)) \qquad \text{with} \qquad \frac{\partial \bar{a}_j}{\partial x_j} = \bar{a}_j(x_j, \delta_j) \frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j} > 0 \tag{A.8}$$

Let $v_j(\boldsymbol{x}, \boldsymbol{\delta})$ be a shorthand for $v_j(\boldsymbol{x}, \boldsymbol{\delta}) = V(q_0^\star(\boldsymbol{x}, \boldsymbol{\delta})\bar{a}_j(x_j, \delta_j))$. Together with definition 9, I propose

Proposition 7 (Market clearing response)**.** *In equilibrium, the market clearing demand share of the outside good follows*

$$\frac{\partial q_0^\star}{\partial x_j} = -q_0^\star(\boldsymbol{x}, \boldsymbol{\delta}) s_j(\boldsymbol{x}, \boldsymbol{\delta}) \frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j} < 0 \tag{A.9}$$

where $s_j(\boldsymbol{x}, \boldsymbol{\delta}) \in [0, 1]$ is a support function defined as

$$s_j(\boldsymbol{x}, \boldsymbol{\delta}) = \frac{\bar{a}_j(x_j, \delta_j) \frac{\partial v_j}{\partial z_j}\big|_{z_j = q_0^\star(\boldsymbol{x},\boldsymbol{\delta})\bar{a}_j(x_j,\delta_j)}}{1 + \sum_{n=1}^{N} \bar{a}_n(x_n, \delta_n) \frac{\partial v_n}{\partial z_n}\big|_{z_n = q_0^\star(\boldsymbol{x},\boldsymbol{\delta})\bar{a}_n(x_n,\delta_n)}} \tag{A.10}$$

Proof. Follows trivially from application of the implicit function theorem. □

For a constant vector of rival monitoring, $\boldsymbol{x}_{-j}$, this immediately implies that firm j's equilibrium demand share is strictly increasing whereas those of its competitors are strictly decreasing in the investor's active monitoring of firm j. That is

$$\frac{\partial q_j^\star}{\partial x_j} = q_0^\star \bar{a}_j \frac{\partial v_j}{\partial z_j} \left(1 - s_j\right) \frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j} > 0 \qquad \text{and} \qquad \frac{\partial q_k^\star}{\partial x_j} = -q_0^\star \bar{a}_k \frac{\partial v_k}{\partial z_k} s_j \frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j} < 0 \quad \forall k \in N \setminus j \tag{A.11}$$

whereas all function expressions are understood with their respective dependencies on $\boldsymbol{x}$ and $\boldsymbol{\delta}$.

With this result, it is straightforward to verify that the *price-effort indeterminacy* continues to hold under Bertrand competition, albeit subject to further confounding factors through active monitoring of competitors. That is

$$\frac{\partial p_j^\star}{\partial x_j} = \begin{cases} \frac{1}{(1-q_j^\star(\boldsymbol{x},\boldsymbol{\delta}))^2}\frac{\partial q_j^\star}{\partial x_j} & > 0, \quad \text{if } \delta_j = 0 \\ \frac{1}{(1-q_j^\star(\boldsymbol{x},\boldsymbol{\delta}))^2}\frac{\partial q_j^\star}{\partial x_j} + \frac{\partial c_j}{\partial x_j} & < 0, \quad \text{otherwise.} \end{cases} \tag{A.12}$$

Lastly, notice that the comparative statics of firm j's equilibrium markup ratio remain qualitatively unchanged w.r.t. the investor's active monitoring in the firm. That is

$$\frac{\partial m_j^\star}{\partial x_j} = \frac{1}{c_j(x_j,\delta_j)(1-q_j^\star(\boldsymbol{x},\boldsymbol{\delta}))^2}\frac{\partial q_j^\star}{\partial x_j} - \frac{1}{c_j^2(x_j,\delta_j)(1-q_j^\star(\boldsymbol{x},\boldsymbol{\delta}))}\frac{\partial c_j}{\partial x_j} > 0 \quad \forall j \in N \tag{A.13}$$

Taken together, these *univariate* comparative statics support the predictions obtained from subgame $\mathcal{G}_3$ in the main text. In product market equilibrium, a firm's product should see both, an increased demand share and an increased markup ratio, if the institutional investor holdings its shares exerts more effort to actively monitor the firm. Notice however that both statements are ceteris paribus and equilibrium monitoring efforts in *all firms* may change with modifications of a single model parameter. I return to this issue in the simulation study that follows below.

