Competitive Dynamics in Organizations

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Abstract

This paper extends Ronald Coase's (1937) insight on contractual authority by conceptualizing political authority as the key element that distinguishes organizations from markets. Political authority must be actively maintained, and the process of maintaining it shapes internal incentives and organizational productivity. We develop a principal–agent model in which superiors adjust the intensity of internal competition in response to institutional conditions in order to preserve political authority. The model shows that this mechanism not only reinforces the conventional view that strong legal institutions promote economic growth, but also provides a microfoundation for sustained high productivity under weak legal enforcement. Authority accumulation emerges as intrinsic to hierarchical organization rather than as a distortion: it constitutes a core mechanism through which organizations maintain stable operations and high productivity even in weak or volatile legal environments. Our theory offers implications for productivity divergence, economic inequality, and institutional stability.

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Keywords: political authority; legal enforcement; incentive design; productivity divergence; economic inequality

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Introduction

If authority within organizations must be actively maintained, how does this reshape internal competition and productivity?

Mainstream organizational economics often speaks as if superiors' authority were born fully formed the moment an employment contract is signed—its strength guaranteed by external enforcement, with courts, legal sanctions and alternative informal threats presumed to secure sufficient compliance from subordinates automatically. Yet this idealized simplification comes at a cost. By treating authority as something that need not be sustained internally, the literature has largely focused on designing elegant, efficiency-maximizing incentive schemes. While analytically powerful, such approaches offer limited leverage in explaining the pronounced differences in organizational productivity and economic inequality observed across institutional contexts. These broader economic patterns have remained largely outside the field's analytical scope, leaving a persistent gap in our systematic understanding: we still lack an incentive-dynamics perspective capable of explaining divergence in economic performance across organizations.

Our study addresses this gap by developing a theory of competitive dynamics that applies to all hierarchical organizations, a category encompassing firms, governmental agencies, and other authority-based collectives. We begin by extending Coase's theory of the firm (1937), arguing that organizations are distinguished from markets not by their use of contractual authority, but by their reliance on political authority to govern within their boundaries. Political authority emerges inherently from the deliberate design of hierarchical structures within organizations. Unlike contractual authority

guaranteed by external enforcement, political authority must be continually maintained, typically by allocating rewards and advancement opportunities in ways that favor loyal subordinates and thus reinforce hierarchical control.

We argue that the extent of such loyalty-based favoritism varies with superiors' reliance on political authority, a proxy for the strength of contractual enforcement in the institutional environment. Together with the stock of authority capital, the reliance on political authority generates systematic variation in internal competition, which plays a crucial role in driving fluctuations in productivity. In contrast to existing studies, which largely attribute productivity differences to fragmented, idiosyncratic factors, we view productivity divergence across countries and regions as a systematic pattern rooted in the need to maintain political authority, making incentive intensity an institutional choice rather than a universal optimum.

Model Framework. To explore how sustaining political authority reshapes organizational productivity, we then build a principal–agent framework that generalizes

standard multi-player tournaments into broader authority-based incentive settings. Standard tournament models treat internal competition as a perfect market-like rule that mechanically rewards the best performer and thus leaves no room for managerial discretion. Yet discretion is precisely what distinguishes organizations from markets: whereas markets operate through impersonal, spontaneous competition, organizational structures and incentive rules are deliberately designed and reflect the preferences of those in power. In contrast to standard tournament models that abstract from discretion, our framework incorporates it because superiors use loyalty-based preferences to sustain their political authority. We assume that the superior chooses the eligibility threshold through a parameter $k \in 1, \ldots, n$, which defines how many top performers are eligible for rewards. This adjustable competition intensity k gives the superior room to exercise discretion and thereby strengthen political authority by promoting and rewarding loyal subordinates within the top k. In our model, internal competition is thus generalized from a purely rank-based mechanism to a dynamic process that flexibly incorporates authority maintenance.

Under this setting, the superior's preference for loyalty is structural but probabilistic, in contrast to existing models that treat favoritism as a fixed and deterministic external assumption. In our model, loyal subordinates are systematically favored for their higher voluntary compliance with directives, but only if they rank within the top k performers. Disloyal subordinates are consequently disadvantaged because they can win only when no loyal subordinate enters the top k—an event that becomes increasingly unlikely as the superior chooses a larger k. By varying k, the superior adjusts the probability that loyalty-based favoritism becomes operative. When $k = 1$, rewards are purely performance-driven and favoritism is absent. As k increases, loyalty and performance jointly determine reward allocation, forming a mixed authority–performance incentive system. At the extreme $k = n$, where n is the total number of subordinates, eligibility is unrestricted and allocation becomes fully preference-driven, eliminating meritocratic discipline. These competitive dynamics induce both loyal and disloyal subordinates to adjust their effort, endogenously reshaping the overall organizational productivity.

The key insight is that the superior's selection of competition intensity k is not technologically given but emerges as an institutional choice in equilibrium. In our framework, the optimal k depends jointly on internal authority capital and external legal strength. Legal strength influences the extent to which political authority is needed to secure compliance. When legal enforcement is strong, contractual authority is effective and compliance relies less on personal loyalty. Consequently, the incentive for the superior to differentiate between loyal and disloyal subordinates diminishes as the value of loyalty-based favoritism declines. When legal enforcement is weak, contracts cannot guarantee compliance, making political authority indispensable and increasing the value of rewarding loyal subordinates. Hence, external legal strength shapes the supe-

rior's reliance on favoritism and thereby influences the choice of the optimal internal competition intensity k.

The superior's authority capital also affects her choice of k through a structural probability channel. We conceptualize authority capital as the superior's existing level of political authority and measure it by the number of loyal subordinates. A larger pool of loyal subordinates indicates that the superior has stronger authority capital, while a smaller pool implies weaker authority capital. A smaller loyal share increases the likelihood that all top-k spots are taken by disloyal subordinates, lowering the probability that any loyal subordinate can be rewarded and making political authority more difficult to sustain; a larger loyal share has the opposite effect. Because authority capital affects how easily political authority can be reinforced, it structurally shapes the superior's optimal choice of internal competition k.

Main results. Our model shows that authority maintenance influences the intensity of internal competition in a nonlinear way, shaped by the interaction of two patterns. In the first pattern, greater reliance on political authority (a weaker legal institutions) leads superiors to implement less intense internal competition, resulting in lower organizational productivity. This pattern is intuitive: greater reliance on political authority increases favoritism in promotion and reward decisions. As superiors place more weight on loyalty than performance, they adopt less stringent performance-based competition, allowing more discretion to favor loyal subordinates. This reduces the marginal incentive to exert effort across the board, ultimately lowering organizational productivity.

Meanwhile, superiors with more loyal subordinates (stronger authority capital) implement more intense internal competition and achieve higher productivity, whereas those with fewer loyal subordinates (weaker political capital) adopt more relaxed competition, leading to lower organizational output. The logic is that when the pool of loyal subordinates is sufficiently large, even intense merit-based competition is unlikely to threaten a superior's political authority, as those promoted are still likely to be loyal. This allows strong leaders to reap the incentive benefits of performance-based advancement while preserving authority. By contrast, weak leaders with a smaller share of loyal subordinates face a greater risk that merit-based promotion will elevate disloyal individuals. To mitigate this threat, they relax performance thresholds, granting themselves more discretion to reward loyalists over higher-performing but disloyal subordinates. While this strategy helps sustain their authority, it ultimately reduces organizational productivity.

