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Abstract

I study how firms' defensive investments affect aggregate total factor productivity in a general-equilibrium model where incumbents invest both to raise productivity and to deter entry or imitation; entry occurs either by new firms into existing markets or by leading firms in entirely new product lines. Calibrating the model to US firm size, productivity, and market share distributions, I find that cracking down on defensive investments increases TFP by 1.9 percent, about three-quarters of which reflects higher technical efficiency, driven mainly by improved firm-level productivity. This gain is substantially offset by reduced product variety; absent this loss, the TFP effect would be more than four times as large. Profit taxes targeted at high-productivity leaders – those most prone to block imitation – can stimulate frontier innovation while limiting variety losses. Firm-level US evidence supports these mechanisms.

Keywords: defensive investment, total factor productivity, firm dynamics, competition policy.

JEL classification: E22, D23, D43, L11, L13, L60, O33, O43.

Resumen

En este documento se estudia cómo las inversiones defensivas de las empresas afectan a la productividad total de los factores (PTF) agregada en un modelo de equilibrio general, en el que las empresas establecidas invierten tanto para aumentar la productividad como para disuadir la entrada o la imitación; dicha entrada se refiere tanto a la de nuevas empresas en mercados existentes como a la de una empresa líder en una línea de producto completamente nueva. Calibrando el modelo según la distribución de tamaño, productividad y cuota de mercado de las empresas estadounidenses, se encuentra que eliminar las inversiones defensivas aumenta la PTF en un 1,9 %, del cual aproximadamente tres cuartas partes reflejan una mayor eficiencia técnica, impulsada principalmente por la mejora de la productividad empresarial. Esta ganancia se ve compensada de forma sustancial por la reducción en la variedad de productos; sin esta pérdida, el efecto sobre la PTF sería más de cuatro veces mayor. Los impuestos sobre los beneficios dirigidos a los líderes de alta productividad —los más propensos a bloquear la imitación— pueden estimular la innovación en la frontera tecnológica y, al mismo tiempo, limitar las pérdidas de variedad. La evidencia a escala empresarial en Estados Unidos respalda estos mecanismos.

Palabras clave: inversión defensiva, productividad total de los factores, dinámica empresarial, política de competencia.

Códigos JEL: E22, D23, D43, L11, L13, L60, O33, O43.

1 Introduction

Market concentration has become a common feature across developed economies, with a small number of large firms taking up a substantial market share.[1] This has caused policy-makers to question the potentially anti-competitive nature of such large firms' dominance, scrutinizing, for instance, their defensive practices that distort knowledge diffusion and make it difficult for competitors to compete.[2] These policy debates reflect a broader economic concern: firms' defensive behavior constitutes an important source of distortions in technology adoption and factor allocation. Investments in preemptive patenting and regulatory lobbying are often undertaken not to raise productivity but to preserve incumbency rents by deterring entry or imitation.[3] Although these strategies are known to impede technology diffusion and exacerbate factor misallocation, their broader impact on aggregate productivity remains underexplored.[4] At the same time, stronger appropriability raises firms' private returns to

[1]See, for example, Covarrubias, Gutiérrez, and Philippon (2020), Autor, Dorn, Katz, Patterson, and Van Reenen (2020), for seminal works.

[2]Senator Elizabeth Warren has criticized pharmaceutical firms for abusing the patent system to block generic entry and has proposed taxing excessive lobbying (Warren, 2024; Warren, 2019). The Federal Trade Commission (FTC) has warned that the improper listing of patents can foreclose competition (FTC, 2023). The Subcommittee on Antitrust, Commercial and Administrative Law of the Committee on the Judiciary has found that dominant platforms exclude rivals (Subcommittee on Antitrust, 2020). Disney's lobbying secured the 1998 "Mickey Mouse Protection Act," delaying public-domain entry, later criticized in Senator Hawley's rollback proposal (Harvard Law, 2023; Hawley, 2022).

[3]On the distortive role of non-productive intangibles and entry barriers, see Krusell and Rios-Rull (1996); Parente and Prescott (2002); Bellettini and Ottaviano (2005); Comin and Hobijn (2009); Mukoyama and Popov (2014); Zingales (2017); Stigler (2021); Akcigit, Baslandze, and Lotti (2023); Bao and Eeckhout (2023); Fernández-Villaverde, Yu, and Zanetti (2025); on preemptive patenting, see Gilbert and Newbery (1982); Farrell and Shapiro (2008); Abrams, Akcigit, and Grennan (2013); Galasso and Schankerman (2015); Argente, Baslandze, Hanley, and Moreira (2020); Baslandze (2021). Defensive behavior can also take other forms beyond those analyzed in this paper, including killer acquisitions (Cunningham, Ederer, and Ma, 2021; Fons-Rosen, Roldan-Blanco, and Schmitz, 2021), lock-in innovations (Casal, 2024), and predatory pricing (Besanko, Doraszelski, and Kryukov, 2014).

[4]On the aggregate costs of markups, see Baqaee and Farhi (2020); De Loecker, Eeckhout, and Mongey (2021); Edmond, Midrigan, and Xu (2023); on declining knowledge diffusion and business dynamism, see Akcigit and Ates (2021, 2023).

innovation, encouraging improvements in existing products and the creation of new ones.[5]

In view of these considerations, the paper asks: how do defensive investments affect aggregate productivity, accounting for the potential redirection of innovation across firms and products? To address this question, I build a general-equilibrium model with endogenous technology adoption and oligopolistic competition in which leading firms invest both to raise productivity and to deter entry and imitation. A central feature of the model is that entry can take two distinct forms: into an existing product market or as a new leading firm in a new product market. I find that cracking down on defensive investments raises TFP by 1.9 percent, about three-quarters of which reflects higher net technical efficiency, driven primarily by improved firm-level productivity.[6] Yet, despite sizable gains in firms' productivity, net technical efficiency rises only moderately, as adjustments along the variety margin substantially offset within-firm improvements.

The mechanism operates through two channels. First, firm productivity rises as the removal of deterrence intensifies competition in markets led by the most productive incumbents, who are most inclined to block frontier rivalry by deterring imitation. Facing stronger pressure at the frontier, leaders reallocate effort toward productivity-enhancing investment to escape competition, thereby raising within-firm efficiency. Second, product variety falls since defensive behavior also fostered product proliferation as a protective fence, so its removal reduces the creation of new product markets. This reduction tempers the overall gain in net technical efficiency. Absent

[5] For evidence on non-monotonic competition–innovation relationships and appropriability, see Aghion, Bloom, Blundell, Griffith, and Howitt (2005); Acemoglu and Akcigit (2012); Cavenaile, Celik, and Tian (2019); for patent-induced product differentiation, see Maskus and Penubarti (1995); Smith (1999); Ivus (2010); Kyle and McGahan (2012); Cockburn, Lanjouw, and Schankerman (2016).

[6] I show that changes in aggregate productivity decompose into changes in allocative efficiency and in net technical efficiency, measured net of intangible-investment costs (see Section 2.4 and Appendix B).

this channel, the implied improvement in TFP would be more than four times larger. This mechanism underscores the importance of distinguishing between the two entry margins when evaluating competition policy. Compared to existing frameworks that overlook this distinction, the analysis shows that cracking down on defensive investments raises within-firm productivity but curtails product creation, leading to substantially more cautious policy implications.

Finally, these dynamics are also reflected in the firm size distribution. Cracking down on defensive investments weakens superstar dominance, making the distribution more symmetric. At the same time, although overall variability declines, intensified rivalry in high-productivity markets increases the distance between firms across the central percentiles of the distribution, widening the interdecile ranges P90–P10 and P75–P25. In other words, the distribution becomes less skewed at the top, but greater separation emerges in the middle as larger firms come to reflect higher productivity rather than disproportionate market power.

The paper takes three steps to demonstrate the aforementioned results. First, I develop a general-equilibrium model that combines oligopolistic competition à la Atkeson and Burstein (2008); Edmond, Midrigan, and Xu (2015); Edmond et al. (2023) with the technology-adoption framework of Sedláček (2020), with two key departures: (i) two non–productivity-enhancing intangible-investment margins—one aimed at deterring entry and the other at deterring imitation; and (ii) two entry margins—new brands within existing product markets and new leaders of entirely new product lines. These features allow the model to capture the joint effects of defensive investment on allocative efficiency and on technical efficiency through firm-level productivity, brand variety, and product variety. The framework endogenously implies that larger and more dominant firms devote greater resources to defensive strategies, consistent with evidence that lobbying scales with firm size (Bombardini and Trebbi, 2012) and that large firms patent more aggressively while garnering fewer forward citations (Akcigit and Kerr, 2018; Argente et al., 2020; Baslandze, 2021). I discipline the model by calibrating it to the empirical relationship between size, productivity, and market shares using a merged dataset combining Compustat with firm-level productivity from İmrohoroğlu and Tüzel (2014) and product similarity scores from Hoberg and Phillips (2016).

Second, I consider three counterfactual exercises: (i) a comprehensive ban that prevents both imitation-blocking and entry-blocking investments; (ii) a targeted ban that removes only investments aimed at deterring technological catch-up through imitation; and (iii) a targeted ban that removes only those investments designed to block entry into incumbent product markets. The results reveal a sharp asymmetry. Aggregate productivity gains from curbing defensive behavior come entirely from restricting imitation-blocking: cracking down on this investment intensifies rivalry at the technological frontier—especially in markets led by high-productivity incumbents—strengthens the incentive to escape competition, shifts effort from defense toward adoption and frontier intangible investments, and increases within-firm efficiency. By contrast, removing only entry-blocking lowers aggregate productivity: it eases product-market access but leaves diffusion frictions intact, weakening lower-productivity leaders' incentives to upgrade. The same asymmetry emerges in the firm size distribution. Removing imitation-blocking widens the interdecile ranges P90–P10 and P75–P25 while reducing skewness, as rivalry between highly productive leaders and their closest followers intensifies and superstar dominance weakens. By contrast, removing entry-blocking reduces the standard deviation of firm size by fostering a proliferation of firms in low-productivity markets, thereby compressing the overall dispersion. Taken together, these results imply that maximizing firm-level productivity requires greater dispersion along both dimensions: a wider interdecile spread and a higher standard deviation. This parallels the findings of Hsieh and Klenow (2009, 2014), who show that removing resource misallocation produces more dispersed firm size distributions.

Third, I validate the model using two proxies for defensive investment: an Average Citation Gap (ACG) built from Kogan, Papanikolaou, Seru, and Stoffman (2017) patent citations and a five-year Lobbying Expenditure (LE) from LobbyView (Kim, 2018). I relate these proxies to product-market proximity—TNIC3 similarity scores from Hoberg and Phillips (2016)—between incumbents and recent entrants. Consistent with the model, higher ACG or LI is associated with lower similarity to entrants among large firms.

The analysis highlights a fundamental policy trade-off: any instrument must curb defensive investment—reducing leaders' ability to obstruct technological catch-up—while minimizing adverse effects on product variety and process innovation. This challenge has taken on renewed importance in recent years, as competition authorities in both the United States and the European Union have intensified efforts to limit the market power of dominant firms and promote more competitive market structures. Recent initiatives, such as the proposed *Competition and Antitrust Law Enforcement Reform Act* in the US and the adopted *Digital Markets Act* in the EU, are designed to reduce the ability of large incumbents to shield themselves from competitive pressure.[7] While most initiatives focus on antitrust enforcement and regulatory obligations, fiscal instruments—such as profit-based taxes on dominant firms—are rarely discussed. I use the model to evaluate how a carefully designed profit tax can discipline imitation-blocking behavior at the technological frontier without unduly discouraging innovation or product creation. The results show that a tiered productivity-based schedule

[7]See S.130, 119th Congress (2025–2026); and Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act).

performs best: it exempts low-productivity leaders, applies a moderate rate to mid-productivity leaders, and imposes the highest burden on frontier leaders, who are precisely those most prone to engage in imitation-blocking. This structure recovers nearly two thirds of the aggregate productivity loss from defensive investment by targeting distortions where they are most severe—at the frontier—while limiting penalties on near-frontier firms. By shifting resources away from defense and toward productivity-enhancing investment, the tiered schedule delivers larger TFP gains with smaller losses in product variety than a uniform tax. Intuitively, sparing low-productivity leaders and taxing mid-tier leaders only lightly avoids discouraging new product entry entry and process innovation, while the higher rate at the frontier curbs the tendency of the most productive leaders to invest in imitation-blocking, thereby raising competition and strengthening innovation incentives. Taken together, these results show that failing to distinguish between the two entry margins leads to overly aggressive policy prescriptions, since overlooking the product-variety channel risks overstating the true benefits of tough competition policy.

Related literature

There are three major areas of macroeconomics related to this paper.

First, this paper connects to the misallocation literature (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009). Similar to Hsieh and Klenow (2009, 2014), I find that maximizing firm-level productivity requires greater dispersion in the firm size distribution. In addition, it complements recent contributions that study markup dispersion as a source of factor misallocation (Edmond et al., 2015; Baqaee and Farhi, 2020; De Loecker et al., 2021; Edmond et al., 2023; Eeckhout, Weng, Li et al., 2021). Relative to these papers, I examine how firms' defensive investment shapes aggregate productivity within a technology–adoption framework. When the productivity distribution is endogenous, the aggregate effects of greater markup dispersion can be attenuated, as discussed earlier.[8]

Second, the paper also contributes to the literature on the aggregate implications of barriers to technology diffusion (Gilbert and Newbery, 1982; Krusell and Rios-Rull, 1996; Comin and Hobijn, 2009; Bombardini and Trebbi, 2012; Abrams et al., 2013; Mukoyama and Popov, 2014; Gutiérrez and Philippon, 2019; Argente et al., 2020; Akcigit and Ates, 2023; Akcigit et al., 2023; Bao and Eeckhout, 2023; Fernández-Villaverde et al., 2025). A distinguishing feature of my analysis is that it incorporates two defensive margins and two entry margins—elements typically abstracted from diffusion models—to assess whether different forms of defensive investment have distinct aggregate consequences, given their heterogeneous effects on entry and technology adoption across product–market structures. I show that accounting for the entry margin substantially dampens the aggregate productivity loss from defensive investment, and that the loss stems exclusively from investments that block imitation of high productive leaders rather than from those that deter new entry. These features are crucial for designing a feasible fiscal instrument that recovers part of the productivity loss.