Appendix A.2. Enhancement Stage

Objective function and first-order-conditions. I now substitute the competition stage solution into the investor's general objective function. I obtain

$$\max_{\boldsymbol{x}} \Omega(\boldsymbol{x}) \approx \max_{\boldsymbol{x}} \left[\boldsymbol{\alpha}'\boldsymbol{\pi}(\boldsymbol{x}) - \frac{1}{2}\boldsymbol{x}'\boldsymbol{x} + C\right] =$$

$$= \max_{\boldsymbol{x}} \left[\sum_{j=1}^{N} \alpha_j \underbrace{\left(\ln v_j(\boldsymbol{x},\boldsymbol{\delta}) - \ln\left[1 - v_j(\boldsymbol{x},\boldsymbol{\delta})\right]\right)}_{\text{Expected log profit of firm } j} - \underbrace{\sum_{j=1}^{N}\frac{1}{2}x_j^2}_{\text{Cost}} + \underbrace{C}_{\text{Constant}}\right] \tag{A.14}$$

where the same structure of three blocks as in the main text emerges. As before, I derive her first-order-conditions of optimality w.r.t. the active monitoring effort in each portfolio firm. A typical element of this vector is given by

$$\frac{\partial \Omega}{\partial x_j} = \underbrace{\alpha_j \frac{\overline{a}_j(x_j,\delta_j) q_0^\star(\boldsymbol{x},\boldsymbol{\delta})}{v_j(\boldsymbol{x},\boldsymbol{\delta})(1-v_j(\boldsymbol{x},\boldsymbol{\delta}))} \frac{\partial v_j}{\partial z_j}\bigg|_{z_j = q_0^\star(\boldsymbol{x},\boldsymbol{\delta})\overline{a}_j(x_j,\delta_j)} \left(1 - s_j(\boldsymbol{x},\boldsymbol{\delta})\right) \frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j}}_{\Delta\text{Expected benefit of active monitoring}} - \underbrace{x_j}_{\Delta\text{Cost}} - \dots$$

$$\dots - \underbrace{\sum_{l \neq j}^{N} \alpha_l \frac{\overline{a}_l(x_l,\delta_l) q_0^\star(\boldsymbol{x},\boldsymbol{\delta})}{v_l(\boldsymbol{x},\boldsymbol{\delta})(1-v_l(\boldsymbol{x},\boldsymbol{\delta}))} \frac{\partial v_l}{\partial z_l}\bigg|_{z_l = q_0^\star(\boldsymbol{x},\boldsymbol{\delta})\overline{a}_l(x_l,\delta_l)} s_j(\boldsymbol{x},\boldsymbol{\delta}) \frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j}}_{\Delta\text{Common ownership externalities}} = 0 \qquad \forall j \in N \tag{A.15}$$

where I continue to employ the shorthand $v_j(\boldsymbol{x},\boldsymbol{\delta}) = V(q_0^\star(\boldsymbol{x},\boldsymbol{\delta})\overline{a}_j(x_j,\delta_j))$ introduced in the previous section. Notice a large fraction of the coefficients in this expression depend on the implicitly determined solution of the product market clearing condition in equation A.4. The analytical treatment of this property presents a significant technical challenge. Nevertheless, in order to make a robust statement about the equilibrium behavior of the modified model, I conduct an extensive simulation study.

Nash Equilibrium. Before turning to this simulation-based model validation, I analyze the equilibrium properties of the investor's active monitoring choices under concentrated ownership. Intuitively, if the model is well-behaved, the monitoring efforts under concentrated ownership should constitute a strict upper bound on the investor's active monitoring under common ownership. Therefore it is useful to understand whether the modified model actually has at least one Nash equilibrium in pure strategies when common ownership externalities are not present. I establish this property in the next proposition.

Proposition 8 (Existence under concentrated ownership)**.** *The subgame $\mathcal{G}_2^B$ has at least one Nash equilibrium in pure strategies under concentrated ownership.*

Proof. Under concentrated ownership, the first-order-condition of the institutional investor holding firm j's shares is given by

$$\frac{\partial \Omega_j^\star}{\partial x_j} = \underbrace{\alpha_j \frac{\overline{a}_j(x_j,\delta_j) q_0^\star(\boldsymbol{x},\boldsymbol{\delta})}{v_j(\boldsymbol{x},\boldsymbol{\delta})(1-v_j(\boldsymbol{x},\boldsymbol{\delta}))} \frac{\partial v_j}{\partial z_j}\bigg|_{z_j = q_0^\star(\boldsymbol{x},\boldsymbol{\delta})\overline{a}_j(x_j,\delta_j)} \left(1 - s_j(\boldsymbol{x},\boldsymbol{\delta})\right) \frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j}}_{\Delta\text{Expected benefit of active monitoring}} - \underbrace{x_j}_{\Delta\text{Cost}} = b_j^\star(\boldsymbol{x},\boldsymbol{\delta}) - x_j = 0 \quad \forall j \in N \tag{A.16}$$

where I introduce $b_j(\boldsymbol{x},\boldsymbol{\delta})$ as an expression for marginal expected benefit of active monitoring. Notice that this expression is a product of four positive coefficients that satisfies