The interaction of these two patterns provides a framework for demystifying the long-standing puzzle of productivity divergence across institutional contexts. A widely accepted view holds that strong formal institutions—particularly robust legal enforcement—

are essential for sustaining economic prosperity. Yet this perspective cannot explain why some economies with weak legal institutions nevertheless maintain high organizational productivity. Our model shows that legal strength and political authority function as substitutes in supporting high-powered internal incentives. When legal institutions are strong, contractual authority is effective, and the superior can rely on formal enforcement to sustain intense competition without depending on personal loyalty. Conversely, even when legal enforcement is weak, a superior with strong political authority can still maintain high-powered internal competition, thereby preserving high organizational output. Productivity declines only when both institutional pillars are weak: when legal institutions are too weak to enforce contracts and political authority is too limited to sustain compliance, the superior must soften internal competition to preserve her authority, reducing overall productivity.

Contributions. Our study contributes to multiple strands of the literature. First, we provide a new conceptual foundation for understanding authority and incentives in organizations, with broad implications for productivity and institutional development. We move beyond Coase's contractual view by formalizing political authority as the organizational capacity to elicit voluntary compliance through asymmetric exchange institutionalized by hierarchical power. By embedding this logic within a unified framework that links authority maintenance to variation in legal institutions, we offer a novel explanation for persistent productivity differences across organizations, sectors, and countries. In doing so, we not only extend the theoretical boundaries of the firm but also deepen our understanding of how incentive dynamics mediate the impact of institutional environments on economic performance.

In contrast to classic explanations of productivity—which emphasize external factors such as capital accumulation and technological innovation (Solow 1956; Romer 1990; Lucas 1988), or credible, well-enforced institutions and secure property rights that reduce transaction costs or foster investment (North 1992; Acemoglu and Robinson 2012)—our theory shifts the analytical lens inward, focusing on the political foundations of authority within organizations. These internal organizational dynamics have received limited attention in current explanations of productivity divergence.

Second, we contribute to the longstanding debate over whether regime type impacts productivity. Existing studies yield mixed findings—some associate democracy with higher growth (Lipset 1960; Persson and Tabellini 2006; Acemoglu et al. 2019), while others find negative (Huntington 1973; Tavares and Wacziarg 2001; Mobarak 2005) or null effects (Przeworski 2000; Gerring et al. 2005). Yet these accounts struggle to explain why some non-democratic regimes have consistently achieved sustained growth. Our theory reconciles these findings by shifting the focus from regime labels to the internal composition of authority, contractual and political, shaped by legal institutions.

Our theory indicates that both democratic and non-democratic regimes can sustain high productivity either through strong rule-of-law institutions that enable contractual authority or through sufficient political authority rooted in loyal subordinates. When neither condition is met, regardless of whether the regime is democratic or not, leaders face diminished control and respond by softening internal competition to preserve political stability, ultimately at the expense of economic performance. This perspective sheds light on the sustained growth of large authoritarian economies such as China, as well as historical episodes of rapid development under non-democratic regimes, including Prussia's nineteenth-century industrialization, Japan's Meiji-era modernization, and the postwar takeoffs of South Korea and Taiwan.

Third, our model reveals an endogenous mechanism of unequal development rooted in political favoritism. To sustain political authority, superiors tend to favor loyal subordinates who are more likely to be promoted to key positions or receive discretionary rewards. These loyal subordinates consequently enjoy stronger incentives, exert greater effort, and achieve higher performance, while disloyal ones are marginalized, facing weaker incentives and lower performance. We show that such an effort and productivity gap between loyal and disloyal groups arises when internal competition is moderate rather than maximal, and it peaks when the superior relies heavily on political authority while maintaining a large pool of loyalists.

This loyalty-based favoritism generates within-organization divergence and scales up to explain regional inequality across states. In many authoritarian or hybrid developmental countries, such as China, Singapore, Vietnam, Rwanda, Ethiopia, and South Korea during the 1960s–1980s, political centralization coexists with economic decentralization. Local officials, appointed by the central leaders, compete for promotion based on economic indicators such as GDP growth, fiscal revenue, or investment attraction. Regional disparities in development thus largely reflect differences in incentive intensity across political factions shaped by loyalty. Accordingly, our model offers a micro-foundation for understanding how politically driven favoritism can endogenously produce unequal patterns of economic performance and regional development.

Finally, we advance current understanding of institutional erosion and democratic backsliding from the perspective of organizational economics. Our model extension endogenizes both the superior's reliance on political authority and the share of loyalists. We show that superiors have a persistent and rational preference for consolidating political authority, even when their reliance on it is minimal. We also show that a superior does not have the motivation to erode legal institutions and strengthen loyalty-based favoritism until the existing level of the rule of law falls below a critical threshold. After this tipping point, weakening legal institutions becomes a rational choice for superiors, even at the cost of long-term efficiency. Together, these results provide an organizational foundation for understanding why institutional erosion and

democratic backsliding can arise endogenously, even when stronger rule of law would improve aggregate welfare.

Related literature. Since Coase's (1937) insight that firms substitute authority for prices to economize on transaction costs, the dominant view in organizational economics has treated authority as contractual and externally enforceable. Even within the incomplete-contract literature, authority is typically modeled as an allocable decision or residual control right that can be specified in contracts and legally enforced to solve agency problems (Fama and Jensen 1983; Hart and Moore 1990; Aghion and Tirole 1997; Dessein and Santos 2006; Alonso et al. 2008; Deimen and Szalay 2019.

A central logical tension in this strand of literature is that it invokes contractual incompleteness to motivate the allocation of decision rights, while either presuming an enforcement environment strong enough to render those rights effective, or leaving unexplained the mechanisms through which allocated rights become effective under contractual incompleteness. Yet under contractual incompleteness, the enforceability of allocated decision rights itself cannot be taken for granted. As a result, authority allocation relies on an enforcement premise that contradicts the conditions it is meant to address.

An alternative strand of the literature emphasizes relational contracts, in which cooperation is sustained through repeated interaction and self-enforcement supported by future rents or credible punishment (Bull 1987; MacLeod and Malcomson 1989; Fudenberg et al. 1990; Baker et al. 2002; Levin 2003, Watson et al. 2020; Kostadinov and Kuvalekar 2022; Achim and Knoepfle 2024). While analytically powerful, this approach remains rooted in an enforcement-based logic inherited from contract theory, relying on external or quasi-external sanctions to sustain cooperation. As a result, it primarily explains minimal compliance and remains limited in accounting for the pervasive and routine coordination observed within organizations.