Finally, the paper contributes to the literature on the welfare and growth implications of product variety (Melitz, 2003; Broda and Weinstein, 2006; Arkolakis, Demidova, Klenow, and Rodréguez-Clare, 2008; Feenstra and Weinstein, 2017; Garcia-Macia, Hsieh, and Klenow, 2019; Aghion, Bergeaud, Boppart, Klenow, and Li, 2019). Complementing this line of research, the paper emphasizes the importance of accounting for the product variety margin when designing competition policies. In this

[8] This is consistent with Cavenaile et al. (2019) and Peters (2020), who show that the gains from reducing markup distortions can be offset—or even overturned—by weaker innovation incentives.

respect, the analysis is also related to work on how advertising shapes incentives to create new products (Cavenaile and Roldan-Blanco, 2021; Cavenaile, Celik, Perla, and Roldan-Blanco, 2023; Baslandze, Greenwood, Marto, and Moreira, 2023), as well as to the literature on the aggregate implications of ex ante start-up heterogeneity (Sterk, Sedláček, and Pugsley, 2021; De Haas, Sterk, and Van Horen, 2022). The model implies that removing defensive practices changes the composition of entry.

Organization

The rest of the paper is organized as follows. Section 2 develops the general equilibrium model. Section 3 presents the model's calibration and quantitative results. Section 4 provides empirical support using firm-level data. Section 5 discusses policy implications and 6 concludes.

2 Theoretical Framework

This section develops a quantitative heterogeneous-firm model to study how defensive behavior affects aggregate productivity. The framework combines the nested CES structure of Atkeson and Burstein (2008); Edmond et al. (2015, 2023) with the technology-adoption framework of Sedláček (2020), with two key departures: (i) two non–productivity-enhancing intangible-investment margins—one aimed at deterring entry and the other at deterring imitation; and (ii) two entry margins—new brands within existing product markets and new leaders of entirely new product lines. These features allow the model to capture the joint effects of defensive investment on allocative and technical efficiency.

2.1 Model Environment

The economy is stationary and populated by heterogeneous firms engaged in Cournot competition, endogenous technology adoption, and strategic entry and imitation deterrence. Firms invest in both productivity-enhancing innovation and nonproductive intangibles to preserve incumbency rents. Dynamic competition is modeled as aggregative games, ensuring a unique Nash equilibrium under convex costs.[9]

Households and Firms. The economy consists of a representative household and a continuum of product markets populated by heterogeneous firms. The household maximizes lifetime utility $U(C, L)$ over consumption C and labor supply L. It owns all firms and accumulates physical capital K, which depreciates at rate δ. Consumption is a CES aggregate of differentiated product varieties.

Within each product market, firms represent distinct brands that rent capital and hire labor to produce intermediate goods.[10] Firms are either leaders or followers, with leaders being relatively more productive. Strategic choices over output, innovation, and defensive investment depend on market position.

Production. Production features a nested CES structure: firm-level technologies aggregate into product-market output, which in turn aggregates into final output.

Final output Y is produced by a competitive firm that combines product-market outputs y_j as

$$Y = \left(\int_0^M y_j^{\frac{\eta-1}{\eta}} dj \right)^{\frac{\eta}{\eta-1}}, \quad \eta > 1. \tag{1}$$

Each product market $j \in [0, M]$ consists in a finite number of n_j^L leaders and n_j^F

[9]In Section 2.2.5, I prove that the Nash equilibria of the different contests are unique when costs are convex.

[10]For example, in the product market for high-performance sports cars, brands could include Ferrari, Lamborghini, and Maserati.

followers, producing

$$y_j = \left(\sum_{i=1}^{N_j} y_{i,j}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}, \quad \rho > \eta. \tag{2}$$

Firm i in market j produces with a Cobb-Douglas technology:

$$y_{i,j} = \begin{cases} \varepsilon_{d,j}\, k_{i,j}^{\alpha}\, l_{i,j}^{1-\alpha}, & \text{if } i \text{ is a leader,} \\ \varepsilon_{d-f,j}\, k_{i,j}^{\alpha}\, l_{i,j}^{1-\alpha}, & \text{if } i \text{ is a follower,} \end{cases} \tag{3}$$

where $\varepsilon_{d,j} > \varepsilon_{d-f,j}$ captures the endogenous productivity gap (see Section 2.2). The state of a product market is summarized by $\Omega \equiv (\varepsilon_d, \varepsilon_{d-f}, n^L, n^F)$.

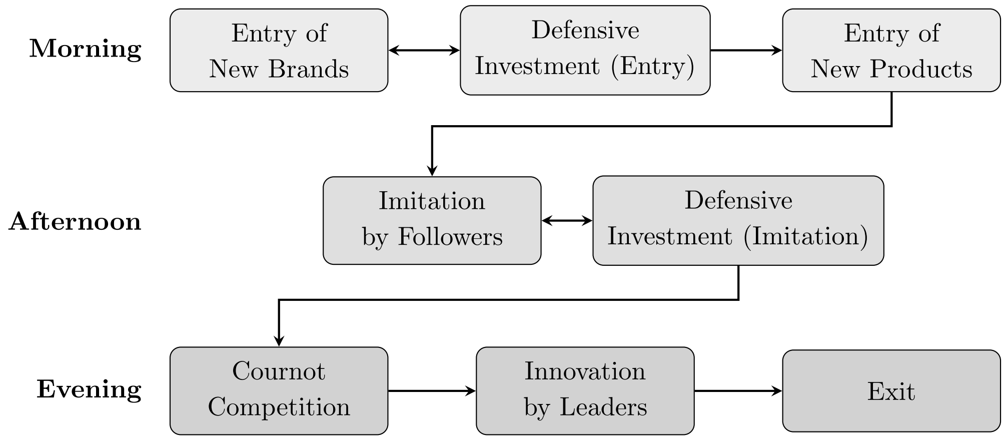
Timing. The timing of decisions determines how incumbents and entrants interact over the innovation cycle. Each period consists of three subperiods (Figure 1):

- Morning: Entry occurs through (i) new brand entry, where firms enter existing product markets and compete with incumbents, who may invest defensively to deter them; and (ii) new product entry, where firms introduce differentiated goods, creating new product markets.

- Afternoon: Followers attempt to imitate leaders' technology. Leaders may invest defensively to block this catch-up. If imitation succeeds, the follower becomes an additional leader in the next subperiod; otherwise, the market structure is unchanged.

- Evening: Firms compete in the goods market à la Cournot. Leaders may then invest in productivity-enhancing intangibles to push the market's technological frontier forward. A successful innovator becomes the sole leader in the next period, demoting other leaders to followers and forcing existing followers to exit. If the innovator was already the only leader, it increases its technological lead. If no leader succeeds, the market structure persists.

Figure 1: Intra-Period Timing



Notes: The figure illustrates the sequence of strategic decisions within a period, divided into morning, afternoon, and evening subperiods. Double arrows indicate simultaneous actions.

2.2 Decision Problems

This subsection presents the recursive decision problems faced by the representative household and the different types of firms at each stage of the period. Firms choose effort x, which maps into labor via $x = \sqrt{2l}$, implying a convex cost function $C(x) = \frac{w}{2}x^2$.

2.2.1 Representative Household

The representative household maximizes expected lifetime utility:

$$U(C, 1-L) = \log C + \kappa(1-L), \tag{4}$$

where $\kappa > 0$ governs the disutility of labor. The household owns all firms, supplies labor, and accumulates capital, which depreciates at rate δ. The optimality conditions are:

$$\frac{1}{C} = \beta \frac{1}{C'}(r' + 1 - \delta), \tag{5}$$

$$\frac{1}{C} w = \kappa. \tag{6}$$

2.2.2 Firms in the Morning: Entry

In the morning, entry occurs in two forms: (i) firms can enter an incumbent product market as followers through new brand entry, and (ii) firms can introduce differentiated goods through new product entry, thereby creating new product markets.

New Brand Entry In each product market j, a finite number $N_j^{E,br}$ of potential brand entrants exert effort $x_{i,j}^{E,br}$ in order to enter as followers. The probability that a follower enters market j is

$$\Theta_j^{E,br}(X_j^{E,br}, X_j^{L,en}) = \frac{\gamma}{X_j^{L,en} + \gamma} \cdot \frac{X_j^{E,br}}{X_j^{E,br} + \upsilon}, \tag{7}$$

where $X_j^{L,en} = \sum_{i=1}^{n_j^L} x_{i,j}^{L,en}$ is the total entry-blocking effort of leaders, $X_j^{E,br} = \sum_{i=1}^{N_j^{E,br}} x_{i,j}^{E,br}$ is the total entry effort of potential brand entrants, and the parameters $\gamma, \upsilon > 0$ govern the effectiveness of defense and entry effort.[11]

[11] The pool of potential entrants is given by $N_j^{E,br} = N^{\max} - (n_j^L + n_j^F)$, with $N^{\max}$ denoting the maximum number of firms in each product market.

The probability that a specific brand entrant i successfully enters is

$$\theta_{i,j}^{E,br}(x_{i,j}^{E,br}, X_j^{E,br}, X_j^{L,en}) = \Theta_j^{E,br}(X_j^{E,br}, X_j^{L,en}) \cdot \frac{x_{i,j}^{E,br}}{X_j^{E,br}}. \tag{8}$$

The value function of a potential brand entrant is

$$V_M^{E,br}(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) = \max_{x^{E,br}} \left\{-C(x^{E,br}) + \theta^{E,br}(x^{E,br}, X^{E,br}, X^{L,en}) V_A^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F + 1)\right\}, \tag{9}$$

The value function of a leader deciding how much entry-blocking effort $x^{L,en}$ to exert is

$$\begin{aligned} V_M^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) = \max_{x^{L,en}} \Big\{ & - C(x^{L,en}) + \theta^{E,br}(X^{E,br}, X^{L,en}) V_A^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F + 1) \\ & + \big(1 - \theta^{E,br}(X^{E,br}, X^{L,en})\big) V_A^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F)\Big\}. \end{aligned} \tag{10}$$

In both value functions, $V_A^F(\cdot)$ and $V_A^L(\cdot)$ are the continuation values of followers and leaders in the afternoon stage, respectively, and the term $n^F + 1$ reflects that, conditional on successful entry, the number of followers in the market increases by one. This change in market structure alters the competitive environment and, consequently, the expected profitability of both leaders and followers.[12]

New Product Entry A mass Σ of potential new product producers chooses effort $x_i^{E,pr}$ to develop a new product. The probability of success of potential new product

[12]Followers make no active decisions in the morning. Their value reflects expected continuation, weighted by the probability of successful entry:

$$V_M^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) = \theta^{E,br}(X^{E,br}, X^{L,en}) V_A^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F + 1) + \big(1 - \theta^{E,br}(X^{E,br}, X^{L,en})\big) V_A^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F).$$

producer i is

$$\theta_i^{E,pr}(x_i^{E,pr}) = \frac{x_i^{E,pr}}{x_i^{E,pr} + \gamma}. \tag{11}$$

The value function of a potential new product entrant is

$$V_M^{E,pr} = \max_{x^{E,pr}} \left\{ -C(x^{E,pr}) + \theta^{E,pr}(x^{E,pr})\, V_A^L(\varepsilon_1, \varepsilon_0, 1, 0) \right\}. \tag{12}$$

Newly introduced products begin at the lowest productivity level among incumbent leaders, consistent with Klepper (1996). In particular, the state $(\varepsilon_1, \varepsilon_0, 1, 0)$ reflects that a new product market starts with one leader at the base productivity ε_1, no followers, and relative follower productivity ε_0.

2.2.3 Firms in the Afternoon: Imitation and Defensive Investment

In the afternoon, followers may invest in imitation to catch up with the technological frontier, while leaders may invest in defense to block such attempts. Let $x_{i,j}^F$ denote the imitation effort of follower i in market j, and $x_{i,j}^{L,im}$ the imitation-blocking effort of leader i in market j.

The probability that a follower reaches the frontier in market j is

$$\Theta_j^F(X_j^F, X_j^{L,im}) = \frac{\gamma}{X_j^{L,im} + \gamma} \cdot \frac{X_j^F}{X_j^F + \upsilon}, \tag{13}$$

where $X_j^{L,im} = \sum_{i=1}^{n_j^L} x_{i,j}^{L,im}$ is total imitation-blocking effort of leaders, and $X_j^F = \sum_{i=1}^{n_j^F} x_{i,j}^F$ is total imitation effort of followers.

The probability that follower i individually becomes an additional leader is

$$\theta_{i,j}^F(x_{i,j}^F, X_j^F, X_j^{L,im}) = \Theta_j^F(X_j^F, X_j^{L,im}) \cdot \frac{x_{i,j}^F}{X_j^F}. \tag{14}$$

The follower's value function is

$$
\begin{aligned}
V_A^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) = \max_{x^F} \Big\{ & -C(x^F) + \theta^F(x^F, X^F, X^{L,im}) V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L+1, n^F-1) \\
& + \Big(\Theta^F(X^F, X^{L,im}) - \theta^F(x^F, X^F, X^{L,im})\Big) V_E^F(\varepsilon_d, \varepsilon_{d-f}, n^L+1, n^F-1) \\
& + \big(1 - \Theta^F(X^F, X^{L,im})\big) V_E^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) \Big\}. \qquad (15)
\end{aligned}
$$

If imitation is successful by the focal follower, the market transitions to (n^L+1, n^F-1) and the firm becomes a leader, with continuation value $V_E^L(\cdot)$ in the evening stage. If another follower succeeds, the transition is also to (n^L+1, n^F-1), but the focal firm remains a follower, continuing with $V_E^F(\cdot)$ in the evening. If no imitation occurs, the state remains (n^L, n^F) and the follower continues with $V_E^F(\cdot)$.