$$b_j(\boldsymbol{x},\boldsymbol{\delta}) = \underbrace{\alpha_j}_{\in(0,1)} \underbrace{\frac{\overline{a}_j(x_j,\delta_j) q_0^\star(\boldsymbol{x},\boldsymbol{\delta})}{v_j(\boldsymbol{x},\boldsymbol{\delta})(1-v_j(\boldsymbol{x},\boldsymbol{\delta}))} \frac{\partial v_j}{\partial z_j}}_{\in(0,1)} \underbrace{\left(1 - s_j(\boldsymbol{x},\boldsymbol{\delta})\right)}_{\in(0,1)} \underbrace{\frac{\partial f_j}{\partial x_j}\bigg|_{\delta_j}}_{\in(0,1)} \in (0,1) \tag{A.17}$$

for any vector of active monitoring efforts $\boldsymbol{x}$ with finite Euclidean norm. Since this expression is strictly positive, for an arbitrary amount of rival monitoring $\boldsymbol{x}_{-j}$ any $x_j > 1$ must be strictly dominated by some $x_j \in [0,1]$. Therefore it suffices to limit the analysis to the hypercube of undominated strategies given by $\mathcal{U}^N = [0,1]^N$.

Let rival monitoring $\boldsymbol{x}_{-j}$ take any value in $\mathcal{U}^{N-1}$. Then, at the lower and upper boundary of her strategy space, the investor's first-order-condition evaluates to

$$\left.\frac{\partial \Omega_j^\star}{\partial x_j}\right|_{(0,\boldsymbol{x}_{-j})} = b_j^\star(0,\boldsymbol{x}_{-j},\delta) > 0 \qquad \text{and} \qquad \left.\frac{\partial \Omega_j^\star}{\partial x_j}\right|_{(1,\boldsymbol{x}_{-j})} = b_j^\star(1,\boldsymbol{x}_{-j},\delta) - 1 < 0 \qquad \forall j \in N \tag{A.18}$$

Since this is true for all investors' first-order-conditions under concentrated ownership the subgame $\mathcal{G}_2^B$ satisfies the requirements of the Poincaré-Miranda theorem.[40] Therefore it has at least one Nash equilibrium in pure strategies.

This completes the proof. □

Appendix B. Simulation study

In this section, I complement my theoretical results with a large-sample simulation study to examine the equilibrium behavior of the baseline and modified versions of the game. Moreover, I verify that the central prediction regarding reduced active monitoring of the investor under common ownership holds unanimously in the relevant parameter space and that this leads to observable effects in product market outcomes.

Appendix B.1. Data generating process & sample

The data generating process is implemented as follows. To attain full replicability, I begin by instantiating a total of 1,000,000 seeds for the pseudo-random number generator that will govern the simulation process. Each of these seeds contains a reproducible series of random draws from an i.i.d. uniform distribution. I use probability integral transform[41] to map these random numbers into a representation of one industry configuration each. Every industry is characterized by its number of firms, number of firms in the investor's portfolio, portfolio weights and firm-level parameters. The empirical cumulative distribution functions underlying the probability integral transform are taken from the calibration process in Rötzer (2021) and are depicted in figure B.3. In order to avoid concerns that an investor with holdings drawn from the distribution of S&P500 portfolio weights could be too thinly spread, I scale all drawn

[40] See e.g. Kulpa (1997) or Mawhin (2019).

[41] Compare e.g. Cameron and Trivedi (2005).

portfolio weights by a factor ten while ensuring that they never exceed a total of one on the industry-level. To calibrate the missing managerial attention I assume that $\phi_j = 1$ unanimously. In contrast to Rötzer (2021), I allow for some variation in firms' cost-adjusted-attractiveness and use the residual variance from that calibration process to simulate mean zero, normally distributed random draws for for firms' expected utility of consumption u_j. This process fully parametrizes the model.

Appendix B.2. Model solution & validation

I analyze the equilibrium behavior of each simulated industry-investor pairing across six scenarios differentiated in terms of concerning mode of competition and firms' enhancement technology. The modes of competition *Bertrand* and *Cournot* correspond to the managers' choice variable in maximizing firm profit. Market price or output quantity. Technology represents an assignment where all firms in the industry are ether assigned the *utility* enhancing technology, the *cost* reducing technology or the assignment is *mixed* which corresponds to a fifty-fifty split among technologies.