Empirically, compliance often persists even where dismissal threats are weak or absent (e.g., tenure systems, civil service, and highly secure internal labor markets), indicating that routine obedience cannot be fully accounted for by punishment-based enforcement. In practice, organizational authority relies less on coercion in day-to-day governance, particularly given that directives are often vague, incomplete, or ex post revised, requiring subordinates not merely to comply but to interpret, supplement, and sometimes correct instructions.

Our study offers a new perspective on authority in organizations. We argue that organizations themselves function as deliberately designed institutional arrangements capable of generating authority at low cost. As a result, routine coordination and cooperation within organizations can be sustained primarily by this endogenous authority even if external enforcement or threats are absent. Because this internal authority rests

on superiors' commitment to organizational stability and the voluntary acceptance of superiors' directives by subordinates, it is political in nature and operates through non-coercive, non-punitive economic mechanisms. This political authority is fundamentally distinct from externally enforced contractual authority or compliance induced by credible punishment.

Our paper also speaks to personnel economics literature, which typically treats promotion as a mechanism for incentive provision. In this view, hierarchical structures are designed to create scarcity in rewards and thereby stimulate effort through rank-based competition (Malcomson 1984, Eriksson 1999). Classic models in this tradition, often built on the assumption of complete contracts, focus on identifying optimal promotion rules that maximize incentives (Lazear and Rosen 1981; Nalebuff and Stiglitz 1983; Gibbons and Waldman 1999; Ghosh and Waldman 2010; Rosen 1986; O'Keeffe et al. 1984; DeVaro and Waldman 2012; Connelly et al. 2014).[1] Departing from this paradigm, we view promotion not merely as an incentive tool but as a core political institution that sustains and reinforces organizational authority—especially when contractual authority is weak. Our model shows that promotions serve a dual function: they motivate effort and consolidate political authority by rewarding loyal subordinates. This political dimension is not an incidental distortion of ideal incentives but a fundamental feature of authority-based governance. Unlike conventional tournament models that abstract away from internal politics, we demonstrate that authority maintenance alters the optimal intensity of internal competition, with implications for organizational productivity. In doing so, we reinterpret promotion as a mechanism that balances political control and economic incentives, offering a unified explanation for observed deviations from purely performance-based advancement.

Finally, we depart from the prevailing view of favoritism as an irrational distortion that undermines meritocracy (Prendergast and Topel 1996; Herbertz and Sliwka 2013; Bandiera et al. 2009; de Janvry et al. 2023; Deng et al. 2023). We show that favoritism can be a politically rational strategy whose efficiency effects depend on institutional context. Rather than treating it as a fixed bias, we model favoritism as an endogenous outcome of authority maintenance. Our framework explains its variable impact on performance and reconciles mixed empirical findings by highlighting its institutional roots.

The remainder of the paper is organized as follows. Section 2 states the political foundation of organizations. Section 3 presents the model. Section 3 discusses practical implications Section 4 extends the model. Section 5 discusses implications for institutional reform. Section 6 Concludes.

[1]For instance, Lazear and Rosen (1981) argue that promoting the top performer yields maximal effort; Nalebuff and Stiglitz (1983) highlight non-convexities arising from winner-take-all structures and propose multiple prizes as a remedy; and more recent work explores how heterogeneity in ability can be addressed through group-based or staged tournaments(Rosen 1986; O'Keeffe et al. 1984).

Theoretical Foundation: The Political Nature of Organizations

Organizational economics has inherited Coase (1937)'s contractual view of authority, confining the source of managerial authority to formal and informal contracts: beyond these contracts, superiors have no legitimate power to command, and employees have no incentives to comply. While the conception of contractual authority deepens our understanding of organizations, it simultaneously limits our understanding of why organizations exist. For instance, the contractual view of authority cannot account for the existence of organizations capable of exercising sufficient authority to coordinate collective action that emerged long before the formation of modern states with established systems of legal enforcement, such as family-based trading firms, clans, tribes, and religious institutions. Even in modern society, it is still widely observed that subordinates often comply voluntarily with superiors' extra-contractual directives. Although relational contracts may substitute for legal enforcement by relying on informal threats, they operate through the same enforcement logic as formal contracts—both depend on externally imposed discipline. Because such contract-based authority can arise both within and outside organizations, it cannot explain why authority-based governance is a distinctive feature of firms as opposed to markets. In addition, informal contracts, like their formal counterparts, also suffer from incompleteness. For instance, the threat of termination within organizations may serve only as a last resort rather than a routine means of control. Because dismissal is costly—particularly when subordinates possess firm-specific human capital or when employment contracts stipulate generous severance payments—the threat is often not credible. These limitations point to a deeper question: under incomplete contracting, what organizational mechanisms, independent of contractual enforcement, enable superiors to sustain authority?

We argue that an organization's ability to sustain extra-contractual authority stems from its unique political embeddedness, which is absent in market-based transactions. First, organizations replace contractual multiplicity with exclusive commitment. Unlike markets, where contracting parties retain independent status and can engage with multiple partners simultaneously, joining an organization entails exclusive commitment. Once an individual enters into an employment contract, they largely forgo the option of contracting with other organizations and devote most of their time and effort to a single employer. This dependency creates a condition for extra-contractual compliance to emerge.

Second, organizational hierarchies institutionalize political interdependence between superiors and subordinates. Positional power structures reciprocal discretion: subordinates' future payoff—such as mobility, compensation, evaluation, access to key

resources—depends on superiors' discretion, while superiors rely on subordinates' discretionary compliance to carry out directives. By virtue of positional power, both parties gain greater capacity to influence each other's outcomes than in markets, with bargaining power disproportionately concentrated in the hands of superiors. This mutual embeddedness, though imbalanced, reinforces incentives for reciprocal compliance: superiors strengthen authority by advancing loyal subordinates, while subordinates display loyalty in hopes of promotion, rewards, or access to key resources. Obedience thus extends beyond contractual obligation, taking the form of non-enforced compliance rooted in mutual dependence and organizational discretion. When subordinates comply in anticipation of favorable treatment under superiors' discretionary power, the resulting authority acquires a distinctly political character—what we define as political authority.

Political authority differs from contractual authority in two fundamental ways. First, while contractual authority arises from symmetrical exchange and therefore relies on third-party enforcement or credible threats, political authority is rooted in asymmetrical exchange shaped by internal cost structures. Such asymmetry generates Pareto improvements: the beneficiary derives substantial utility from a favor or resource that imposes little or no cost on the benefactor. This logic allows political authority to emerge endogenously without external enforcement. For superiors, discretion over evaluations, resource allocations, and promotions entails minimal budgetary cost yet yields "authority rents" by favoring loyal subordinates and consolidating control. For subordinates, internal cost accounting and reimbursement mechanisms reduce the marginal cost of extra-contractual compliance to near zero. As a result, both parties rationally engage in a self-sustaining, asymmetric exchange of favors, enabling the organization to internalize and reproduce political authority independently of formal enforcement or threat.