The leader's value function when choosing imitation-blocking effort $x^{L,im}$ is

$$
\begin{aligned}
V_A^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) = \max_{x^{L,im}} \Big\{ & -C(x^{L,im}) + \Theta^F(X^F, X^{L,im}) V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L+1, n^F-1) \\
& + \big(1 - \Theta^F(X^F, X^{L,im})\big) V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) \Big\}. \qquad (16)
\end{aligned}
$$

If imitation succeeds despite defense, the number of leaders rises to n^L+1 and followers fall to n^F-1, and the leader continues with $V_E^L(\cdot)$. If defense is effective, the state remains (n^L, n^F), with continuation value $V_E^L(\cdot)$.

2.2.4 Firms in the Evening: Production, Innovation, and Exit

Within each product market j, the n_j^L incumbent leaders compete in an innovation contest. Let $x_{i,j}^{L,in}$ denote the innovation effort of leader i, and define $X_j^{L,in} = \sum_{h=1}^{n_j^L} x_{h,j}^{L,in}$. The probability that a leader innovates is

$$
\Theta^{L,in}(X_j^{L,in}) = \frac{X_j^{L,in}}{X_j^{L,in} + \gamma},
$$

and the probability that leader i is the winner is

$$\theta_{i,j}^{L,in}(x_{i,j}^{L,in}, X_j^{L,in}) = \Theta^{L,in}(X_j^{L,in}) \cdot \frac{x_{i,j}^{L,in}}{X_j^{L,in}}.$$

The leader's evening problem is

$$\begin{aligned} V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) = \max_{y^L,\, x^{L,\text{in}}} \Big\{ & \pi^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) - C(x^{L,\text{in}}) \\ & + \widehat{\beta}(1-\phi)\Big[\theta^{L,\text{in}}(x^{L,\text{in}}, X^{L,\text{in}})\Big(\mathbf{1}_{\{n^L>1\}} V_M^L(\varepsilon_{d+1}, \varepsilon_{d-1}, 1, n^L - 1) \\ & + \mathbf{1}_{\{n^L=1\}} V_M^L(\varepsilon_{d+1}, \varepsilon_{\max\{d-f-1,0\}}, 1, n^F)\Big) \\ & + \left(\Theta^{L,\text{in}}(X^{L,\text{in}}) - \theta^{L,\text{in}}(x^{L,\text{in}}, X^{L,\text{in}})\right) V_M^F(\varepsilon_{d+1}, \varepsilon_{d-1}, 1, n^L - 1) \\ & + \left(1 - \Theta^{L,\text{in}}(X^{L,\text{in}})\right) \mathbf{1}_{\{d>1\}} V_M^L(\varepsilon_{d-1}, \varepsilon_{\max\{d-f-1,0\}}, n^L, n^F)\Big]\Big\} \end{aligned} \tag{17}$$

where $\widehat{\beta}$ is given by Equation (6), and ϕ is the exogenous destruction probability. The bracketed term describes the expected continuation value of the leader depending on the outcome of the innovation contest:

- With probability $\theta^{L,in}(x^{L,in}, X^{L,in})$, the focal leader wins. If $n^L > 1$, she becomes the sole leader and other leaders are demoted: continuation is $V_M^L(\varepsilon_{d+1}, \varepsilon_{d-1}, 1, n^L - 1)$. If $n^L = 1$, she deepens her technological lead while followers remain: continuation is $V_M^L(\varepsilon_{d+1}, \varepsilon_{\max\{d-f-1,0\}}, 1, n^F)$.

- With probability $\Theta^{L,in}(X^{L,in}) - \theta^{L,in}(x^{L,in}, X^{L,in})$, some other leader wins. The focal leader becomes a follower next period, with continuation $V_M^F(\varepsilon_{d+1}, \varepsilon_{d-1}, 1, n^L - 1)$.

- With probability $1 - \Theta^{L,in}(X^{L,in})$, no leader innovates. Relative productivity declines by one rung (if $d > 1$), and the market structure is unchanged: continuation is $V_M^L(\varepsilon_{d-1}, \varepsilon_{\max\{d-f-1,0\}}, n^L, n^F)$.

Followers make no dynamic choices in the evening. Their continuation value depends on whether a single leader innovates or not.[13]

2.2.5 Equilibrium Characterization

This subsection characterizes equilibrium behavior in the games played between leaders and followers in the afternoon and evening stages. We state the propositions formally and then interpret their economic meaning. Proofs are provided in Appendix A.[14]

Defensive Games

Proposition 1. Given $X^{L,im}$, let x^{F*} denote the symmetric equilibrium of Equation (15). If $C'(x^F) > 0$ and $C''(x^F) > 0$ for all $x^F > 0$, and $C(0) = 0$, then:

(i) x^{F*} increases with $V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L+1, n^F-1) - V_E^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F)$;

(ii) x^{F*} increases with $V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L+1, n^F-1) - V_E^F(\varepsilon_d, \varepsilon_{d-f}, n^L+1, n^F-1)$;

(iii) x^{F*} decreases with $X^{L,im}$;

(iv) For given $X^{L,im}$, the equilibrium x^{F*} is unique.

Proof. See Appendix A.1. ■

[13]The follower's evening problem is

$$V_E^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) = \max_{y^F} \Big\{ \pi^F(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) + \widehat{\beta}(1-\phi) \big[\Theta^{L,in}(X^{L,in})\, \mathbf{1}_{\{n^L=1\}}\, V_M^F(\varepsilon_{d+1}, \varepsilon_{\max\{d-f-1,0\}}, 1, n^F) + \big(1 - \Theta^{L,in}(X^{L,in})\big)\, \mathbf{1}_{\{d>1\}}\, V_M^F(\varepsilon_{d-1}, \varepsilon_{\max\{d-f-1,0\}}, n^L, n^F) \big] \Big\}.$$

where $V_M^F(\cdot)$ is the follower's next-morning continuation value. If a single leader innovates, followers continue in a market with an enlarged frontier lead; if no innovation occurs, relative productivity depreciates by one step provided $d > 1$.

[14]For brevity, the main text presents results for the afternoon defensive game. The same logic applies to the morning entry-blocking game, with corresponding propositions in Appendix A.5–A.7.

Part (i) uses the gap $V_E^L(\cdot; n^L{+}1, n^F{-}1) - V_E^F(\cdot; n^L, n^F)$, which is the payoff from becoming an additional leader relative to remaining a follower in the current market structure. A larger gap raises the return to imitation and increases x^{F*}. Part (ii) considers $V_E^L(\cdot; n^L{+}1, n^F{-}1) - V_E^F(\cdot; n^L{+}1, n^F{-}1)$, the payoff from becoming an additional leader conditional on another follower also succeeding. If this conditional gap is high, imitation remains attractive and x^{F*} rises. Part (iii) reflects deterrence: a higher $X^{L,im}$ lowers the probability that either value gain can be realized, reducing optimal imitation effort. Uniqueness in part (iv) ensures a well-defined follower best response given leader defense.

Proposition 2. Given X^F, let $x^{L,im*}$ denote the symmetric equilibrium of Equation (16). If $C'(x^{L,im}) > 0$ and $C''(x^{L,im}) > 0$ for all $x^{L,im} > 0$, and $C(0) = 0$, then:

(i) $x^{L,im*}$ increases with $V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) - V_E^L(\varepsilon_d, \varepsilon_{d-f}, n^L + 1, n^F - 1)$;

(ii) $x^{L,im*}$ increases with X^F;

(iii) The equilibrium $x^{L,im*}$ is unique.

Proof. See Appendix A.2. ■

Part (i) hinges on the gap $V_E^L(\cdot; n^L, n^F) - V_E^L(\cdot; n^L{+}1, n^F{-}1)$, which measures the leader's loss in continuation value from the arrival of an additional leader through imitation. A larger loss strengthens the incentive to defend, raising $x^{L,im*}$. This theoretical result aligns with evidence that larger and more dominant firms allocate greater resources to defensive strategies. In particular, lobbying expenditures scale with firm size (Bombardini and Trebbi, 2012), and large firms patent more aggressively yet with lower forward citation rates—patterns consistent with strategic defense (Akcigit and Kerr, 2018; Argente et al., 2020; Baslandze, 2021). Part (ii) captures the threat scale: higher aggregate imitation X^F raises the likelihood of that unfavorable transition, further increasing optimal defense. Uniqueness in part (iii) guarantees a single defensive strategy consistent with follower behavior.

Proposition 3. The game defined by Equations (16) and (15) admits a unique symmetric equilibrium $(x^{L,im**}, x^{F**})$.

Proof. See Appendix A.3. ■

Proposition 3 establishes that the imitation–defense game admits a unique symmetric equilibrium $(x^{L,im**}, x^{F**})$. Uniqueness arises because two opposing forces discipline behavior: deterrence, whereby stronger leader defense reduces the return to imitation and limits follower effort, and the threat scale, whereby greater imitation risk increases the leader's incentive to defend. These forces jointly ensure that follower imitation and leader defense adjust consistently, pinning down a unique and stable equilibrium outcome.

Innovation Game.

Proposition 4. Let $x^{L,in*}$ denote the symmetric equilibrium of Equation (17). If $C'(x^{L,in}) > 0$ and $C''(x^{L,in}) > 0$ for all $x^{L,in} > 0$, and $C(0) = 0$, then:

(i) $x^{L,in*}$ increases with

$$\begin{aligned}&\mathbf{1}_{\{n^L>1\}}\, V_M^L(\varepsilon_{d+1}, \varepsilon_{d-1}, 1, n^L - 1) + \mathbf{1}_{\{n^L=1\}}\, V_M^L(\varepsilon_{d+1}, \varepsilon_{\max\{d-f-1,0\}}, 1, n^F)\\&\quad - \mathbf{1}_{\{d>1\}}\, V_M^L(\varepsilon_{d-1}, \varepsilon_{\max\{d-f-1,0\}}, n^L, n^F);\end{aligned}$$

(ii) $x^{L,in*}$ increases with

$$\mathbf{1}_{\{n^L>1\}} V_M^L(\varepsilon_{d+1}, \varepsilon_{d-1}, 1, n^L - 1) + \mathbf{1}_{\{n^L=1\}} V_M^L(\varepsilon_{d+1}, \varepsilon_{\max\{d-f-1,0\}}, 1, n^F)$$
$$- V_M^F(\varepsilon_{d+1}, \varepsilon_{d-1}, 1, n^L - 1);$$

(iii) The equilibrium $x^{L,in*}$ is unique.

Proof. See Appendix A.4. ■

Proposition 4 shows that leaders' innovation incentives depend on continuation-value gaps that capture the consequences of winning or losing the innovation contest. In part (i), the relevant comparison is between the continuation value if the leader successfully innovates and the continuation value if no innovation occurs: innovation raises the frontier one step, making the winner the sole leader in the next period, and the gap $V_M^L(\varepsilon_{d+1}, \cdot) - V_M^L(\varepsilon_{d-1}, \cdot)$ measures the payoff from escaping depreciation and consolidating leadership. In part (ii), the relevant comparison is between the continuation value if the focal leader innovates versus if another leader innovates, in which case the focal leader is demoted to follower with continuation value $V_M^F(\varepsilon_{d+1}, \cdot)$; the gap $V_M^L(\varepsilon_{d+1}, \cdot) - V_M^F(\varepsilon_{d+1}, \cdot)$ therefore captures the loss from demotion relative to the gain from becoming sole leader. In part (iii), uniqueness ensures that these strategic forces pin down a single equilibrium level of innovation effort. Overall, Proposition 4 implies that leaders innovate more aggressively when the payoff from maintaining sole leadership is high (escape from depreciation) or when the cost of demotion is large (avoiding being overtaken). This reflects the Schumpeterian "escape from competition" mechanism: the greater the threat of being surpassed, the stronger the innovation response (Aghion et al., 2005).

2.3 Balanced Growth and Markov Perfect Equilibrium

This paper focuses on the Balanced Growth Path Markov Perfect Equilibrium (BGP–MPE), in which equilibrium strategies depend solely on the payoff-relevant state variable $\Omega \equiv (\varepsilon_d, \varepsilon_{d-f}, n^L, n^F)$, and all aggregate variables grow at the common rate g^ε.[15]

A stationary equilibrium consists of:

- a set of prices $(r, w, p^L, p^F_{i,j})$,
- a set of allocations $(Y, C, I, y^L_{i,j}, y^F_{i,j})$,
- a set of policies $(x^{E,br}, x^{E,pr}, x^{L,en}, x^F, x^{L,im}, x^{L,in})$,

such that the following conditions hold:

1. Given prices, competitive final-good producers maximize profits.
2. Given Ω, the outputs y^L and y^F maximize the profits of oligopolistic firms in each industry.
3. The effort $x^{E,pr}$ maximizes the value of a potential product entrant, $V^{E,pr}(\Omega)$.
4. Given Ω, $X^{L,en}$, and $X^{E,br}$, the effort $x^{E,br}$ maximizes the value of a potential brand entrant, $V^{E,br}_M(\Omega)$.
5. Given Ω, $X^{E,br}$, and $X^{L,en}$, the effort $x^{L,en}$ maximizes the value of a leader engaged in entry-blocking, $V^L_M(\Omega)$.
6. Given Ω, X^F, and $X^{L,im}$, the effort x^F maximizes the value of a follower in the imitation game, $V^F_M(\Omega)$.

[15] The technology frontier is the sole source of growth. Firm-level and aggregate employment are stationary. All other variables can be stationarized by dividing them by $\varepsilon_{N^\varepsilon}$.

7. Given Ω, X^F, and $X^{L,im}$, the effort $x^{L,im}$ maximizes the value of a leader defending against imitation, $V_M^L(\Omega)$.

8. Given Ω and $X^{L,in}$, the effort $x^{L,in}$ maximizes the value of a leader in the innovation game, $V_E^L(\Omega)$.