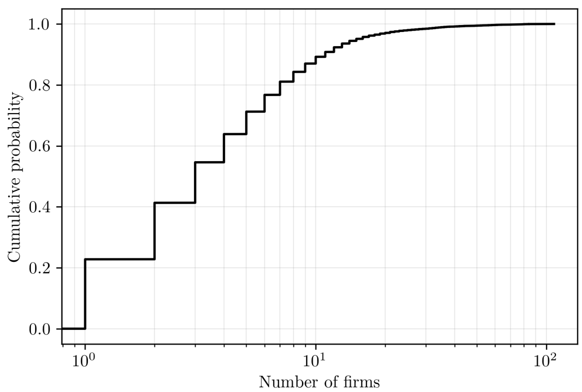
I solve the model by application of a contraction mapping. For each industry-investor pairing and for each of the described six scenarios, I determine the investor's optimal active monitoring efforts from 100 different starting vectors. I repeat this procedure for the diffuse and concentrated ownership counterfactuals. This allows me to not only assess existence and uniqueness of a Nash equilibrium in any possible configuration of the game, but also to verify that product market outcomes change as expected in relation to these counterfactuals.

Nash equilibrium. The first test I perform verifies that the simulated industries each have exactly one Nash equilibrium in pure strategies irrespective of scenario or ownership structure. To do so, I check that the contraction scheme converges within a specified number of iterations and that the absolute and relative distance among the equilibrium vectors resulting from the 100 starting vectors never exceeds a threshold of $\varepsilon = 10^{-6}$. If either of these conditions is violated I assign a dummy equal to one that identifies this particular combination of industry and technology as multiple equilibrium. Otherwise I assign a value of zero. Using the 1,000,000 observations of this test value, I conduct a binomial test to falsify the following hypothesis using a threshold probability of $\rho = 0.001\%$.

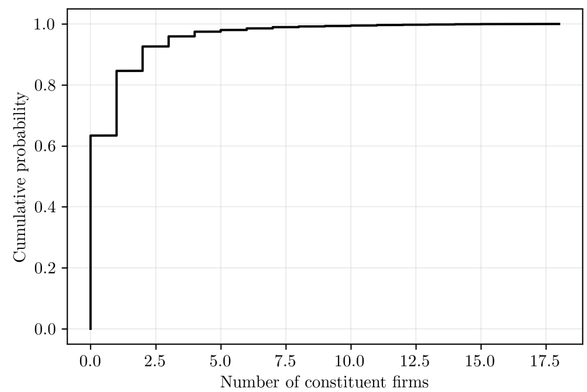
Hypothesis 1 (Uniqueness of Nash equilibrium)**.** *Let $\boldsymbol{x}^\star$ and $\boldsymbol{x}^{\star\star}$ be two equilibrium vectors of the same game. The probability that their absolute (relative) distance $\Delta(\boldsymbol{x}^\star, \boldsymbol{x}^{\star\star})$ exceeds a threshold ε is less than or equal ρ. Formally, I test*

$$\mathcal{H}_0^1 : \mathbb{P}(\Delta(\boldsymbol{x}^\star, \boldsymbol{x}^{\star\star}) > \varepsilon) \geq \rho, \quad vs. \quad \mathcal{H}_A^1 : \mathbb{P}(\Delta(\boldsymbol{x}^\star, \boldsymbol{x}^{\star\star}) > \varepsilon) < \rho$$

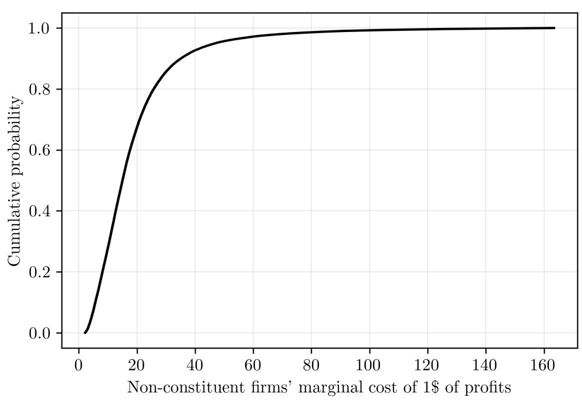
The results of this hypothesis test are reported in table B.1. Table B.1a on the left reports the outcomes under a common ownership structure whereas table B.1b reports results under concentrated ownership. I do not identify a single multiple equilibrium candidate in the entire simulated sample, regardless of ownership structure, mode of competition or firm enhancement technologies. The null hypothesis is rejected



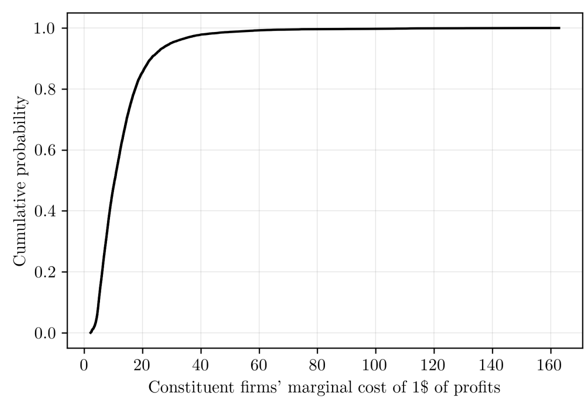
(a) Empirical CDF of the number of firms competing in a given SIC4-industry-year