Although political authority emerges endogenously from hierarchical structures, the extent to which superiors rely on it for internal coordination is inversely shaped by the broader institutional environment—particularly the strength of the rule of law. In stronger legal environments, organizations rely more on contracts and formal rules for coordination, reducing reliance on political authority sustained through the preferential advancement of loyal subordinates. Numerous real-world examples illustrate this relationship. In the absence of robust legal systems, authority within organizations is often sustained through personal connections, which tend to elicit greater loyalty than institutional obligations. By contrast, in settings with more mature legal institutions, organizations increasingly rely on third-party enforcement, as reflected in partnerships among less connected individuals, joint-stock companies, and more democratic governance structures.

Second, while contractual authority exerts uniform and impersonal discipline, po-

litical authority is inherently individualized and heterogeneous. Contractual mechanisms apply symmetrically across agents because they induce compliance through standardized rules and third-party enforcement. Political authority, by contrast, depends on subordinates' voluntary willingness to obey, which varies across individuals and introduces heterogeneity into superior–subordinate relations. In practice, such heterogeneous political relations between superiors and subordinates often manifest as informal networks—cliques, political factions, kinship, and social ties—that pervade a wide range of organizational forms. This heterogeneity becomes particularly salient when superiors allocate key positions with greater positional power, often favoring closely connected subordinates who signal stronger loyalty to sustain authority and control. As the composition of loyal subordinates shifts and superiors' reliance on political authority evolves with the strength of legal institutions, changes in the degree of favoritism may lead to variation in the optimal intensity of internal competition and organizational productivity.

The Model

Set Up

Organizational Structure and Agent Types. Consider an organization with a three-tier hierarchical structure. A superior S occupies the top tier, n subordinates populate the bottom tier, and a single position or reward $V > 0$ is available at the intermediate level. One subordinate may be promoted to the intermediate position or receive the reward V.

The superior specifies the rules of internal competition, under which subordinates exert costly effort to compete for V. Subordinates are identical in ability and effort costs, but they differ in their degree of loyalty to the superior. Based on this heterogeneity, subordinates are classified into two types: loyal (l) and disloyal (d). We assume that among the n subordinates, m are loyal and $n - m$ are disloyal, where $m \in \{0, 1, \ldots, n\}$.

Loyalty is defined in terms of post-promotion behavior. After receiving the position or reward V, a loyal subordinate provides voluntary compliance with the superior's directives, whereas a disloyal subordinate exhibits weaker compliance, increasing coordination frictions. Accordingly, the number of loyal subordinates m captures the superior's authority capital, with a larger m reflecting a higher level of existing political authority. We treat m as an exogenously given organizational characteristic reflecting pre-existing political authority.

Heterogeneous loyalty is captured by parameter $\alpha > 0$: promoting a loyal subordinate generates an additional payoff α for the superior, reflecting the benefit of voluntary compliance, while promoting a disloyal subordinate yields a payoff of $-\alpha$, reflecting the

cost of reduced compliance. For any $\alpha > 0$, whenever both types are eligible for V, the superior strictly prefers a loyal subordinate to a disloyal one, denoted by

$$l \succ d.$$

Legal Strength. The symmetric authority payoff $\pm\alpha$ makes α a convenient index of legal strength. We interpret a smaller α as stronger legal enforcement: as contracts become more enforceable, contractual authority more effectively secures compliance, reducing both the marginal value of loyalty and the marginal cost of disloyalty. Accordingly, the payoff gap between loyal and disloyal subordinates (2α) shrinks, making the two types less distinct. Conversely, under weaker legal enforcement, superiors rely more heavily on personalized political authority, which widens the payoff gap and is reflected in a larger α. Hence, cross-institutional variation in α captures differences in legal strength.

Adjustable Competition Rule. Scarcity of promotions and rewards at higher hierarchical tiers makes internal competition inevitable. Unlike market competition, however, competition within organizations is institutionally designed and reflects managerial discretion. We capture managerial discretion through an eligibility threshold $k \in \{1, \ldots, n\}$ chosen by the superior, which determines how many top-ranked subordinates are eligible for promotion or rewards. By varying k, the superior adjusts the intensity of performance-based competition within the organization. The extreme case $k = 1$ corresponds to a strict tournament in which only the top-ranked subordinate is eligible, while $k = n$ eliminates meritocratic competitiveness altogether, making all subordinates eligible regardless of rank. Thus, by choosing k, the superior directly controls how tightly promotion or reward V are tied to relative performance. This assumption creates scope for the superior to strengthen political authority by promoting or rewarding loyal subordinates within the eligible set k subject to her own discretion.

Stochastic Favoritism. We assume that loyal subordinates are structurally favored over disloyal ones conditional on ranking within the top k performers. Favoritism therefore operates only within the eligible set and remains disciplined by performance thresholds. Since entry into the top k is itself uncertain, favoritism is inherently probabilistic rather than deterministic. For any eligible loyal subordinates, the final selection depends on the composition of the top-k group. If there are $q \in \{1, \ldots, k\}$ loyal subordinates among the top k performers, the superior selects one of them uniformly at random, so each loyal subordinate in the eligible set is promoted with conditional probability $1/q$.

Symmetrically, the disadvantage faced by disloyal subordinates is also probabilistic. A disloyal subordinate's entry into the top k is uncertain, and ranking within the eligible set does not automatically preclude promotion. A disloyal subordinate still obtains a strictly positive promotion probability when all top-k performers are disloyal, in which case each is selected with equal probability $1/k$. By contrast, if at least one loyal subordinate ranks within the top k, disloyal subordinates receive zero probability of promotion or reward V. Thus, disloyalty entails a stochastic disadvantage that depends on both relative performance and the composition of the eligible set.

The Superior. The superior cares not only about aggregate organizational output but also about maintaining sufficient authority for coordination. She chooses the competition intensity k to maximize her utility, given by

$$U_S \equiv \max_{k\in\{1,\dots,n\}} \left\{ \sum_{i=1}^{m} x_{l_i}(k) + \sum_{j=1}^{n-m} x_{d_j}(k) + \alpha\big(P_l(k) - P_d(k)\big) \right\}. \tag{1}$$

where $\sum_{i=1}^{m} x_{l_i} + \sum_{j=1}^{n-m} x_{d_j}$ denotes expected aggregate productivity, defined as the sum of effort levels exerted by loyal subordinates $\{x_{l_i}\}_{i=1}^{m}$ and disloyal subordinates $\{x_{d_j}\}_{j=1}^{n-m}$.[2] The terms $P_l(k)$ and $P_d(k)$ denote the probabilities that a loyal and a disloyal subordinate, respectively, prevails in internal competition under competition intensity k. The term $\alpha\big(P_l(k) - P_d(k)\big)$ represents the superior's expected political authority payoff generated by competition outcomes. It captures the net contribution of internal competition to political authority, as determined by the relative likelihood that loyal rather than disloyal subordinates get promotion or reward V.