9. Given prices, consumption C satisfies the household's Euler condition (Equation (5)).

10. The real interest rate satisfies:

$$r = \frac{1+g^{\varepsilon}}{\beta} + \delta - 1.$$

11. The resource constraint holds:

$$Y = C + I,$$

where investment is given by:

$$I = \delta \int \left(n^L \frac{y^L}{\varepsilon_d} + n^F \frac{y^F}{\varepsilon_{d-f}} \right) \left[\frac{\alpha}{1-\alpha} \cdot \frac{w}{r} \right]^{1-\alpha} \mu(d\Omega).^{16}$$

12. The industry distribution $\mu(\Omega)$ is a fixed point consistent with the transition dynamics implied by the policy functions $(x^{E,br}, x^{E,pr}, x^{L,en}, x^F, x^{L,im}, x^{L,in})$.

2.4 Decomposing Aggregate TFP

This subsection establishes a decomposition of aggregate total factor productivity (TFP) into allocative and technical efficiency components, explicitly incorporating

[16] μ is a probability measure on the mixed state space $\Omega = (\varepsilon_d, \varepsilon_{d-f}, n^L, n^F)$, where $(\varepsilon_d, \varepsilon_{d-f})$ are continuous and (n^L, n^F) are discrete. Formally, $\mu(d\Omega) = \sum_{n^L=1}^{N^{\max}} \sum_{n^F=0}^{N^{\max}-n^L} \mu(d\varepsilon_d,\, d\varepsilon_{d-f};\, n^L, n^F)$.

intangible investments such as innovation, patenting, or lobbying, and distinguishing between brand and product variety.

Lemma 1. Aggregate TFP can be expressed as

$$\mathcal{E} = \underbrace{\mathcal{E}^{(1)}}_{\text{Allocative Efficiency}} \cdot \underbrace{\mathcal{E}^{(2)}}_{\substack{\text{Technical Efficiency net of} \\ \text{intangible investment costs}}}, \tag{18}$$

where

$$\mathcal{E}^{(1)} = (1 + \lambda^{\mu}),$$

$$\mathcal{E}^{(2)} = (1 + \lambda^{L})(1 + \lambda^{M})(1 + \lambda^{n})\,\bar{\varepsilon}.$$

Here λ^{μ} captures efficiency losses due to markup dispersion, λ^{L} measures the cost of intangible investment in terms of foregone production labor, λ^{M} and λ^{n} measure the contributions of product and brand variety, and $\bar{\varepsilon}$ is average firm-level productivity.

Proof. See Appendix B. ■

Lemma 1 shows that aggregate productivity is shaped by two fundamental determinants. Part (i), $\mathcal{E}^{(1)}$, reflects allocative efficiency: heterogeneous markups distort the allocation of resources across firms, lowering aggregate productivity. Part (ii), $\mathcal{E}^{(2)}$, reflects technical efficiency: it depends on average firm-level productivity and the gains from both product and brand variety, while netting out the cost of labor diverted into intangible activities. The novelty of this decomposition lies in explicitly accounting for the dual contribution of product and brand variety to technical efficiency, alongside the role of intangible investments.

3 Quantitative Analysis

This section presents the quantitative analysis in three steps. First, I describe the calibration strategy. Second, I assess the aggregate effect of defensive practices on total factor productivity (TFP) by simulating a counterfactual in which leaders cannot engage in such strategies, and I decompose the contribution of the distinct channels through which competition policy influences aggregate productivity. Finally, I evaluate the separate effects of each type of defensive investment.

3.1 Calibration

Table 1: **Targeted and Untargeted Moments**

Panel A: Targeted Moments			
Description	Parameter Sensitivity	Data	Model
Capital-Output Ratio	α	2.30	2.33
Total Hours Worked	κ	0.33	0.33
Entry Rate	$\gamma^L, \gamma^F, \phi, N^{\max}$	0.09	0.09
Intangible Investment Intensity (%)	$\gamma^L, \gamma^F, \rho, \eta, N^{\max}$	6.00	5.92
Elasticity of Firm TFP w.r.t. Size	$\gamma^L, \gamma^F, \rho, \eta$	0.17	0.14
Elasticity of Product Product Market Share w.r.t. Size	$\gamma^L, \gamma^F, \rho, \eta, N^{\max}$	0.56	0.70
Std. Dev. of Market Share (log)	$\gamma^L, \gamma^F, \rho, \eta, N^{\max}$	2.13	1.84
Average Product Market Share	$\gamma^L, \gamma^F, \rho, \eta, N^{\max}$	0.39	0.41
Panel B: Untargeted Moments			
Elasticity of Intangible Investment Intensity w.r.t. Size	–	−0.35	−0.60
Average Relative Size of Entering Firms	–	0.21	0.25
Std. Dev. of Firm Size (log)	–	2.56	1.66

Note: Panel A reports targeted moments used in calibration, with the "Parameter Sensitivity" column indicating which parameters primarily influence each moment. Panel B reports untargeted moments, which serve as over-identification checks. Data sources and empirical estimation methods are described in Appendix C.

In this section, I describe the calibration strategy used to discipline the model's parameters. Time is annual, and each period corresponds to one year. Parameters fall into two groups: those set exogenously based on values from the literature, and those calibrated internally to match key empirical moments.

A central element of the calibration is the specification of the demand system, governed by two elasticities: the elasticity of substitution across products, η, and the elasticity of substitution within products, ρ. These parameters shape the mapping from firm size differences to observable variation in firm-level productivity and market share. The elasticity η captures the ease with which consumers substitute across distinct products. A higher η makes consumers more responsive to price differences between products, enabling more productive firms to capture a disproportionate share of demand. This weakens the link between firm size and market share within a given product market. By contrast, ρ measures substitutability within a product market—that is, across firms offering the same product. When ρ is high, demand within the product category is more elastic, so even modest productivity advantages translate into large market share differences. This attenuates the relationship between firm size and absolute productivity while strengthening incentives for lagging firms to imitate the leaders' technology.

Predetermined parameters. Five parameters are set according to standard values in the literature. The household discount factor is set to $\beta = 0.97$, implying an average real interest rate of approximately 3 percent (Sedláček, 2020). The capital depreciation rate, $\delta = 0.1$, targets the average investment-to-capital ratio (Sedláček, 2020). The growth rate of the technology frontier is set to $g^{\varepsilon} = 0.018$, consistent with average labor productivity growth from the BEA (Sedláček, 2020). Finally, the mass of potential new product producers, Σ, is normalized such that the steady-state total mass of products equals $M = 1$ in the benchmark economy. Table 2 summarizes these values.

Calibrated parameters. The remaining seven parameters are jointly calibrated to match key empirical moments. These include: (1) the capital share, α, (2) the preference parameter, κ, (3) the exogenous product destruction probability, ϕ, (4) the intangible investment efficiency shifter of leaders, γ,(5) the intangible investment efficiency shifter of followers, υ, (6) the across-product elasticity of substitution, η,(7) the within-product elasticity of substitution, ρ, and (8) the maximum number of firms per product market, $N^{\max}$.

The calibration targets the following eight empirical moments. These comprise: (1) the aggregate capital-output ratio is set to 2.3, based on the average private capital-to-output ratio between 1954 and 2002 reported by Khan and Thomas (2013), (2) total hours worked are normalized to one-third of available time, (3) the intangible intensity is targeted at approximately 6 percent, consistent with David and Gourio (2023), (4) the average firm entry rate over 2001–2019 is targeted at approximately 0.09, according to the BDS (Decker and Haltiwanger, 2023), (5) standard deviation of product market share,[17], (6) Average product market share, (7) the elasticity of market share with respect to firm size is targeted at 0.46,[18] and (8) the elasticity of firm size with respect to TFP is targeted at 0.17[19].

Table 1 shows that the model also performs well on untargeted moments, providing an additional check on the calibration. It delivers a negative elasticity of intangible–investment intensity with respect to firm size that is close in magnitude to the data, capturing the fact that larger firms invest less intensively in intangibles

[17]Market share is computed as $\mathrm{MS}_i = \frac{\mathrm{sale}_i}{\mathrm{sale}_i + \sum_{j \neq i} \mathrm{score}_{ij} \cdot \mathrm{sale}_j}$, where score_{ij} are product similarity scores from Hoberg and Phillips (2016). These scores are interpreted as the share of firm j's sales associated with products similar to those of firm i, allowing us to construct a similarity-weighted measure of rival sales. Sales data are from Compustat over 2001–2019. See Appendix C for details.

[18]The target is obtained from estimating a regression of the log of market share on the log of firm size (SALE), controlling for firm age and including SECTOR × YEAR fixed effects over 2001–2019. See Appendix C for details.

[19]The target is obtained from estimating a regression of the log of firm size (SALE) on the log of firm TFP, controlling for firm age and including SECTOR × YEAR fixed effectsover 2001–2019. TFP is sourced from İmrohoroğlu and Tüzel (2014), and sales from Compustat. See Appendix C for details.

relative to sales.[20] The model reproduces about two–thirds of the dispersion in firm size observed in the data, and the average relative size of entrants is reasonably close to the empirical benchmark in Decker and Haltiwanger (2023).

For the numerical implementation, I normalize the final good's price to 1 and discretize the productivity state space into 70 grid points, allowing for a rich representation of firm-level heterogeneity.

Table 2: **Parameter Values**

Panel A: Pre-determined Parameters		
Description	Parameter	Value
Discount Factor	β	0.97
Depreciation Rate	δ	0.10
Growth Rate of the Technology Frontier	g^{ε}	0.018
Mass of Potential New Product Producers	Σ	0.058
Panel B: Calibrated Parameters		
Capital Share	α	0.41
Preference Parameter	κ	2.19
Leaders' Investment Technology	γ	0.025
Followers' Investment Technology	υ	0.040
Between-Product Elasticity of Substitution	η	5.30
Within-Product Elasticity of Substitution	ρ	12.80
Product Destruction Probability	ϕ	0.030
Maximum Number of firms	$N^{\max}$	4

Note: Panel A reports parameters set exogenously based on values from the literature or standard macroeconomic calibrations. Panel B reports parameters chosen to match empirical moments of the U.S. economy, as described in Section 3.1. The between-product elasticity η governs substitution across product markets, while the within-product elasticity ρ governs substitution across brands within a market.

[20] Size is defined as the log of sales from Compustat; intangible–investment intensity is constructed from Compustat following Peters and Taylor (2017).

3.2 Effect on TFP

Table 3: **Defensive Investment and Aggregate Total Factor Productivity**

	Ban All Defensive Investment	Ban Imitation-Blocking	Ban Entry-Blocking
Panel A: TFP and Welfare			
Allocative Efficiency, $\Delta\ln(\mathcal{E}^{(1)})$	0.44	0.43	-0.11
Brand Variety	0.46	-2.38	2.47
Product Variety	-6.41	-2.95	-3.17
Firm-level Productivity	7.39	9.07	-2.40
Net Technical Efficiency, $\Delta\ln(\mathcal{E}^{(2)})$	1.45	4.25	-2.28
Total Factor Productivity, $\Delta\ln(\mathcal{E})$	1.89	4.68	-2.39
Welfare	6.10	9.77	-3.36
Panel B: Moments			
Std. Dev. of Markups	-52.85	-34.10	-24.18
Number of Brands	12.29	-14.54	31.02
Mass of Products	-24.08	-11.90	-12.73
Leaders' Productivity	3.26	5.14	-0.70
Followers' Productivity	23.52	12.66	0.97
Elasticity of Product Product Market Share w.r.t. Size	-98.42	-95.41	-11.18
Elasticity of Firm TFP w.r.t. Size	65.47	64.03	6.45

Note: Panel A reports the effects of three competition-policy scenarios on aggregate total factor productivity (TFP) and welfare. Panel B reports the corresponding percentage changes in key moments of the stationary equilibrium. The policies are: banning all defensive investment (both entry-blocking and imitation-blocking), banning defensive investment against imitation only, and banning defensive investment against entry only. All changes are expressed relative to the benchmark economy with defensive investment. The TFP decomposition follows Equation 18, and welfare is measured as the consumption-equivalent variation. The standard deviation of markups refers to the cross-sectional distribution of firm-level markups. The number of brands is the average number of firms per product market. The mass of products is the total number of product markets in the economy. Leaders' and followers' productivity are defined as the quantity-weighted harmonic mean of firm productivities among leaders and followers, respectively. The elasticities of firm productivity and market share with respect to firm size are calculated by log–log regressions across firms within the stationary distribution.

This subsection evaluates the macroeconomic implications of stricter competition policy by focusing on the first counterfactual, in which all forms of defensive behavior are removed. The benchmark equilibrium allows firms to engage in defensive practices—such as preemptive patenting or strategic lobbying—that deter entry and imitation without improving productive efficiency. In contrast, the post-reform equilibrium represents an economy in which an omnipotent competition authority effectively suppresses all such behavior. The goal is to assess how this shift alters equilibrium allocations, with particular emphasis on total factor productivity (TFP).

Following the decomposition in equation (18), aggregate TFP gains can be expressed as the sum of two components: improvements in production allocative efficiency, which reflect reductions in markup dispersion, and gains in net technical efficiency, which capture the combined effects of changes in firm-level productivity and variety.

The first column of Table 9 shows that cracking down on defensive investment increases aggregate TFP by 1.89 percent. Roughly one-quarter of this gain, equal to 0.44 percentage points, is attributable to reduced markup dispersion, while the remaining three-quarters, equal to 1.45 percentage points, stem from improvements in net efficient TFP.

Relative to the findings of Edmond et al. (2015) and Edmond et al. (2023), the contribution of changes in factor misallocation to TFP is broadly consistent. However, the overall impact is more moderate here because markup dispersion is not fully removed. In the absence of defensive tools, leaders redirect resources toward innovation in order to preserve their advantage over increasingly capable followers. This endogenous response sustains part of their markup-related rents while still delivering improvements in allocative efficiency.