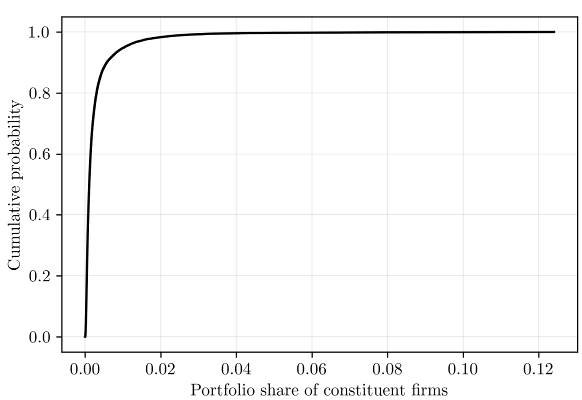
(b) Empirical CDF of the number of S&P 500 constituent firms observed in a given SIC4-industry-year



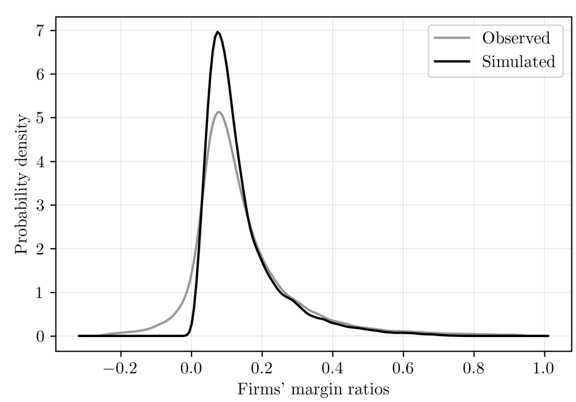
(c) Empirical CDF of S&P 500 non-constituent firms' marginal cost of production for 1$ profit



(d) Empirical CDF of S&P 500 constituent firms' marginal cost of production for 1$ profit



(e) Empirical CDF of S&P 500 constituent firms' index weights



(f) Kernel density estimates of the observed and simulated net markup ratio distributions

Figure B.3: *Empirical cumulative distribution functions (CDF) of structural parameters.* The number of firms in an industry-year, the number of index constituent firms in an industry-year and the index weights are directly observed in the data. Marginal costs of production for index constituent and non-constituent firms are estimated using the fixed point iteration described in Rötzer (2021). Panel B.3f depicts a comparison of the kernel density fitted to observed and simulated data. All plots taken from Rötzer (2021).

Technology	(1) Bertrand	(2) Cournot
Utility	0e+00***	0e+00***
	[0e+00, 1e-05]	[0e+00, 1e-05]
Cost	0e+00***	0e+00***
	[0e+00, 1e-05]	[0e+00, 1e-05]
Mixed	0e+00***	0e+00***
	[0e+00, 1e-05]	[0e+00, 1e-05]
Observations	1,000,000	1,000,000

99.9999% confidence interval in square brackets
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Common Ownership

Technology	(1) Bertrand	(2) Cournot
Utility	0e+00***	0e+00***
	[0e+00, 1e-05]	[0e+00, 1e-05]
Cost	0e+00***	0e+00***
	[0e+00, 1e-05]	[0e+00, 1e-05]
Mixed	0e+00***	0e+00***
	[0e+00, 1e-05]	[0e+00, 1e-05]
Observations	1,000,000	1,000,000

99.9999% confidence interval in square brackets
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Concentrated Ownership

Table B.1: *Binomial test of Uniqueness of Nash equilibria.* For each simulated industry, I determine the equilibrium vectors of the investor's active monitoring from a set of 100 starting points. When the maximum absolute or relative distance between any two equilibrium vectors exceeds a threshold of $\varepsilon = 10^{-6}$, I assign a value of 1 to an indicator variable that flags the industry as an instance of equilibrium multiplicity. Otherwise I assign a value of zero conditional on convergence of the contraction scheme. Using the full sample of 1,000,000 simulated industries, I test against the null hypothesis that the probability of observing an instance of equilibrium multiplicity $\mathbb{P} \geq \rho = 0.001$. Table B.1a reports results under a common ownership structure, table B.1b reports results for the dedicated ownership counterfactual. Columns (1) and (2) distinguish results by mode of competition. Rows correspond to the type of technology used to enhance firms' competitiveness. Mixed rows represent industries where firms use either type of technology with 50% probability. Coefficients and confidence intervals are reported in engineering notation for ease of exposition.

for all model configurations with a p-value of less than 1% in all cases. Moreover, I report the 99.9999% confidence intervals for the probability of observing a game configuration with multiple equilibrium candidates given the data generating process. In all cases, this probability never exceeds $\rho = 0.001\%$. Therefore, I conclude that the model almost guarantees a unique Nash equilibrium in pure strategies for empirically relevant model configurations.