The Subordinates. After observing the competition intensity k, loyal and disloyal subordinates choose their effort levels $\{x_{l_i}\}_{i=1}^{m}$ and $\{x_{d_j}\}_{j=1}^{n-m}$, respectively, to maximize their expected utilities. Taking k as given, the problem of a loyal subordinate $i \in \{1,\dots,m\}$ is given by

$$U_{l_i} \equiv \max_{x_{l_i}\geq 0} \left\{ P_{l_i}\big(x_{l_i}, x_{-i}; k\big)\, V - \frac{x_{l_i}^2}{2} \right\}. \tag{2}$$

where the term $P_{l_i}(x_{l_i}, x_{-i}; k)$ represents the probability that loyal subordinate i obtains reward/position in the middle layer under competition intensity k, which depends on his own effort x_{l_i}, the efforts of competing subordinates x_{-i}, the competition intensity k and the composition of the top-k group, in particular the number q of loyal subordinates among the top k performers. We assume that this probability is increasing in x_{l_i}

[2] We deliberately adopt a neutral aggregation of effort to isolate the incentive effects of authority maintenance from technological complementarities.

and decreasing in the efforts of competing subordinates, as standard in contest models. $V > 0$ denotes the value of the reward/position in the middle layer. The quadratic term $\frac{x_{l_i}^2}{2}$ captures the convex cost of exerting effort. Thus, each loyal subordinate chooses effort to trade off the expected benefit from winning the internal competition against the cost of effort.

Taking k as given, the problem of a disloyal subordinate $j \in \{1, \ldots, n-m\}$ is given by

$$U_{d_j} \equiv \max_{x_{d_j} \geq 0} \left\{ P_{d_j}\left(x_{d_j}, x_{-j}; k; q\right) V - \frac{x_{d_j}^2}{2} \right\}. \tag{3}$$

where $P_{d_j}(x_{d_j}, x_{-j}; k)$ represents the probability that disloyal subordinate j obtains the promotion or reward V under competition intensity k. The interpretation of $P_{d_j}(\cdot)$ follows analogously. The quadratic term $\frac{x_{d_j}^2}{2}$ captures the convex cost of exerting effort.

Winning Probabilities

Under stochastic favoritism, the winning probabilities of loyal and disloyal subordinates are piecewise defined across two cases, depending on whether the number of disloyal subordinates is sufficient to fill the top-k group. When $n - m \geq k$, the number of disloyal subordinates $n - m$ is no less than k, so it is feasible that the entire top-k group consists of disloyal subordinates. Hence, the winning probability for disloyal subordinates is positive. When $n - m < k$, there are fewer than k disloyal subordinates in total, implying that the top-k group must contain at least one loyal subordinate in every realization. Therefore, disloyal subordinates are excluded from selection with certainty, and their promotion probability is zero. Thus, the winning probability for a loyal subordinate $i \in \{1, \ldots, m\}$ is given by:[3]

$$P_{l_i} = \begin{cases} \dfrac{x_{l_i} \frac{1}{m}\left[\binom{n}{k} - \binom{n-m}{k}\right] + x_{l_{\bar{i}}}\left[\frac{m-1}{m}\binom{n}{k} - \binom{n-1}{k} + \frac{1}{m}\binom{n-m}{k}\right] + (n-m)x_{d_j}\frac{1}{m}\left[\binom{n-1}{k-1} - \binom{n-m-1}{k-1}\right]}{\binom{n-1}{k-1}\left[x_{l_i} + (m-1)x_{l_{\bar{i}}} + (n-m)x_{d_j}\right]}, & \text{if } n-m \geq k, \\ \dfrac{\frac{1}{m}\binom{n}{k} x_{l_i} + (m-1)x_{l_{\bar{i}}}\left(\frac{1}{m}\binom{n}{k} - \frac{1}{m-1}\binom{n-1}{k} + \frac{1}{m(m-1)}\binom{n-m}{k}\right)}{\binom{n-1}{k-1}\left[x_{l_i} + (m-1)x_{l_{\bar{i}}}\right]}, & \text{if } n-m < k. \end{cases} \tag{4}$$

[3]The mathematical expressions of P_{l_i} and P_{d_j} are based on Berry's (1993) Contest Success Function that describes an agent's probability of being rewarded in a competition with multiple winners. To incorporate authority maintenance, we develop Berry's (1993) Contest Success Function by including the winning likelihood conditioning on the performance that has ranked in the top k. See Appendix for more details.

$$P_{l_i} = \begin{cases} \dfrac{\begin{array}{l} x_{l_i} \sum\limits_{q=1}^{\min(m,k)} \frac{1}{q}\binom{m-1}{q-1}\binom{n-m}{k-q} + (m-1)x_{l_{\bar{i}}} \sum\limits_{q=2}^{\min(m,k)} \frac{1}{q}\binom{m-2}{q-2}\binom{n-m}{k-q} \\ +(n-m)x_{d_j} \sum\limits_{q=1}^{\min(m,k)} \frac{1}{q}\binom{m-1}{q-1}\binom{n-m-1}{k-q-1} \end{array}}{\binom{n-1}{k-1}[x_{l_i}+(m-1)x_{l_{\bar{i}}}+(n-m)x_{d_j}]} & \text{if } n-m \geq k \\ \dfrac{\sum\limits_{j=0}^{n-m} \frac{1}{k-j}\binom{n-m}{j}\binom{m-1}{k-j-1}x_{l_i} + (m-1)\sum\limits_{j=0}^{n-m} \frac{1}{k-j}\binom{n-m}{j}\binom{m-2}{k-j-2}x_{l_{\bar{i}}}}{\binom{n-1}{k-1}[x_{l_i}+(m-1)x_{l_{\bar{i}}}]}, & \text{if } n-m < k \end{cases} \tag{5}$$

The winning probability for disloyal subordinate $j \in \{1, \ldots, n-m\}$ is given by:

$$P_{d_j} = \begin{cases} \dfrac{1}{k} \dfrac{\binom{n-m-1}{k-1}x_{d_j} + (n-m-1)\binom{n-m-2}{k-2}x_{d_{\bar{j}}}}{\binom{n-1}{k-1}\left(x_{d_j} + (n-m-1)x_{d_{\bar{j}}} + mx_{l_i}\right)}, & \text{if } n-m \geq k, \\ 0, & \text{if } n-m < k. \end{cases} \tag{6}$$

$$P_{d_j} = \begin{cases} \frac{1}{k} \dfrac{\binom{n-m-1}{k-1}x_{d_j} + (n-m-1)\binom{n-m-2}{k-2}x_{d_{\bar{j}}}}{\binom{n-1}{k-1}[x_{d_j} + (n-m-1)x_{d_{\bar{j}}} + mx_{l_i}]} & \text{if } n-m \geq k \\ 0, & \text{if } n-m < k \end{cases} \tag{7}$$

Accordingly, the likelihood P_l that the superior can promote or reward any loyal subordinate, equivalently, the likelihood $1 - P_d$ that no disloyal subordinates win is given by:

$$P_l = 1 - P_d = \begin{cases} 1 - \dfrac{(n-m)\binom{n-m-1}{k-1}x_{d_j}}{\binom{n-1}{k-1}[(n-m)x_{d_j} + mx_{l_i}]} & \text{if } n-m \geq k \\ 1, & \text{if } n-m < k \end{cases} \tag{8}$$

Incentives, Effort, and Aggregate Output

Taking the competition intensity k as given, this section analyzes subordinates' equilibrium effort incentives and the resulting aggregate output.