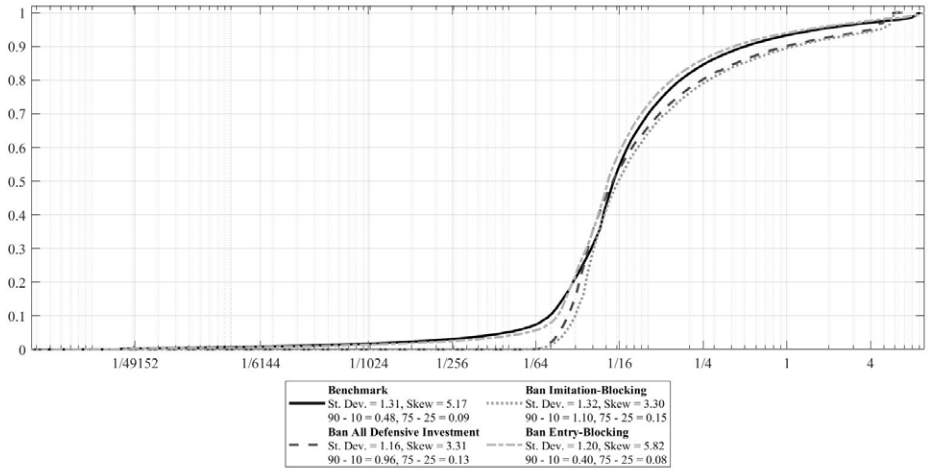
The net technical efficient TFP component reveals a more complex picture. Tackling defensive investment has an inherent drawback: it tends to disincentivize product proliferation. As shown in Table 9, product variety declines by 24 percent, substantially offsetting the positive contributions from higher brand variety, which increases by 12 percent, and firm-level efficiency—especially among followers, whose productivity rises by over 23 percent. This reflects a broader trade-off: policies that prevent distortive strategic behavior can unintentionally suppress beneficial differentiation. If the loss in variety is ignored, one risks overestimating the productivity and welfare gains from aggressive competition enforcement.

A further implication concerns the distribution of firm size, as reported in Figure 2. Cracking down on defensive investments reshapes both the tails and the central mass of the distribution. On one hand, the policy reduces asymmetry by shrinking the relative scale of the largest superstar firms, thereby lowering skewness, since these firms can no longer defend their market shares. On the other hand, it produces countervailing effects on dispersion. While overall variability is compressed, as reflected in a lower standard deviation, the interdecile ranges—specifically the difference between the ninetieth and tenth percentiles and between the seventy-fifth and twenty-fifth percentiles—widen, revealing greater separation between mid-sized firms and smaller firms within the core of the distribution. The intuition is that removing defensive practices intensifies product market rivalry and generates more direct competition between highly productive leaders and their immediate followers. These mechanisms are consistent with the elasticity results. The fall in the elasticity of market share with respect to size indicates the weakening of superstar dominance, while the rise in the elasticity of size with respect to productivity captures the strengthening of direct competition. Taken together, these results indicate that while superstar dominance is curtailed and overall dispersion declines, competitive pressures in the middle of the distribution intensify, leading to a more balanced yet more polarized firm size landscape.

Overall, the policy delivers meaningful gains, with welfare rising by more than 6 percent. These are driven not just by better resource allocation and higher firm-level efficiency, but also by rechanneling intangible investment away from unproductive defense and toward innovation that benefits the broader economy.

Appendix D shows that the qualitative results hold under alternative demand elasticity calibrations. Varying η and ρ by 20 percent while keeping other parameters fixed, the appendix confirms that banning defensive investments consistently improves TFP and overall welfare, although reductions in product variety substantially offset the gains from higher firm-level productivity.

Figure 2: Firm Size CDFs



Notes: Figure 2 plots the cumulative distribution functions (CDFs) of firm size for the four economies considered. The CDFs are shown on a logarithmic scale, with firm size normalized by the average size in each economy so that distributions are comparable across counterfactuals. For each distribution, we also report higher-order moments to capture dispersion and asymmetry: the standard deviation, skewness, the 90–10 percentile difference, and the 75–25 percentile difference.

3.2.1 Mechanisms: Which Defensive Investments Matter for TFP?

To isolate the mechanisms underlying the aggregate TFP gains in the comprehensive reform, I consider two additional counterfactual competition policies. In the first, No Imitation-Blocking, only defensive investments aimed at preventing technological catch-up are prohibited. In the second, No Entry-Blocking, only investments designed to deter new product-market entry are removed. The objective is to identify which channel accounts for the aggregate productivity effects observed under the comprehensive No Defensive Investment reform, in which all defensive behavior is removed.

Table 9 reveals a striking asymmetry: the entire TFP increase under No Defensive Investment is driven by the removal of imitation-blocking activities. Under No Imitation-Blocking, aggregate TFP rises by 4.68 percent, exceeding even the gain from the comprehensive reform, while under No Entry-Blocking, TFP falls by 2.39 percent.

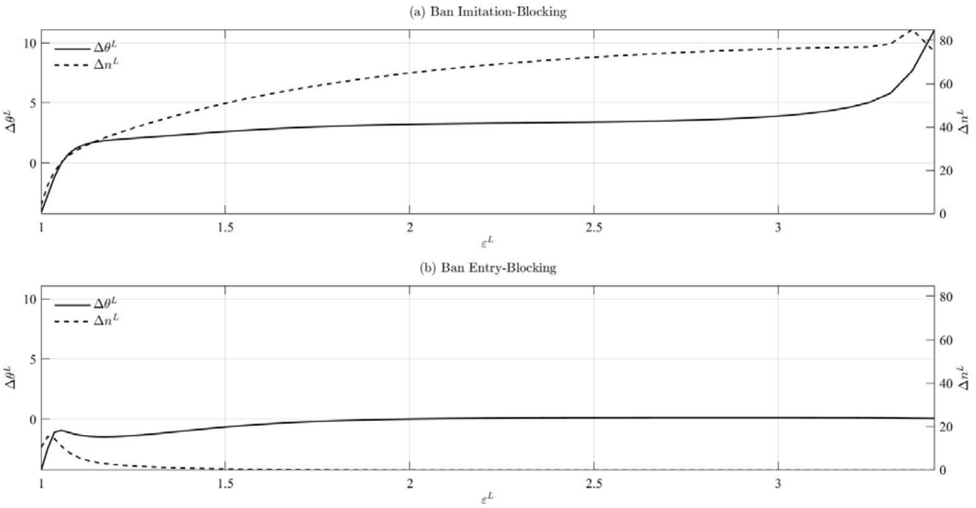
The mechanism reflects the heterogeneity in leader types. Low-productivity leaders—those whose technological advantage over rivals is modest—derive the greatest benefit from entry-blocking activities, since potential entrants typically possess comparable technologies. High-productivity leaders—those far ahead of their rivals—benefit more from imitation-blocking, as entrants are unlikely to match their technology immediately but can erode the gap via catch-up.

When imitation-blocking is removed, competitive pressure intensifies most in product market led by high-productivity incumbents. Facing a heightened risk of being caught, these leaders increase productivity-enhancing innovation to escape competition. By contrast, cracking down on entry-blocking primarily affects sectors with low-productivity leaders. Deprived of the ability to deter entry, these leaders reduce innovation investment, lowering the firm-level productivity by 2.40 percent and resulting in a net TFP loss.

Figure 3 illustrates these dynamics. The top panel illustrates the percentage change in the average probability that a leader innovates and in the number of leaders in an Imitation-Blocking Ban economy, relative to the benchmark economy in which defensive investment is present. The bottom panel presents the same metrics under the Entry-Blocking Ban economy, also relative to the benchmark. These metrics are calculated across product markets that share the same level of leader productivity. In both reforms, innovation rates fall in markets led by low-productivity incumbents, consistent with reduced appropriability. However, only under No Imitation-Blocking do high-productivity leaders sharply increase innovation, responding to the intensified catch-up threat. This asymmetry explains why targeting imitation-blocking behavior yields substantial productivity gains, while targeting entry-blocking behavior does not.

A further implication concerns how different forms of defensive investment affect the distribution of firm size. Cracking down on imitation-blocking practices widens the interquartile range—specifically the difference between the ninetieth and tenth percentiles and between the seventy-fifth and twenty-fifth percentiles—while simultaneously making the distribution more symmetric. The mechanism is twofold. On one hand, more intense rivalry between highly productive leaders and their immediate followers generates tighter neck-to-neck competition, stretching out the distribution across percentiles. On the other hand, the relative scale of the very largest superstar firms shrinks, since they can no longer defend their market shares, which lowers skewness. By contrast, cracking down on entry-blocking reduces dispersion, as measured by the standard deviation of firm size. By allowing entry into low-productivity markets, it leads to a proliferation of small firms concentrated in less productive product markets, which lowers overall dispersion. Taken together with the firm-level productivity results in Table 9, these patterns show that the configuration yielding the greatest dispersion—both in terms of standard deviation and interquartile differences—is also the one with the highest firm-level productivity. In other words, maximizing efficiency requires removing imitation-blocking practices, which intensify competition and widen the percentile range, while maintaining entry-blocking, which prevents excessive entry into low-productivity niches. This echoes the insights of Hsieh and Klenow (2009, 2014), who find that removing resource misallocation produces more dispersed firm size distributions.

Figure 3: Innovation Probability and Number of Leaders under Alternative Competition Policies

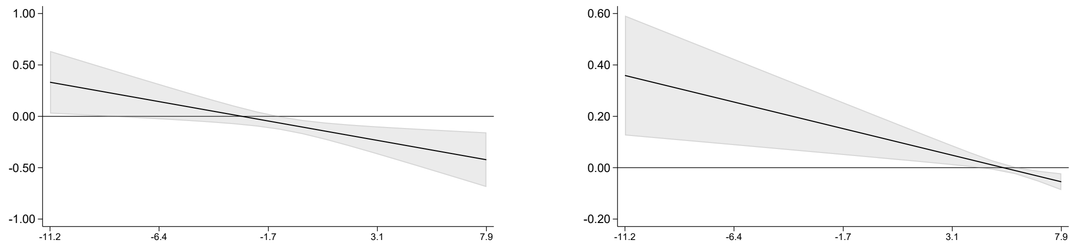


Notes: $\Delta\theta^L$ and Δn^L denote the percentage variation in, respectively, the average probability that a leader innovates and the number of leaders, computed across product markets characterized by the same leader productivity. All changes are expressed relative to the benchmark economy with defensive investment.

4 Empirical Evidence

Figure 4: Product Similarity and Defensive Behavior by Firm Size

(a) (b)



Note: Estimated relationships between product similarity with recent entrants and two firm-level measures of defensive behavior—average citation gap (ACG) and lobbying intensity (LI)—across the firm size distribution, for firms older than six years. Panel (a) reports $\beta_1^{(\text{ACG})} \cdot \text{ACG}_{i,t} + \beta_3^{(\text{ACG})} \cdot (\text{ACG}_{i,t} \times \text{Size}_{i,t})$. Panel (b) reports $\beta_1^{(LI)} \cdot \text{LI}_{i,t} + \beta_3^{(LI)} \cdot (\text{LI}_{i,t} \times \text{Size}_{i,t})$. Shaded regions denote 90 percent confidence intervals based on robust standard errors. Variable definitions and sample construction are in Appendix C.

The model predicts that defensive investments foster the creation of new products, increasing differentiation from rivals and shaping the aggregate productivity effects of incumbency. This section evaluates whether patterns in U.S. firm-level data between 1989 and 2019 are consistent with these mechanisms. The analysis focuses on the correlation between proxies for defensive behavior and the degree of product similarity between incumbents and recent entrants. The exercise is descriptive: it does not attempt to identify causal effects, but rather tests whether the data line up with the model's predictions.

Data and Measurement. The analysis combines several sources. Compustat provides accounting and financial information. To proxy for defensive behavior, I use two complementary measures. First, patent data from Kogan et al. (2017) record forward citations by CPC subclass. Following Argente et al. (2020); Akcigit and Kerr (2018); Baslandze (2021), patents with relatively low forward citations are interpreted as defensive—useful for blocking rivals rather than advancing the frontier. Second, lobbying expenditures come from the LobbyView database (Kim, 2018), aggregated by OpenSecrets. As argued by Gutiérrez and Philippon (2019), lobbying increasingly serves incumbents as a tool to shape regulation and deter entry. Together, these sources provide complementary indicators of defensive activity.

Product market proximity is measured using the TNIC3 dataset of Hoberg and Phillips (2016), which constructs cosine similarity scores from the text of firms' 10-K product descriptions. Scores range from zero, indicating no overlap, to one, indicating identical descriptions. For firm i in year t, I define

$$\mathrm{SM}_{i,t} = \ln\left(1 + \frac{1}{N_{it}} \sum_{j \in \Gamma_t} \text{Similarity Score}_{i,j,t}\right), \tag{19}$$

where Γ_t is the set of firms that entered Compustat for the first time in year t. This measure captures how closely an incumbent's product space overlaps with the entrants in its sector.

Defensive lobbying is captured by a five-year sum of lobbying expenditures, log-transformed:

$$\mathrm{LI}_{i,t} = \ln\left(1 + \sum_{s=t-4}^{t} \text{LobbyingRaw}_{i,s}\right). \tag{20}$$

Defensive patenting is captured by the Citation Gap Index (CGI), which measures the distance between a patent's forward citations and the most cited patent in the same CPC subclass:

$$\text{CGI}_{pct} = \frac{\max_{s\in[t-9,t]} \text{Cites}_{s,c} - \text{Cites}_{p,c,t}}{\max_{s\in[t-9,t]} \text{Cites}_{s,c}}. \tag{21}$$

A higher value indicates a relatively uncited and therefore defensive patent. Firm-level averages are computed annually, then smoothed using a five-year rolling window:

$$\text{ACG}_{i,t} = \ln\left(1 + \frac{1}{5}\sum_{s=t-4}^{t} \overline{\text{CGI}_{i,s}}\right). \tag{22}$$

Specification. For firms older than six years,[21] I estimate

$$\text{SM}_{it} = \beta_1^{(\varphi)}\varphi_{i,t} + \beta_2^{(\varphi)}\text{Size}_{i,t} + \beta_3^{(\varphi)}(\varphi_{i,t} \times \text{Size}_{i,t}) + X_{i,t}'\psi^{(\varphi)} + \zeta_i^{(\varphi)} + \iota_{s,t}^{(\varphi)} + \varepsilon_{i,t}^{(\varphi)} \tag{23}$$

where $\varphi_{i,t}$ is either ACG or LI, ζ_i are firm fixed effects, $\iota_{s,t}$ are 3-digit SIC sector-by-year fixed effects, and $X_{i,t}$ includes controls for intangible investment intensity, patent stock in the previous five years, and age.[22]

Results. Figure 5 reports the marginal associations between defensive behavior and product similarity across the firm size distribution. The patterns are striking. For small and medium-sized incumbents, the relationship is weak or slightly positive. For large incumbents, however, both lobbying and defensive patenting are strongly associated with lower similarity to recent entrants—that is, greater product differentiation.