Active monitoring. Next, I test whether the investor's monitoring efforts under common ownership are consistently weakly dominated by the active monitoring of concentrated owners. Furthermore, I verify the common owners' active monitoring is statistically different from zero which is the assumed monitoring under diffuse ownership. Formally, I implement a student's t-test to test the following hypothesis.[42]

Hypothesis 2 (Active monitoring)**.** *Let $\boldsymbol{x}^\star$ and $\boldsymbol{x}^{\star\star}$ denote the investor's active monitoring under common ownership and concentrated ownership respectively. Let $\mathbf{0}$ be the active monitoring under diffuse ownership and let $\boldsymbol{\gamma} = \boldsymbol{\alpha} \odot \boldsymbol{\phi}$ be a vector of weights corresponding the element-wise product of portfolio weights and managerial attention. I hypothesize that, on average, firms' weighted active monitoring under common ownership is strictly smaller than under dedicated ownership but strictly larger than under diffuse ownership. Formally, I test*

$$\mathcal{H}_0^{2a} : \mathbb{E}[\gamma'(\boldsymbol{x}^\star - \boldsymbol{x}^{\star\star})/\mathbf{1}'\gamma] \geq 0, \quad \textit{and} \quad \mathcal{H}_A^{2a} : \mathbb{E}[\gamma'(\boldsymbol{x}^\star - \boldsymbol{x}^{\star\star})/\mathbf{1}'\gamma] < 0$$

[42]Notice that this is a relatively simple industry-level test. A more sophisticated test could assign firm-level truth values and test their joint distribution.

Technology	(1) Bertrand	(2) Cournot
Utility	-3e-03***	-2e-03***
	(-820.59)	(-833.61)
Cost	-3e-03***	-2e-03***
	(-820.65)	(-833.62)
Mixed	-3e-03***	-2e-03***
	(-820.60)	(-833.59)
Observations	1,000,000	1,000,000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Common minus Concentrated Ownership

Technology	(1) Bertrand	(2) Cournot
Utility	-3e-02***	-3e-02***
	(-634.17)	(-647.51)
Cost	-3e-02***	-3e-02***
	(-634.14)	(-647.45)
Mixed	-3e-02***	-3e-02***
	(-634.17)	(-647.49)
Observations	1,000,000	1,000,000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Diffuse minus Common Ownership

Table B.2: *Student's t-test of differences in active monitoring.* For each simulated industry, I compute the weighted difference of investors' monitoring efforts under common ownership versus concentrated and diffuse ownership structures. Weights γ are the element-wise product of the investors' portfolio weight $\boldsymbol{\alpha}$ and managerial attention $\boldsymbol{\phi}$, re-scaled to a sum of one by observation. I test against the null hypotheses that [2a] active monitoring under common ownership weakly dominates monitoring concentrated ownership and that [2b] active monitoring under diffuse ownership exceeds the investor's monitoring effort under common ownership. Table B.2a reports results for the test of hypothesis [2a], table B.2b reports results for the test of hypothesis [2b]. Columns (1) and (2) distinguish results by mode of competition. Rows correspond to the type of technology used to enhance firms' competitiveness. Mixed rows represent industries where firms use either type of technology with 50% probability. Coefficients are reported in engineering notation for ease of exposition.

as well as

$$\mathcal{H}_0^{2b} : \mathbb{E}[-\boldsymbol{\gamma}'\boldsymbol{x}^\star/\mathbf{1}'\boldsymbol{\gamma}] \geq 0, \quad \textit{and} \quad \mathcal{H}_A^{2b} : \mathbb{E}[-\boldsymbol{\gamma}'\boldsymbol{x}^\star/\mathbf{1}'\boldsymbol{\gamma}] < 0$$

The results of this set of hypothesis tests are reported in table B.2. Table B.2a on the left reports the outcomes of the series of student's t-tests for the difference in active monitoring under common versus concentrated ownership. Table B.2b reports results for diffuse versus common ownership. As hypothesized, the coefficient sign is consistently negative and the null hypothesis is rejected with a high degree of statistical confidence, regardless of mode of competition or firm technologies. Therefore, I conclude that the common ownership externalities do indeed translate into a tangible reduction in the investor's active monitoring compare to a concentrated ownership structure. In the worst case, the common owners does nothing. However, this is not generally the case and common owners do exert a statistically significant amount of monitoring effort.