Subordinates' effort provision. When $n - m \geq k$, loyal subordinate i's FOC is given by:

$$\frac{\partial P_{l_i}}{\partial x_{l_i}} V - x_{l_i} = 0 \tag{9}$$

Disloyal subordinate j's FOC is given by:

$$\frac{\partial P_{d_j}}{\partial x_{d_j}} V - x_{d_j} = 0 \tag{10}$$

The subordinates' reaction curve is given by:

$$x_{l_i} = Bx_{d_j}, \qquad (B \geq 1). \tag{11}$$

where

$$B = \frac{\Delta + \sqrt{\Delta^2 + 4\binom{n-m}{k}\left(\binom{n-1}{k} - \binom{n-m-1}{k}\right)}}{2 \cdot \frac{m}{n-m}\binom{n-m}{k}}, \qquad \Delta \equiv \binom{n-1}{k} - \binom{n-m}{k} - \binom{n-m-1}{k}.$$

The best-response correspondence of loyal and disloyal subordinates are given by

$$\left(x_l^*, x_d^*\right) = \begin{cases} \left(B\sqrt{\frac{V\binom{n-m}{k}(mB+n-m-k)}{\binom{n-1}{k-1}(n-m)(n-m+mB)^2}},\ \sqrt{\frac{V\binom{n-m}{k}(mB+n-m-k)}{\binom{n-1}{k-1}(n-m)(n-m+mB)^2}}\right), & \text{if } n-m \geq k, \\ \left(\frac{1}{m}\left[\frac{\sum_{j=0}^{n-m}\binom{n-m}{j}\binom{m-1}{k-j}}{\binom{n-1}{k-1}}V\right]^{\frac{1}{2}},\ 0\right), & \text{if } n-m < k. \end{cases} \tag{13}$$

Proofs are provided in the Appendix.

Lemma 1 (Effort Asymmetry under Stochastic Favoritism)**.** *In the symmetric equilibrium, loyal subordinates exert weakly higher effort than disloyal subordinates:*

$$x_l^* \geq x_d^*.$$

Lemma 1 characterizes effort incentives when internal competition remains operative. When $n - m \geq k > 1$, favoritism applies within the eligible set, so loyal subordinates enjoy a strictly higher marginal return to effort than disloyal ones. Anticipating priority in the final selection conditional on ranking within the top k, loyal subordinates invest more aggressively in effort provision. By contrast, disloyal subordinates internalize the risk that even conditional on entering the eligible set, their winning probability collapses to zero whenever a loyal subordinate is present, which depresses their effort incentives.

The boundary case $k = 1$ corresponds to a strict tournament. Since favoritism cannot operate when only the top-ranked performer is eligible, loyal and disloyal subordinates face identical winning probabilities. Accordingly, effort provision is symmetric in this case, yielding $x_l^* = x_d^*$.

Corollary 1 (Effort Collapse under Degenerate Competition)**.** *Suppose* $n - m < k$.

If $k < n$*, disloyal subordinates optimally exert zero effort, while loyal subordinates continue to exert positive effort due to residual competition among loyal agents.*

If $k = n$, promotion becomes completely independent of relative performance and depends solely on subordinate types. In this case, internal competition collapses entirely and both loyal and disloyal subordinates optimally exert zero effort in equilibrium.

When $n-m < k < n$, at least one loyal subordinate must rank within the eligible set in every realization. As a result, disloyal subordinates are excluded from winning with certainty and optimally choose zero effort. Loyal subordinates, by contrast, continue to exert positive effort as long as $k < n$, reflecting residual competition among loyal agents within the eligible set.

When $k = n$, eligibility is unrestricted and promotion is entirely decoupled from performance. Since winning probabilities no longer depend on effort, all subordinates optimally choose zero effort and incentive provision collapses.

Aggregate Output Using the Vandermonde identity, aggregate output in the organization is given by

$$E^*(k) = mx_l^* + (n-m)x_d^* = \sqrt{V\,\frac{n-k}{k}}. \tag{14}$$

Proposition 1 (Aggregate Output Invariance)**.** *For any given organizational size n and prize value V, aggregate effort in equilibrium is independent of political authority capital m and strictly decreasing in the competition intensity parameter k.*

Proof. Substituting the equilibrium effort ratio B into the expression for total effort and applying standard binomial identities yields

$$(E^*)^2 = \frac{V\binom{n-1}{k}}{\binom{n-1}{k-1}},$$

which is independent of m. The detailed derivation is provided in Appendix. □

An increase in k expands the eligible set, diluting individual winning probabilities and weakening effort incentives, thereby reducing aggregate effort. However, for a given competition intensity k, increasing the number of loyal subordinates m mechanically replaces disloyal subordinates with loyal ones. Although a larger m intensifies competition within the eligible set and reduces each loyal subordinate's individual winning probability, thus lowering individual effort incentives, this incentive dilution is exactly offset by a composition effect. Loyal subordinates exert higher equilibrium effort than disloyal ones, so replacing a disloyal subordinate with a loyal subordinate raises per-capita effort at the margin. As a result, the reduction in individual effort caused by intensified within-group competition is compensated by the higher effort level of the

additional loyal subordinate. Consequently, while competition intensity k directly governs aggregate output, variations in authority capital m affect the distribution of effort across agents but do not alter total effort as long as k remains fixed.[4]

Visual Illustration: Effort levels and Aggregate Output in Partial Equilibrium Figure 1 depicts the relationship between authority capital m and competition intensity k, which may be selected by the superior S. It also illustrates subordinates' effort levels x_{l_i}, x_{d_j} and the overall productivity $mx_{l_i} + (n-m)x_{d_j}$ in the partial equilibrium.

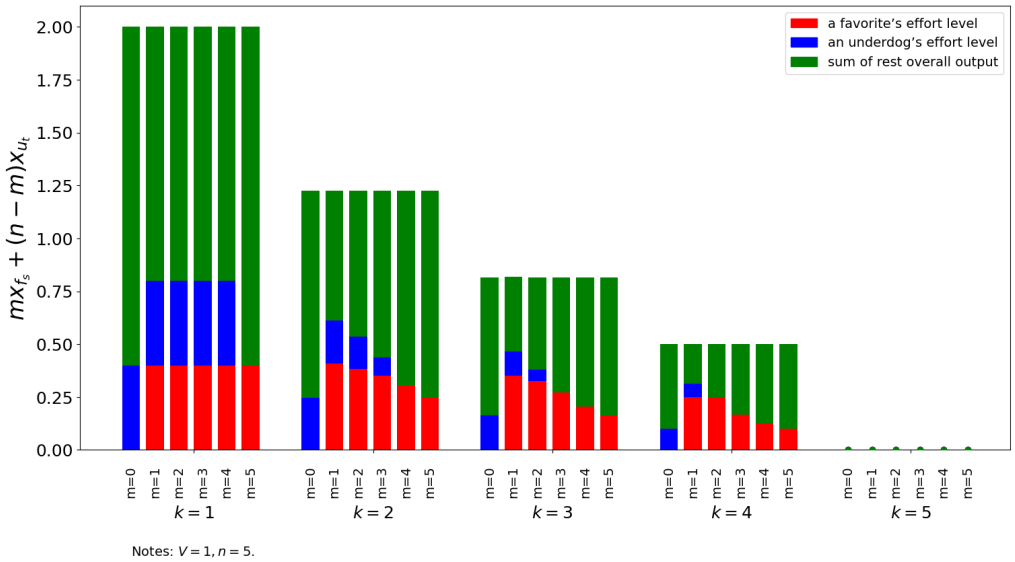


Figure 1 Effort levels and Aggregate Output in Partial Equilibrium

Consistent with the analytical results derived above, Figure 1 visually confirms that aggregate output is strictly decreasing in the competition intensity k, while remaining invariant to the level of authority capital m in the partial equilibrium.