The magnitudes are economically meaningful. A firm at the 95th percentile of the size distribution (Size = 5) has an average similarity score of 0.043 with recent

[21] Firm age is measured as years observed in Compustat. Results are robust to alternative age cutoffs.

[22] All monetary variables are deflated using CPI series A191RD3A086NBEA from FRED. Size is log real sales. Intangible investment is constructed as in Peters and Taylor (2017). See Appendix C.

entrants. At this point, a 1 percent increase in the ACG measure is associated with a 7 percent reduction in similarity. While the estimates are not causal, they provide descriptive evidence consistent with the model's prediction: defensive investments by large incumbents are correlated with greater product differentiation from younger rivals, a mechanism that underpins the aggregate productivity implications studied in Section 2 and 3.

5 Policy Implications

Table 4: **Profit-Tax Policies Targeting Single-Product Leaders: Effects on TFP and Welfare**

	Uniform Tax on All Leaders	High Tax on Lower-Frontier Leaders	Tiered Tax by Productivity
TFP and Welfare			
Allocative Efficiency, $\Delta \ln(\mathcal{E}^{(1)})$	0.28	0.27	0.41
Brand Variety	-1.47	-1.47	-2.16
Product Variety	-4.91	0.32	-1.31
Firm-level Productivity	2.68	-2.88	3.30
Net Technical Efficiency, $\Delta \ln(\mathcal{E}^{(2)})$	-1.95	-2.45	0.78
Total Factor Productivity, $\Delta \ln(\mathcal{E})$	-1.67	-2.18	1.19
Welfare	-2.26	-3.02	3.34

Note: The table reports the effects of three profit-tax policies applied to single-product leaders on aggregate total factor productivity (TFP) and welfare. All results are expressed as percentage changes relative to the benchmark economy with defensive investment. The TFP decomposition follows Equation 18, and welfare is measured as the consumption-equivalent variation. Policies differ in their targeting: (i) a uniform 60 percent tax on all leaders, (ii) an 60 percent tax only on leaders just above the lower threshold, and (iii) a tiered structure taxing mid-tier leaders at 40 percent and top leaders at 80 percent.

In recent years, competition authorities in both the United States and the European Union have intensified efforts to limit the market power of dominant firms and promote more competitive market structures. The legislative proposal *Competition and Antitrust Law Enforcement Reform Act* in the US and the currently adopted *Digital Markets Act* in the EU aim to reduce the ability of large incumbents to shield themselves from competitive pressure.[23] While most initiatives focus on antitrust enforcement and regulatory obligations, fiscal instruments—such as profit-based taxes targeted at dominant firms—are rarely discussed. The model developed here provides a framework to evaluate how such taxes might be structured to raise aggregate productivity while minimizing negative effects on product variety and innovation incentives.

The quantitative results above highlight three mechanisms relevant for policy design. First, defensive investments that prevent imitation reduce aggregate TFP by insulating highly productive leaders from competition, lowering their incentives to adopt frontier technologies. Second, this behavior creates highly concentrated product markets in which leaders maintain wide productivity gaps over followers. Third, while cracking down on defensive practices can improve improve firm-level productivity, it can also reduce product variety—an important driver of productivity. These trade-offs suggest that effective policy should target leaders whose defensive behavior is most harmful, while limiting adverse effects on variety and innovation.

To illustrate these ideas, I consider three profit-tax policies applied to single-product leaders. The productivity distribution is discretized into 70 grid points, from lowest to highest productivity. The policies are:

1. Uniform Tax on All Leaders: A profit tax of $\tau = 0.6$ on all single-product leaders, regardless of productivity.

2. High Tax on Lower-Frontier Leaders: A profit tax of $\tau = 0.6$ on leaders with productivity above ε_{16} (the 16th grid point), untaxed otherwise.

3. Tiered Tax by Productivity: Leaders with productivity $\varepsilon_{16} \leqslant \varepsilon^L \leqslant \varepsilon_{25}$ pay

[23] See S.130, 119th Congress (2025-2026); and see also Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act).

$\tau/2 = 0.4$, while those above ε_{25} pay the full 0.8 rate.

Table 4 reports the effects. The uniform tax substantially raises firm-level productivity by 2.68 percent, but lowers total factor productivity by 1.67 percent because it sharply reduces product variety by 4.91 percent. Low productive leaders—key drivers of new product creation—face lower after-tax returns, reducing the entry of new varieties.

The high tax on lower-frontier leaders performs worst, cutting TFP by 2.18 percent and welfare by 3.02 percent. These leaders already face intense competition from similar entrants and are not major users of defensive practices. Taxing them heavily reduces their incentives to innovate, while firms just below the threshold may avoid productivity improvements to escape higher taxation.

The tiered tax delivers the best results: TFP rises by 1.19 percent and welfare by 3.34 percent. The moderate tax on mid-tier leaders reduces harmful imitation-blocking without overly discouraging innovation, while the high tax on top leaders increases competition at the frontier and stimulates their innovation. This structure preserves more product variety than the uniform tax and avoids the severe efficiency losses seen under the high-tax-on-lower-frontier policy.

These experiments suggest that fiscal instruments targeting defensive investment should be conditioned on the productivity position of leaders. Uniform taxes risk blunting incentives for product creation, while poorly targeted high taxes can suppress innovation among vulnerable leaders. A tiered, state-dependent tax can harness the benefits of reducing harmful defensive practices while limiting variety losses and preserving incentives for frontier innovation.

6 Conclusion

In this paper, I examine the macroeconomic consequences of defensive corporate behavior within a heterogeneous-firm general equilibrium framework featuring endogenous technology adoption. The model incorporates two defensive margins—entry-blocking and imitation-blocking—and two entry channels: expansion into existing markets and diversification into new product lines. I demonstrate that cracking down on defensive investments enhances aggregate productivity, with the gains stemming exclusively from the removal of imitation-blocking. This mechanism intensifies frontier competition in markets dominated by highly productive incumbents. However, the overall improvement is tempered by a reduction in product variety, which substantially offsets the rise in within-firm efficiency.

These findings yield clear policy implications. A tiered, productivity-based profit tax targeting single-market leaders—minimal or zero for low-productivity firms, moderate for mid-tier, and highest for frontier firms—effectively curbs imitation-blocking where it is most distortionary, while preserving product variety. By imposing the greatest burden on frontier leaders and a moderate one on near-frontier firms, this policy design diminishes incentives to block imitation, strengthens competition at the technological frontier, reallocates resources from defensive to productivity-enhancing investments, and thereby recovers a substantial share of the productivity losses attributable to defensive behavior.

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Online Appendix

A Propositions

A.1 Proof of Proposition 1

Let

$$\Delta\widehat{V}_E^F(\Omega) \;\equiv\; V_E^L(\varepsilon_d, \varepsilon_{d-f},\, n^L{+}1, n^F{-}1) \;-\; V_E^F(\varepsilon_d, \varepsilon_{d-f},\, n^L, n^F),$$

be the value gain for a follower from becoming an additional leader relative to remaining a follower when no one succeeds, and

$$\Delta\widetilde{V}_E^F(\Omega) \;\equiv\; V_E^L(\varepsilon_d, \varepsilon_{d-f},\, n^L{+}1, n^F{-}1) \;-\; V_E^F(\varepsilon_d, \varepsilon_{d-f},\, n^L{+}1, n^F{-}1),$$

be the value gain from the focal follower becoming a leader relative to the case in which another follower succeeds.

Step 1. Corner solution. If $\Delta\widehat{V}_E^F(\Omega) \leqslant 0$, imitation effort is strictly dominated and the unique symmetric equilibrium is $x^{F*} = 0$.

Step 2. Interior solution. If $\Delta\widehat{V}_E^F(\Omega) > 0$, the follower's FOC from (15) is

$$\frac{\partial V_A^F(\Omega)}{\partial x^F} = -\,C'(x^F) + \frac{\gamma}{X^{L,im}+\gamma}\,\frac{\upsilon\,\Delta\widetilde{V}_E^F(\Omega) + (X^F - x^F)\,\Delta\widehat{V}_E^F(\Omega)}{(X^F+\upsilon)^2}, \tag{24}$$

with second derivative

$$\frac{\partial^2 V_A^F(\Omega)}{\partial (x^F)^2} = -\,C''(x^F) - 2\cdot\frac{\gamma}{X^{L,im}+\gamma}\,\frac{\upsilon\,\Delta\widehat{V}_E^F(\Omega) + (X^F - x^F)\,\Delta\widetilde{V}_E^F(\Omega)}{(X^F+\upsilon)^3}.$$

Step 3. Existence and uniqueness. Under symmetry (holding $X^{L,im}$ fixed),

$$\lim_{x^F \to 0} \frac{\partial V_A^F}{\partial x^F} > 0, \qquad \lim_{x^F \to \infty} \frac{\partial V_A^F}{\partial x^F} = -\infty, \qquad \frac{\partial^2 V_A^F}{\partial (x^F)^2} < 0 \ \ \forall x^F \geqslant 0.$$

By continuity, a solution to (24) exists; strict concavity implies uniqueness. Hence a unique interior maximum x^{F*} exists and x^{F*} increases in both $\Delta \widehat{V}_A^F(\Omega)$ and $\Delta \widetilde{V}_A^F(\Omega)$.

Step 4. Comparative statics. Since

$$\frac{\partial^2 V_A^F}{\partial x^F \, \partial X^{L,im}} < 0 \qquad \forall \, X^{L,im} \geqslant 0,$$

it follows that

$$\frac{\partial x^{F*}}{\partial X^{L,im}} < 0, \tag{25}$$

i.e., equilibrium imitation effort decreases with leader defense.

A.2 Proof of Proposition 2

Let

$$\Delta \widehat{V}_E^L(\Omega) \ \equiv \ V_E^L(\varepsilon_d, \varepsilon_{d-f}, \, n^L, n^F) \ - \ V_E^L(\varepsilon_d, \varepsilon_{d-f}, \, n^L{+}1, n^F{-}1),$$

be the leader's loss in continuation value from the arrival of an additional leader via imitation.

Step 1. Corner solution. If $\Delta \widehat{V}_E^L(\Omega) \leqslant 0$, defense has no value; the unique symmetric equilibrium is $x^{L,im*} = 0$.

Step 2. Interior solution. If $\Delta\widehat{V}_E^L(\Omega) > 0$, the leader's FOC from (16) is

$$\frac{\partial V_A^L(\Omega)}{\partial x^{L,im}} = -\,C'(x^{L,im}) + \frac{X^F}{X^F+\upsilon}\,\frac{\gamma\,\Delta\widehat{V}_E^L(\Omega)}{(X^{L,im}+\gamma)^2}, \tag{26}$$

with second derivative

$$\frac{\partial^2 V_A^L(\Omega)}{\partial (x^{L,im})^2} = -\,C''(x^{L,im}) - 2\cdot\frac{X^F}{X^F+\upsilon}\,\frac{\gamma\,\Delta\widehat{V}_E^L(\Omega)}{(X^{L,im}+\gamma)^3}.$$

Step 3. Existence and uniqueness. Under symmetry (fixing X^F),

$$\lim_{x\to 0}\frac{\partial V_A^L}{\partial x^{L,im}} > 0, \quad \lim_{x\to\infty}\frac{\partial V_A^L}{\partial x^{L,im}} = -\infty, \quad \frac{\partial^2 V_A^L}{\partial (x^{L,im})^2} < 0.$$

Existence follows by the Intermediate Value Theorem; strict concavity implies uniqueness of the interior $x^{L,im*}$.

Step 4. Comparative statics. Because

$$\frac{\partial^2 V_A^L}{\partial x^{L,im}\,\partial X^F} > 0 \qquad \forall\, X^F \geqslant 0,$$

we have

$$\frac{\partial x^{L,im*}}{\partial X^F} > 0, \tag{27}$$

so optimal defense is increasing in aggregate imitation.

A.3 Proof of Proposition 3

Consider the best responses of leaders and followers in the afternoon imitation–defense game.

Step 1. Leader best response. The leader's best response satisfies

$$\frac{\partial x^{L,im*}}{\partial X^F} > 0 \quad \forall\, X^F \geqslant 0, \qquad \lim_{X^F \to 0} x^{L,im*} = 0,$$

so it is continuous, strictly increasing, and passes through the origin.

Step 2. Follower best response. The follower's best response satisfies

$$\frac{\partial x^{F*}}{\partial X^{L,im}} < 0 \quad \forall\, X^{L,im} \geqslant 0, \qquad \lim_{X^{L,im} \to \infty} x^{F*} = 0, \qquad \lim_{X^{L,im} \to 0} x^{F*} > 0,$$

so it is continuous, strictly decreasing, starts positive, and converges to zero as $x^{L,im} \to \infty$.

Step 3. Existence and uniqueness. The monotone best responses intersect at least once by continuity, as guaranteed by the Intermediate Value Theorem, and since one is increasing and the other decreasing, the intersection is unique. Hence the fixed point $(x^{L,im**}, x^{F**})$ is unique.