Markup ratios. The statistical tests above support the idea that common owners exert consistently less effort to actively monitor their portfolio firms compared to a similar structure of concentrated owners. However they do generally exert a non-zero amount of effort to enhance their portfolio which implies that their effort choices dominate a diffuse ownership structure. I now verify whether firms' markup ratios are fully revealing of this unobserved ranking in effort choices. Formally, I implement a student's t-test to test the following hypothesis.[43]

[43]Notice that this feature, while analytically provable under competition in quantities, is not to be taken for granted under competition in prices. This is because when firms compete á la Bertrand, there is an adjustment of equilibrium demand quantities

Hypothesis 3 (Markup ratios)**.** *Let $\boldsymbol{x}^\star$ and $\boldsymbol{x}^{\star\star}$ denote the investor's active monitoring under common ownership and concentrated ownership respectively. Let $\mathbf{0}$ be the active monitoring under diffuse ownership and let $\boldsymbol{\gamma} = \boldsymbol{\alpha} \odot \boldsymbol{\phi}$ be a vector of weights corresponding the element-wise product of portfolio weights and managerial attention. Furthermore, let $\boldsymbol{m}(\boldsymbol{x})$ denote firms' realized markup ratios for a given vector of active monitoring $\boldsymbol{x}$. I hypothesize that, on average, firms' weighted markup ratios under common ownership are strictly smaller than under dedicated ownership but strictly larger than under diffuse ownership. Formally, I test*

$$\mathcal{H}_0^{3a} : \mathbb{E}[\boldsymbol{\gamma}'(\boldsymbol{m}(\boldsymbol{x}^\star) - \boldsymbol{m}(\boldsymbol{x}^{\star\star}))/\mathbf{1}'\boldsymbol{\gamma}] \geq 0, \quad \textit{versus} \quad \mathcal{H}_A^{3a} : \mathbb{E}[\boldsymbol{\gamma}'(\boldsymbol{m}(\boldsymbol{x}^\star) - \boldsymbol{m}(\boldsymbol{x}^{\star\star}))/\mathbf{1}'\boldsymbol{\gamma}] < 0$$

and

$$\mathcal{H}_0^{3b} : \mathbb{E}[\boldsymbol{\gamma}'(\boldsymbol{m}(\mathbf{0}) - \boldsymbol{m}(\boldsymbol{x}^\star))/\mathbf{1}'\boldsymbol{\gamma}] \geq 0, \quad \textit{versus} \quad \mathcal{H}_A^{3b} : \mathbb{E}[\boldsymbol{\gamma}'(\boldsymbol{m}(\mathbf{0}) - \boldsymbol{m}(\boldsymbol{x}^\star))/\mathbf{1}'\boldsymbol{\gamma}] < 0$$

The results of this set of hypothesis tests are reported in table B.3. Table B.3a presents the outcomes of the series of student's t-tests for the difference in markup ratios under common versus concentrated ownership. Table B.3b presents results for diffuse versus common ownership. As hypothesized, I find strong support for the papers central prediction: Firms' markup ratios are indicative of investors' reduced incentive to actively monitor when they are common owners in multiple firms. This is shown by the negative coefficient estimates in the Student's t-tests that are statistically significantly different from zero with p-values below 1% in all instances. The test statistics observed in parentheses indicate that these results are highly unlikely to be obtained by chance but rather that the observed mechanism in the simulated data embodies precisely the hypothesized channels of influence, i.e. the incentive to actively monitor and the common ownership externality. This prediction is contrary to the canonical idea of the prevalent literature on common ownership where the *Common Ownership Hypothesis* assumes a consistently positive association with markup ratios.

Consumer surplus. In closing, I investigate whether the ordering of concentrated ownership dominates common ownership dominates diffuse ownership found above also prevails in terms of consumer surplus. Building on de Jong et al. (2007), I directly relate the expected consumer surplus in an economy to the reciprocal of the demand share of the outside good, q_0. Formally, I implement a student's t-test to test the following hypothesis.

Hypothesis 4 (Consumer surplus)**.** *Let $\boldsymbol{x}^\star$ and $\boldsymbol{x}^{\star\star}$ denote the investor's active monitoring under common ownership and concentrated ownership respectively. Let $\mathbf{0}$ be the active monitoring under diffuse ownership and let $q_0(\boldsymbol{x})$ be the demand share of the outside good associated in equilibrium for any given $\boldsymbol{x}$. I hypothesize that, on average, the demand share of the outside good under common ownership are strictly smaller than under dedicated ownership but strictly larger than under diffuse ownership. Formally, I test*

$$\mathcal{H}_0^{4a} : \mathbb{E}[q_0(\boldsymbol{x}^{\star\star}) - q_0(\boldsymbol{x}^\star)] \geq 0, \quad \textit{versus} \quad \mathcal{H}_A^{4a} : \mathbb{E}[q_0(\boldsymbol{x}^{\star\star}) - q_0(\boldsymbol{x}^\star)] < 0$$

which, in turn, affects competitors' pricing choices. This is the prime reasons to explicitly take portfolio weights and managerial attention into account when testing hypotheses on an industry-level.