Remark 1 (Resilience of loyal subordinates' effort)**.** *In partial equilibrium, effort provision by loyal subordinates is more resilient than that of disloyal subordinates to both weaker competition intensity (higher k) and greater authority capital m.*

Figure 1 reveals that although effort declines for both types as competition intensity weakens, the decline is markedly less pronounced for loyal subordinates. This asymmetry arises because loyalty preserves expected returns to effort even under diluted

[4]It is important to emphasize that this invariance result holds only in partial equilibrium, where the competition intensity k is taken as given. In this environment, changes in authority capital m affect the composition of effort across loyal and disloyal subordinates but do not alter aggregate output.

In general equilibrium, however, the superior optimally adjusts the competition intensity k in response to changes in m. Authority capital thus influences aggregate output indirectly, by shaping the superior's choice of k, which in turn governs subordinates' effort incentives. Accordingly, while m does not affect total effort conditional on k, it plays a central role in determining aggregate output through its impact on the equilibrium competition rule.

competition. As the eligible set expands, disloyal subordinates face an increasing risk that their winning probability collapses to zero whenever at least one loyal subordinate is present, sharply weakening their marginal incentives. By contrast, loyal subordinates retain priority within the eligible set, so their expected payoff from effort erodes more slowly as k increases.

A similar logic applies when authority capital m increases for a given k. While a larger m intensifies competition among loyal subordinates and reduces each loyal agent's individual winning probability, this effect is relatively moderate. For disloyal subordinates, an increase in m generates a double discouragement: it both reduces the likelihood that the top-k set can be filled entirely by disloyal agents and raises the probability that at least one loyal subordinate enters the eligible set, in which case disloyal agents' winning probability collapses to zero. As a result, effort incentives of disloyal subordinates deteriorate more sharply, reinforcing the greater resilience of loyal subordinates' effort provision.

Visual Illustration: Incentive Divergence and Effort Gaps in Partial Equilibrium. Figure 2 illustrates effort gaps $x_{l_i} - x_{d_j}$ between the loyal and disloyal subordinates for $n = 5$ and $V = 1$ across values of k and authority capital m.

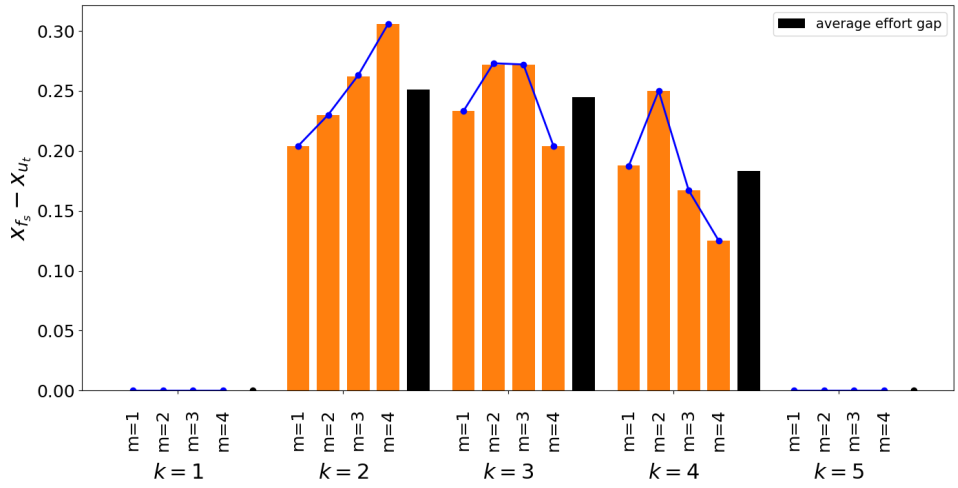
Remark 2 (Hump-shaped effort gaps)**.** *In partial equilibrium, the effort gap between loyal and disloyal subordinates is hump-shaped in competition intensity k: it vanishes at the extremes and peaks at intermediate values.*

Figure 2 illustrates how favoritism creates a systematic wedge in effort provision. Disloyal subordinates are disproportionately discouraged because their winning probability collapses whenever at least one loyal subordinate enters the eligible set, whereas loyal subordinates retain priority conditional on eligibility.

As competition intensity weakens (higher k), effort incentives decline for both types, but disloyal effort falls more sharply. Consequently, the effort gap remains sizable over an intermediate range of k and collapses only when competition becomes either perfectly meritocratic ($k = 1$) or entirely non-meritocratic ($k = n$).

Holding k fixed, a larger authority capital m amplifies this asymmetry: increasing m simultaneously reduces the likelihood that the top-k set consists entirely of disloyal subordinates and raises the probability that at least one loyal subordinate appears, further depressing disloyal incentives relative to loyal ones.

This effort-gap pattern is a *partial-equilibrium* object. In the final equilibrium, m affects outcomes jointly with legal strength α through the superior's endogenous choice of competition intensity $k^*(m, \alpha)$, which determines both aggregate output and the distribution of effort gaps across institutional environments.



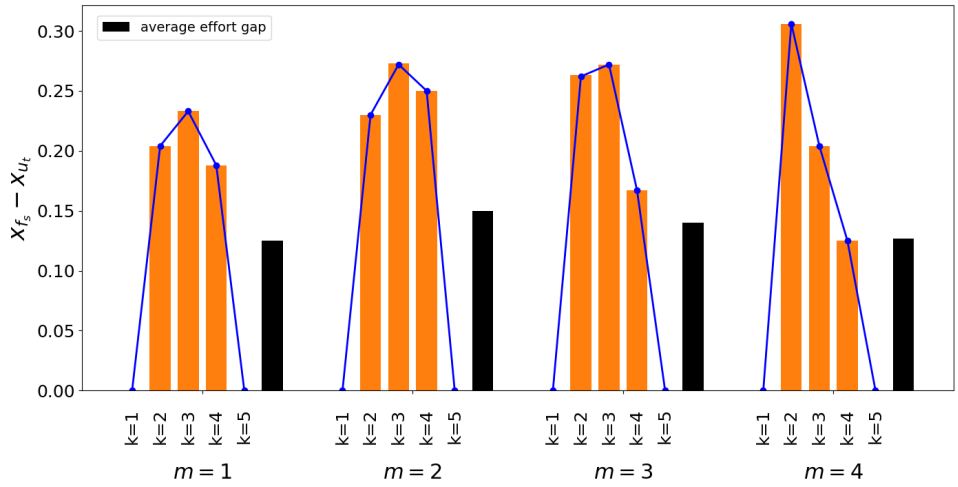


Figure 2 EFFORT GAPS BETWEEN THE LOYAL AND DISLOYAL

The Optimal Choice of Competition

The superior chooses competition intensity $k \in \{1, \dots, n-1\}$ to maximize

$$U_S(k; \alpha, m) = g(k) + \alpha\big(1 - 2P_d(k; m)\big), \qquad g(k) = \sqrt{V\frac{n-k}{k}},$$