A.4 Proof of Proposition 4

Define the post-innovation continuation values

$$\widetilde{V}_M^L(\Omega) \;=\; \mathbf{1}_{\{n^L>1\}}\, V_M^L(\varepsilon_{d+1}, \varepsilon_{d-1},\, 1,\, n^L - 1) \;+\; \mathbf{1}_{\{n^L=1\}}\, V_M^L(\varepsilon_{d+1}, \varepsilon_{\max\{d-f-1,0\}},\, 1,\, n^F),$$

for the case the focal leader wins the innovation contest, and

$$\overline{V}_M^L(\Omega) \;=\; V_M^F(\varepsilon_{d+1}, \varepsilon_{d-1},\, 1,\, n^L - 1),$$

for the case another leader wins (the focal becomes follower next period). Let

$$\Delta\widehat{V}^L_M(\Omega) \;=\; \widetilde{V}^L_M(\Omega) - V^L_M(\varepsilon_{d-1}, \varepsilon_{\max\{d-f-1,0\}}, n^L, n^F), \qquad \Delta\check{V}^L_M(\Omega) \;=\; \widetilde{V}^L_M(\Omega) - \overline{V}^L_M(\Omega),$$

be, respectively, the gain from winning relative to no innovation (with depreciation) and the gain from winning relative to another leader winning.

Step 1. Corner solution. If $\Delta\widehat{V}^L_M(\Omega) \leqslant 0$, innovation is not valuable; the unique symmetric equilibrium is $x^{L,in*} = 0$.

Step 2. Interior solution. If $\Delta\widehat{V}^L_M(\Omega) > 0$, the FOC from (17) is

$$\frac{\partial V^L_E(\Omega)}{\partial x^{L,in}} = -\,C'(x^{L,in}) + \frac{\gamma\,\Delta\widehat{V}^L_M(\Omega) + (X^{L,in} - x^{L,in})\,\Delta\check{V}^L_M(\Omega)}{(X^{L,in} + \gamma)^2}, \tag{28}$$

with

$$\frac{\partial^2 V^L_E(\Omega)}{\partial (x^{L,in})^2} = -\,C''(x^{L,in}) - 2\cdot\frac{\gamma\,\Delta\widehat{V}^L_M(\Omega) + (X^{L,in} - x^{L,in})\,\Delta\check{V}^L_M(\Omega)}{(X^{L,in} + \gamma)^3} \;<\; 0.$$

Step 3. Existence and uniqueness. Under symmetry,

$$\lim_{x^{L,in}\to 0} \frac{\partial V^L_E}{\partial x^{L,in}} > 0, \qquad \lim_{x^{L,in}\to \infty} \frac{\partial V^L_E}{\partial x^{L,in}} = -\infty, \qquad \frac{\partial^2 V^L_E}{\partial (x^{L,in})^2} < 0,$$

so a unique interior $x^{L,in*}$ solves (28).

A.5 Proposition 5

Proposition 5. Given $X^{L,en}$, let $x^{E,br*}$ denote the symmetric equilibrium of Equation (9). If $C'(x^{E,br}) > 0$ and $C''(x^{E,br}) > 0$ for all $x^{E,br} > 0$, and $C(0) = 0$, then:

(i) $x^{E,br*}$ increases with $V_A^L(\varepsilon_d, \varepsilon_{d-f},\, n^L,\, n^F{+}1)$;

(ii) $x^{E,br*}$ decreases with $X^{L,en}$;

(iii) For given $X^{L,en}$, the equilibrium $x^{E,br*}$ is unique.

Proof of Proposition 5

(Brand-entry game in the morning.) For a potential brand entrant,

$$V_A^F(\Omega) \;=\; V_A^F(\varepsilon_d, \varepsilon_{d-f},\, n^L,\, n^F{+}1)$$

is the leader's afternoon continuation value in the entry-success state.

Step 1. Corner solution. If $V_A^F(\Omega) \leqslant 0$, entry is unprofitable and $x^{E,br*} = 0$.

Step 2. Interior solution. If $V_A^F(\Omega) > 0$, the FOC from (9) is

$$\frac{\partial V_M^{E,br}(\Omega)}{\partial x^{E,br}} = -\,C'(x^{E,br}) + \frac{\gamma}{X^{L,en}+\gamma}\,\frac{(\upsilon + X^{E,br} - x^{E,br})\,V_A^F(\Omega)}{(X^{E,br}+\upsilon)^2}, \tag{29}$$

and

$$\frac{\partial^2 V_M^{E,br}(\Omega)}{\partial (x^{E,br})^2} = -\,C''(x^{E,br}) - 2\cdot\frac{\gamma}{X^{L,en}+\gamma}\,\frac{(\upsilon + X^{E,br} - x^{E,br})\,V_A^F(\Omega)}{(X^{E,br}+\upsilon)^3} < 0.$$

Step 3. Existence, uniqueness and comparative statics. Under symmetry (fixing $X^{L,en}$), the derivative in (29) is positive at zero, negative at infinity, and strictly decreasing, yielding a unique interior $x^{E,br*}$ whenever $V_A^L(\Omega) > 0$. Moreover,

$$\frac{\partial^2 V_M^{E,br}}{\partial x^{E,br}\,\partial X^{L,en}} < 0 \quad\Rightarrow\quad \frac{\partial x^{E,br*}}{\partial X^{L,en}} < 0.$$

A.6 Proposition 6

Proposition 6. Given $X^{E,br}$, let $x^{L,en*}$ denote the symmetric equilibrium of Equation (10). If $C'(x^{L,en}) > 0$ and $C''(x^{L,en}) > 0$ for all $x^{L,en} > 0$, and $C(0) = 0$, then:

(i) $x^{L,en*}$ increases with $V_A^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) - V_A^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F{+}1)$;

(ii) $x^{L,en*}$ increases with $X^{E,br}$;

(iii) The equilibrium $x^{L,en*}$ is unique.

Proof of Proposition 6

(Entry-blocking by leaders in the morning.) Define

$$\Delta\widehat{V}_A^L(\Omega) \equiv V_A^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F) - V_A^L(\varepsilon_d, \varepsilon_{d-f}, n^L, n^F{+}1),$$

the loss in leader continuation value from the arrival of an additional follower through brand entry.

Step 1. Corner solution. If $\Delta\widehat{V}_A^L(\Omega) \leqslant 0$, entry-blocking has no value; $x^{L,en*} = 0$.

Step 2. Interior solution. If $\Delta\widehat{V}_A^L(\Omega) > 0$, the leader's FOC from (10) is

$$\frac{\partial V_M^L(\Omega)}{\partial x^{L,en}} = -\,C'(x^{L,en}) + \frac{X^{E,br}}{X^{E,br} + \upsilon}\,\frac{\gamma\,\Delta\widehat{V}_A^L(\Omega)}{(X^{L,en} + \gamma)^2}, \qquad (30)$$

with

$$\frac{\partial^2 V_M^L(\Omega)}{\partial (x^{L,en})^2} = -\,C''(x^{L,en}) - 2\cdot\frac{X^{E,br}}{X^{E,br} + \upsilon}\,\frac{\gamma\,\Delta\widehat{V}_A^L(\Omega)}{(X^{L,en} + \gamma)^3} < 0.$$

Step 3. Existence, uniqueness and comparative statics. Under symmetry (fixing $X^{E,br}$), existence and uniqueness follow as above. Since

$$\frac{\partial^2 V_M^L}{\partial x^{L,en}\,\partial X^{E,br}} > 0,$$

we obtain

$$\frac{\partial x^{L,en*}}{\partial X^{E,br}} > 0.$$

A.7 Proposition 7

Proposition 7. The brand–entry game defined by Equations (10) and (9) admits a unique symmetric equilibrium $(x^{L,en**}, x^{E,br**})$.

Proof of Proposition 7

Consider the best-response functions of leaders and potential entrants in the morning brand–entry game with entry-blocking.

Step 1. Leader best response. Leader effort satisfies

$$\frac{\partial x^{L,en*}}{\partial X^{E,br}} > 0 \quad \forall\, X^{E,br} \geqslant 0, \qquad \lim_{X^{E,br}\to 0} x^{L,en*} = 0.$$

Hence the leader's best response is continuous, strictly increasing, and starts from zero.

Step 2. Entrant best response. Entrant effort satisfies

$$\frac{\partial x^{E,br*}}{\partial X^{L,en}} < 0 \quad \forall\, X^{L,en} \geqslant 0, \qquad \lim_{X^{L,en}\to\infty} x^{E,br*} = 0, \qquad \lim_{X^{L,en}\to 0} x^{E,br*} > 0.$$

Hence the entrant's best response is continuous, strictly decreasing, starts from a positive value, and converges to zero as $x^{L,en} \to \infty$.

Step 3. Existence and uniqueness. Because the leader's best response is strictly increasing and passes through the origin, while the entrant's best response is strictly decreasing and eventually vanishes, their graphs must intersect at least once. By the Intermediate Value Theorem, an intersection exists. Monotonicity of the two responses ensures that the intersection is unique.

Step 4. Conclusion. Therefore, the game admits a unique symmetric equilibrium $(x^{L,en**}, x^{E,br**})$ that solves equations (10) and (9).

B TFP Decomposition Derivations

This appendix provides the derivations underlying Lemma 1, following Edmond et al. (2015); Baqaee and Farhi (2019); Edmond et al. (2023).

—

Step 1. Aggregate production function. Aggregate value-added output is produced using capital K and labor L as

$$Y = \mathcal{E}\, K^{\alpha} L^{1-\alpha},$$

where $\mathcal{E}$ denotes aggregate TFP.

—

Step 2. Total production factor productivity (TPFP). To abstract from the diversion of labor into intangible activities, define total production factor productivity as

$$\mathcal{E}^{\star} = \left(\int_0^M \left(\frac{\mu_j}{\mu} \right)^{-\eta} \left[\left(n_j^L \left(\frac{\mu_j^L}{\mu_j} \right)^{-\rho} (\varepsilon_j^L)^{\rho-1} + n_j^F \left(\frac{\mu_j^F}{\mu_j} \right)^{-\rho} (\varepsilon_j^F)^{\rho-1} \right)^{\frac{1}{\rho-1}} \right]^{\eta-1} dj \right)^{\frac{1}{\eta-1}}, \quad (31)$$

where μ and μ_j denote aggregate and product-level markups, μ_j^L, μ_j^F are firm-level markups, and n_j^L, n_j^F are the numbers of leaders and followers in industry j.

—

Step 3. Efficient benchmark. If resources were allocated efficiently (i.e., absent markup dispersion), aggregate productivity would be

$$\mathcal{E}^{\star}_{\text{efficient}} = \left(\int_0^M \varepsilon_j^{\eta-1} \, dj \right)^{\frac{1}{\eta-1}}, \quad (32)$$

with industry-level productivity

$$\varepsilon_j = \left(n_j^L (\varepsilon_j^L)^{\rho-1} + n_j^F (\varepsilon_j^F)^{\rho-1} \right)^{\frac{1}{\rho-1}}. \quad (33)$$

—

Step 4. Variety benchmarks. To separate the contributions of product and brand variety, we consider two counterfactual benchmarks:

- **No product variety**:

$$\widetilde{\mathcal{E}}^{\star}_{\text{efficient}} = M^{\frac{-1}{\eta-1}} \left(\int_0^M \varepsilon_j^{\eta-1} \, dj \right)^{\frac{1}{\eta-1}}, \quad (34)$$

which strips out cross-industry product variety.

- **Average firm-level productivity (no brand and product variety)**:

$$\overline{\varepsilon} = M^{\frac{-1}{\eta-1}} \left(\int_0^M \left(\frac{n_j^L (\varepsilon_j^L)^{\rho-1} + n_j^F (\varepsilon_j^F)^{\rho-1}}{n_j^L + n_j^F} \right)^{\frac{1}{\rho-1}} dj \right)^{\frac{1}{\eta-1}}, \tag{35}$$

which removes both product and brand variety, leaving only the average productivity of individual firms.

—

Step 5. Defining the determinants. From these objects, we define:

$$\lambda^\mu = \frac{\mathcal{E}^\star}{\mathcal{E}^\star_{\text{efficient}}} - 1, \qquad \text{(markup dispersion loss)}, \tag{36}$$

$$\lambda^M = \frac{\mathcal{E}^\star_{\text{efficient}}}{\widetilde{\mathcal{E}}^\star_{\text{efficient}}} - 1, \qquad \text{(product variety gain)}, \tag{37}$$

$$\lambda^n = \frac{\widetilde{\mathcal{E}}^\star_{\text{efficient}}}{\overline{\varepsilon}} - 1, \qquad \text{(brand variety gain)}. \tag{38}$$

Thus,

$$\mathcal{E}^\star_{\text{efficient}} = (1 + \lambda^M)(1 + \lambda^n)\, \overline{\varepsilon}. \tag{39}$$

—

Step 6. Intangible investment. Let $L = L_1 + L_2$, where L_1 is used in production and L_2 in intangibles (innovation, lobbying, etc.). The labor wedge is

$$\lambda^L = \frac{L_1^{1-\alpha}}{L^{1-\alpha}} - 1, \tag{40}$$

which reduces effective productivity.

—

Step 7. Final decomposition. Substituting these components gives:

$$\mathcal{E} = (1 + \lambda^{\mu}) \cdot \Big[(1 + \lambda^{L})(1 + \lambda^{M})(1 + \lambda^{n})\,\bar{\varepsilon}\Big], \tag{41}$$

which corresponds to Equation (18) in the main text and proves Lemma 1.

C Data

C.1 Panel Construction

Table 5: Summary Statistics

	N	Mean	SD	Min	Max
Size	59273	1.814	1.818	-2.363	7.861
Firm-level productivity (log)	36712	-0.355	0.566	-5.197	2.608
LI	59273	0.007	0.049	0.000	1.391
ACG	26390	0.682	0.020	0.000	0.693
TPS	59273	1.507	2.027	0.000	10.650
SM	16284	0.040	0.044	0.000	0.600
III	58797	-1.658	1.495	-7.559	10.154
Age (log)	59273	2.609	0.798	0.693	4.262
MS	59273	0.408	0.370	0.000	1.000

Notes: This table reports descriptive statistics for the variables used in Sections 3.1 and 4. Counts reflect non-missing observations by variable. Means, standard deviations, minima, and maxima are computed on the reporting sample. Variable definitions and sample construction are described below.