Technology	(1) Bertrand	(2) Cournot
Utility	-2e-05***	-7e-05***
	(-622.66)	(-763.88)
Cost	-7e-05***	-1e-04***
	(-633.14)	(-703.32)
Mixed	-4e-05***	-9e-05***
	(-586.45)	(-714.17)
Observations	1,000,000	1,000,000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Common minus Concentrated Ownership

Technology	(1) Bertrand	(2) Cournot
Utility	-4e-04***	-1e-03***
	(-473.60)	(-551.47)
Cost	-1e-03***	-2e-03***
	(-423.73)	(-476.78)
Mixed	-7e-04***	-2e-03***
	(-391.16)	(-478.50)
Observations	1,000,000	1,000,000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Diffuse minus Common Ownership

Table B.3: *Student's t-test of differences in markup ratios* For each simulated industry, I compute the weighted difference of firms' markup ratios under common ownership versus concentrated and diffuse ownership structures. Weights γ are the element-wise product of the investors' portfolio weight $\boldsymbol{\alpha}$ and managerial attention $\boldsymbol{\phi}$, re-scaled to a sum of one by observation. I test against the null hypotheses that [3a] markup ratios under common ownership weakly dominate markup ratios under concentrated ownership and that [3b] markup ratios under diffuse ownership exceed firms' markup ratios under common ownership. Table B.3a reports results for the test of hypothesis [3a], table B.3b reports results for the test of hypothesis [3b]. Columns (1) and (2) distinguish results by mode of competition. Rows correspond to the type of technology used to enhance firms' competitiveness. Mixed rows represent industries where firms use either type of technology with 50% probability. Coefficients are reported in engineering notation for ease of exposition.

and

$$\mathcal{H}_0^{4b} : \mathbb{E}[q_0(\boldsymbol{x}^\star) - q_0(\mathbf{0})] \geq 0, \quad \textit{versus} \quad \mathcal{H}_A^{4b} : \mathbb{E}[q_0(\boldsymbol{x}^\star) - q_0(\mathbf{0})] < 0$$

The results of this set of hypothesis tests are reported in table B.4. Table B.4a presents the outcomes of the series of student's t-tests for the difference in consumer surplus under common versus concentrated ownership. Table B.4b presents results for diffuse versus common ownership. As above, I find strong support for the hypothesized economic relationship in the simulated data set. This is because coefficient estimates are negative across all modes of competition and specifications of technology with associated p-values that are consistently below 1%. Therefore, the null hypotheses is consistently rejected in all cases with a high degree of statistical confidence. Taken together this implies that the ordering observed in terms of active monitoring and markup ratios is upheld in terms of consumer surplus thereby confirming the initial economic intuition when building the model.

Summary. In conclusion the simulation study confirms the economic intuition employed when developing the model. Concentrated ownership of one firm per product market by institutional investors maximizes active monitoring, profit and consumer surplus and therefore strictly dominates a common ownership structure in all aspects related to product market competition. However, in the absence of unlawful intent, common ownership however is not a dead-weight loss to consumers as it arises only as a byproduct of institutional ownership which by itself has generally positive effects within the boundaries of the model. I find that the externalities on portfolio enhancement incentives experienced by common owners are effective in reducing monitoring efforts but still leave ample gains in profitability and welfare to dominate diffuse ownership consistently. Lastly, I confirm that the model exhibits a unique Nash equi-

Technology	(1) Bertrand	(2) Cournot
Utility	-2e-04***	-1e-04***
	(-736.15)	(-731.42)
Cost	-2e-04***	-1e-04***
	(-736.06)	(-731.28)
Mixed	-2e-04***	-1e-04***
	(-736.03)	(-731.27)
Observations	1,000,000	1,000,000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(a) Common minus Concentrated Ownership

Technology	(1) Bertrand	(2) Cournot
Utility	-1e-03***	-8e-04***
	(-640.25)	(-672.83)
Cost	-1e-03***	-8e-04***
	(-640.12)	(-672.69)
Mixed	-1e-03***	-8e-04***
	(-640.22)	(-672.79)
Observations	1,000,000	1,000,000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Diffuse minus Common Ownership

Table B.4: *Student's t-test of differences in equilibrium consumer surplus.* For each simulated industry, I compute the difference of consumer surplus under common ownership versus the consumer surpluses under concentrated and diffuse ownership structures. I test against the null hypotheses that [4a] consumer surplus under common ownership weakly dominates consumer surplus under the concentrated ownership and that [4b] consumer surplus under the diffuse ownership exceeds consumer surplus under common ownership. Table B.4a reports results for the test of hypothesis [4a], table B.4b reports results for the test of hypothesis [4b]. Columns (1) and (2) distinguish results by mode of competition. Rows correspond to the type of technology used to enhance firms' competitiveness. Mixed rows represent industries where firms use either type of technology with 50% probability. Coefficients are reported in engineering notation for ease of exposition.

librium in pure strategies in all considered configurations which makes the model's predictions broadly applicable in a reduced-form empirical setting.