Sample selection—I construct a firm–year panel for 1989–2019 by merging: Compustat (financials), patent data from Kogan et al. (2017) (forward citations by CPC subclass), LobbyView (Kim, 2018) (lobbying expenditures), TNIC3 from Hoberg and Phillips (2016) (text-based product similarity), and firm-level TFP from İmrohoroğlu and Tüzel (2014). Using SIC, I exclude oil and oil-related (2911, 5172, 1311, 4922–4924, 1389), energy (4900–4940), and financial firms (6000–6999). I drop observations with missing core variables (e.g., sales) required to construct outcomes and controls. Monetary variables are deflated using CPI series A191RD3A086NBEA (FRED).

Variable construction—Variables used in the empirical analysis are:

1. **Size**:

$$\text{Size}_{i,t} \equiv \ln\big(\text{SALE}_{i,t}^{\text{real}}\big),$$

   the natural log of real operating revenues (Compustat SALE deflated with CPI A191RD3A086NBEA).

2. **Firm-level productivity (TFP)**: $\ln(\text{TFP}_{i,t})$ from İmrohoroğlu and Tüzel (2014).

3. **Lobbying intensity (LI)**:

$$\text{LI}_{i,t} \equiv \ln\left(1 + \sum_{s=t-4}^{t} \text{LobbyingRaw}_{i,s}^{\text{real}}\right),$$

   the five-year sum of firm lobbying outlays (LobbyView/OpenSecrets), deflated by CPI.

4. **Average Citation Gap (ACG)**: First construct the patent-level Citation Gap Index

$$\text{CGI}_{p,c,t} \equiv \frac{\max_{s\in[t-9,t]} \text{Cites}_{s,c} \; - \; \text{Cites}_{p,c,t}}{\max_{s\in[t-9,t]} \text{Cites}_{s,c}},$$

where $\text{Cites}_{p,c,t}$ is forward citations to patent p in subclass c (filed at t). Let $\overline{\text{CGI}_{i,s}}$ be the firm–year average of $\text{CGI}_{p,c,s}$. Then

$$\text{ACG}_{i,t} \equiv \ln\left(1 + \frac{1}{5}\sum_{s=t-4}^{t} \overline{\text{CGI}_{i,s}}\right).$$

5. **Total patent stock (TPS)**:

$$\text{TPS}_{i,t} \equiv \ln\left(1 + \sum_{s=t-4}^{t} \text{PatentsFiled}_{i,s}\right).$$

6. **Similarity to recent entrants (SM)**:

$$\text{SM}_{i,t} \equiv \ln\left(1 + \frac{1}{N_{it}}\sum_{j\in\Gamma_t} \text{TNIC3Sim}_{i,j,t}\right),$$

where Γ_t is the set of firms that first appear in Compustat in year t, and $\text{TNIC3Sim}_{i,j,t}$ is the cosine similarity from Hoberg and Phillips (2016).

7. **Intangible investment intensity (III)**: Following Peters and Taylor (2017), intangible investment combines R&D and a portion of SG&A (both deflated). Define

$$\text{III}_{i,t} \equiv \ln\left(\frac{\text{IntangibleInv}_{i,t}}{\text{SALE}^{\text{real}}_{i,t}}\right).$$

8. **Age**:

$$\text{Age}_{i,t} \equiv \ln\big(1 + \text{years observed in Compustat up to } t\big).$$

9. **Market share (MS)**:

$$\text{MS}_{i,t} \equiv \frac{\text{SALE}_{i,t}}{\text{SALE}_{i,t} + \sum_{j\neq i} \text{TNIC3Sim}_{i,j,t}\cdot \text{SALE}_{j,t}},$$

a similarity-weighted share based on TNIC3 scores.

C.2 Calibration Regressions

Table 6: The Relationship Between Firm Size, Productivity, Intangible Investment, and Market Share

	Firm Productivity		III		MS	
	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.147***	0.174***	-0.447***	-0.350***	0.653***	0.555***
	(0.00207)	(0.00238)	(0.00379)	(0.00410)	(0.00506)	(0.00523)
Observations	20632	20628	31050	30133	31191	30268
Adj. R^2	0.197	0.233	0.521	0.650	0.514	0.643
Sector-Year FE	N	Y	N	Y	N	Y

Notes: The table reports coefficients on Size over 2001-2019. Sector-by-year fixed effects (three-digit SIC) are included where indicated. For details on variable definitions and sample selection, see Appendix C. Robust standard errors are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

D Model

How do the aggregate effects of banning all defensive practices depend on the degree of substitutability across and within products? Tables 7 and 8 present results from two alternative calibrations that vary demand elasticities while keeping all other parameters constant. Table 7 increases the elasticity of substitution across products,

η, by 20 percent, whereas Table 8 increases the elasticity of substitution within products, ρ, by 20 percent. As discussed in Section 3.1, these parameters determine how differences in firm size translate into firm-level productivity and market share. In the high-η calibration, the elasticity of productivity with respect to size is 0.13 and the elasticity of market share with respect to size is 0.59; in the high-ρ calibration, the corresponding values are 0.11 and 0.84.

The qualitative conclusions are robust: prohibiting defensive investments improves allocative efficiency, raises net efficient TFP, and increases aggregate productivity and welfare. However, the magnitudes of the gains differ substantially across elasticity configurations.

In the high-η economy, Table 7, column 1, shows that aggregate TFP increases by 1.10 percent—approximately sixty percent of the gain observed in the baseline scenario. The reason for this reduction is twofold. First, a smaller gap between η and ρ lowers the scope for misallocation across products, limiting the allocative efficiency gains (consistent with Edmond et al. (2015, 2023)). Second, the reform triggers a shift in intangible investment toward followers, increasing labor demand for innovation without generating proportionate improvements in technological efficiency. This crowding-out effect—where higher intangible spending absorbs resources but yields limited productivity gains—pushes intangible investment intensity of the economy.

In the high-ρ economy, Table 7, column 1, shows that the TFP gain is 1.0 percent, reflecting stronger improvements in allocative efficiency due to the wider gap between η and ρ. Yet the increase remains below the baseline because net technical efficiency gains are weaker. When competition is already intense, as under high ρ, additional pressure yields smaller marginal returns to innovation—consistent with the inverted-U relationship between competition and innovation (Aghion et al., 2005). Leaders already face significant competitive threats, so removing defensive practices adds little to their incentive to invest in productivity-enhancing innovation. The result is slower technological progress and muted aggregate productivity gains.

Additional results for imitation-blocking-only and entry-blocking-only reforms under both elasticity calibrations are reported in column 2 and column 3 of Tables 7 and 8.

Table 7: **Defensive Investment and Aggregate Total Factor Productivity with** $\eta = 6.36$

	Ban All Defensive Investment	Ban Imitation-Blocking	Ban Entry-Blocking
Panel A: TFP and Welfare			
Allocative Efficiency, $\Delta \ln(\mathcal{E}^{(1)})$	0.24	0.24	-0.08
Brand Variety	0.26	-2.67	2.37
Product Variety	-5.33	-3.37	-1.86
Firm-level Productivity	6.53	8.78	-2.59
Net Technical Efficiency, $\Delta \ln(\mathcal{E}^{(2)})$	0.85	3.05	-1.59
Total Factor Productivity, $\Delta \ln(\mathcal{E})$	1.10	3.29	-1.67
Welfare	4.57	7.16	-2.26
Panel B: Moments			
Std. Dev. of Markups	-46.99	-33.22	-19.54
Number of Brands	9.20	-13.51	24.89
Mass of Products	-24.83	-16.53	-9.49
Leaders' Productivity	1.75	3.16	-0.59
Followers' Productivity	21.07	11.47	2.30
Elasticity of Product Product Market Share w.r.t. Size	-98.98	-94.75	-12.71
Elasticity of Firm TFP w.r.t. Size	40.15	38.63	4.55

Note: Panel A reports the effects of three competition-policy scenarios on aggregate total factor productivity (TFP) and welfare, under a calibration with $\eta = 6.36$. Panel B reports the corresponding percentage changes in key moments of the stationary equilibrium. The policies are: banning all defensive investment (both entry-blocking and imitation-blocking), banning defensive investment against imitation only, and banning defensive investment against entry only. All changes are expressed relative to the benchmark economy with defensive investment. The TFP decomposition follows Equation 18, and welfare is measured as the consumption-equivalent variation. The standard deviation of markups refers to the cross-sectional distribution of firm-level markups. The number of brands is the average number of firms per product market. The mass of products is the total number of product markets in the economy. Leaders' and followers' productivity are defined as the quantity-weighted harmonic mean of firm productivities among leaders and followers, respectively. The elasticities of firm productivity and market share with respect to firm size are calculated by log–log regressions across firms within the stationary distribution.

Table 8: **Defensive Investment and Aggregate Total Factor Productivity with $\rho = 15.36$**

	Ban All Defensive Investment	Ban Imitation-Blocking	Ban Entry-Blocking
Panel A: TFP and Welfare			
Allocative Efficiency, $\Delta \ln(\mathcal{E}^{(1)})$	0.56	0.55	-0.15
Brand Variety	0.31	-2.03	1.99
Product Variety	-6.59	-2.92	-3.42
Firm-level Productivity	6.21	7.85	-2.13
Net Technical Efficiency, $\Delta \ln(\mathcal{E}^{(2)})$	0.42	3.73	-2.13
Total Factor Productivity, $\Delta \ln(\mathcal{E})$	0.99	4.28	-2.89
Welfare	4.85	9.36	-4.08
Panel B: Moments			
Std. Dev. of Markups	-53.83	-35.41	-23.16
Number of Brands	12.45	-14.62	31.46
Mass of Products	-24.67	-11.82	-13.68
Leaders' Productivity	2.84	4.78	-0.54
Followers' Productivity	22.99	12.24	0.60
Elasticity of Product Product Market Share w.r.t. Size	-98.03	-95.83	-7.38
Elasticity of Firm TFP w.r.t. Size	121.15	118.27	9.62

Note: Panel A reports the effects of three competition-policy scenarios on aggregate total factor productivity (TFP) and welfare, under a calibration with $\rho = 20.0$. Panel B reports the corresponding percentage changes in key moments of the stationary equilibrium. The policies are: banning all defensive investment (both entry-blocking and imitation-blocking), banning defensive investment against imitation only, and banning defensive investment against entry only. All changes are expressed relative to the benchmark economy with defensive investment. The TFP decomposition follows Equation 18, and welfare is measured as the consumption-equivalent variation. The standard deviation of markups refers to the cross-sectional distribution of firm-level markups. The number of brands is the average number of firms per product market. The mass of products is the total number of product markets in the economy. Leaders' and followers' productivity are defined as the quantity-weighted harmonic mean of firm productivities among leaders and followers, respectively. The elasticities of firm productivity and market share with respect to firm size are calculated by log–log regressions across firms within the stationary distribution.

E Empirical Evidence

E.1 Benchmark Regressions

Table 9: Product Similarity and Defensive Behavior by Firm Size

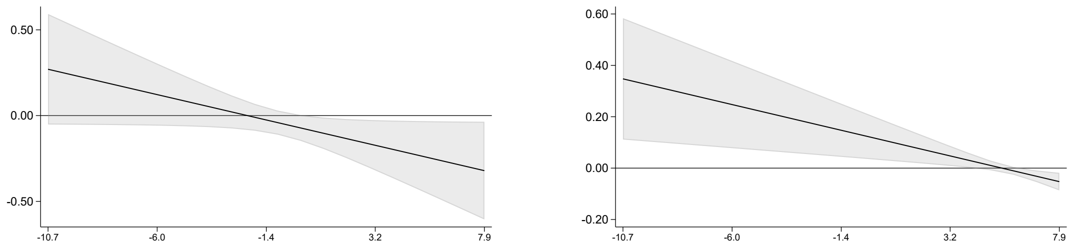
	Panel A: Patent Citations			Panel B: Lobbying		
	(1)	(2)	(3)	(4)	(5)	(6)
ACG	0.375***	0.0246	-0.111***			
	(0.0522)	(0.0406)	(0.0431)			
ACG × Size	-0.0613***	-0.0189	-0.0396**			
	(0.0189)	(0.0121)	(0.0178)			
LI				0.341***	0.0221	0.116**
				(0.0348)	(0.0275)	(0.0485)
LI × Size				-0.0550***	-0.0137***	-0.0217***
				(0.00639)	(0.00506)	(0.00839)
Size (log sales)	0.0395***	0.0146*	0.0291**	-0.00218***	0.00248***	0.00193***
	(0.0130)	(0.00820)	(0.0122)	(0.000208)	(0.000302)	(0.000565)
Observations	5003	4671	4216	9400	8725	7876
Adj. R^2	0.042	0.477	0.727	0.018	0.435	0.654
Sector-Year FE	N	Y	Y	N	Y	Y
Firm FE	N	N	Y	N	N	Y
Controls	N	Y	Y	N	Y	Y

Notes: Panel A reports estimates of equation (23) using *Average Citation Gap Index* (ACG) as the proxy for defensive behavior; Panel B uses *Lobbying Intensity* (LI). Sector-by-year fixed effects are defined at the three-digit SIC level. Controls include for intangible investment intensity, firm age, and patent stock. Variable definitions and sample construction are described in Appendix C. Robust standard errors are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

E.2 Regression Robustness Check

Figure 5: Product Similarity and Defensive Behavior by Firm Size

(a) (b)



Note: Estimated relationships between product similarity with recent entrants and two firm-level measures of defensive behavior—average citation gap (ACG) and lobbying intensity (LI)—across the firm size distribution, for firms older than eight years. Panel (a) reports $\beta_1^{(\mathrm{ACG})} \cdot \mathrm{ACG}_{i,t} + \beta_3^{(\mathrm{ACG})} \cdot (\mathrm{ACG}_{i,t} \times \mathrm{Size}_{i,t})$. Panel (b) reports $\beta_1^{(LI)} \cdot \mathrm{LI}_{i,t} + \beta_3^{(LI)} \cdot (\mathrm{LI}_{i,t} \times \mathrm{Size}_{i,t})$. Shaded regions denote 90 percent confidence intervals based on robust standard errors. Variable definitions and sample construction are in Appendix C.

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