Since k is an integer choice, optimality is characterized by adjacent comparisons. Define the discrete payoff difference

$$\Delta U_S(k; \alpha, m) = U_S(k+1; \alpha, m) - U_S(k; \alpha, m) = \Delta g(k) - 2\alpha\, \Delta P_d(k; m), \tag{15}$$

where $\Delta g(k) = g(k+1) - g(k) < 0$ and $\Delta P_d(k; m) = P_d(k+1; m) - P_d(k; m) < 0$.

For each k, define the switching threshold

$$\alpha_k(m) = \frac{\Delta g(k)}{2\,\Delta P_d(k; m)} = \frac{g(k+1) - g(k)}{2\,[P_d(k+1; m) - P_d(k; m)]}, \tag{16}$$

which is well-defined and positive.

The sequence $\{\alpha_k(m)\}$ partitions the parameter space of α into intervals. In particular, the superior prefers $k+1$ to k if and only if $\alpha \geq \alpha_k(m)$. Consequently, the optimal competition intensity is characterized as

$$k^*(\alpha, m) = k \quad \Longleftrightarrow \quad \alpha \in \big[\alpha_{k-1}(m),\, \alpha_k(m)\big],$$

with the convention $\alpha_0 = 0$ and $\alpha_{n-1} = +\infty$.

Lemma 2 (Benchmark without Authority Concerns)**.** *When $\alpha = 0$, the superior chooses the most intense competition rule $k^* = 1$, which yields the highest aggregate output.*

When $\alpha = 0$, the superior derives no authority payoff from promotion outcomes and therefore maximizes aggregate output alone. In this benchmark case, the superior's problem reduces to choosing the competition intensity k to maximize total effort. Since aggregate output is strictly decreasing in k, the optimal competition rule corresponds to a strict tournament, $k^* = 1$, which yields the first-best aggregate output.

Importantly, this benchmark does not imply that first-best competition cannot arise once authority concerns are introduced. As shown in the numerical analysis below, even when $\alpha > 0$, the superior may still optimally choose $k^* = 1$ over a nontrivial range of parameter values.

Proposition 2 (Optimal competition intensity)**.** *For fixed n and V, the superior's optimal competition intensity $k^*(\alpha, m)$ satisfies the following comparative statics:*

1. *For a given legal environment α, $k^*(\alpha, m)$ is weakly decreasing in authority capital m.*

2. *For a given authority capital m, $k^*(\alpha, m)$ is weakly increasing in α.*

The intuition is as follows. A larger authority capital m raises the likelihood that loyal subordinates enter the eligible set, thereby increasing the superior's expected authority payoff from promotion outcomes. To preserve these authority rents, the superior optimally intensifies competition by choosing a smaller k.

By contrast, a larger α increases the relative importance of authority maintenance vis-à-vis aggregate output. To mitigate the risk of promoting disloyal subordinates, the superior optimally expands the eligible set and relaxes internal competition, resulting in a higher k^*.

Visual Illustration: Optimal Competition Intensity and Aggregate Output. Figure 3 illustrates Proposition 2 using a numerical example with $n = 5$ and $V = 1$. The color gradient in Figure 3 further illustrates the productivity implications implied by Proposition 1: darker cells correspond to lower k^* and therefore higher aggregate output.

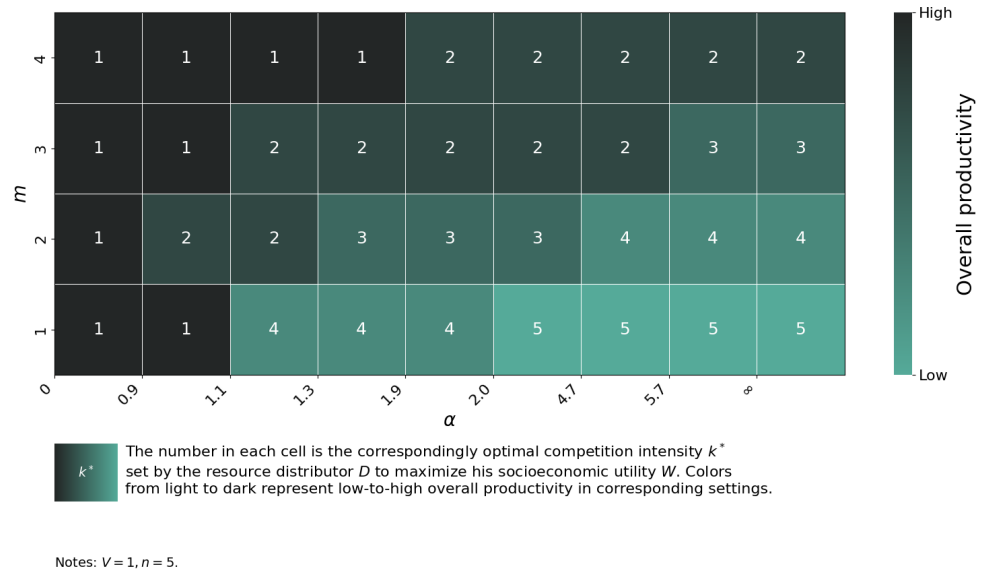


Figure 3 Optimal Competition Intensity across Authority Capital and Legal Strength

The figure highlights three patterns. First, for a fixed authority capital m, the optimal competition intensity k^* increases monotonically with α, reflecting the superior's growing emphasis on authority maintenance under weaker legal enforcement. Second, for a given α, higher authority capital m induces more intense competition, manifested by a lower k^*. Third, the benchmark case $\alpha = 0$ yields $k^* = 1$ for all m, consistent with the first-best strict tournament outcome.

Corollary 2 (Induced Productivity Effects)**.** *In the final equilibrium, aggregate organizational output varies systematically with authority capital m and legal strength*

α *through the superior's endogenous choice of competition intensity* $k^*(\alpha, m)$.

Specifically, environments in which authority capital or legal enforcement induces the superior to choose more intense competition (lower k^**) sustain higher aggregate output, whereas weaker legal environments that lead to relaxed competition (higher* k^**) exhibit lower productivity.*

This result follows directly from the fact that aggregate output is strictly decreasing in k in partial equilibrium.

Visual Illustration: Optimal Competition Intensity and Equilibrium Effort Gaps. Figure 4 depicts the relationship between m, k^*, α, and the effort gaps between the loyal and disloyal $x_{l_i} - x_{d_j}$ when $V = 1$ and $n = 5$.

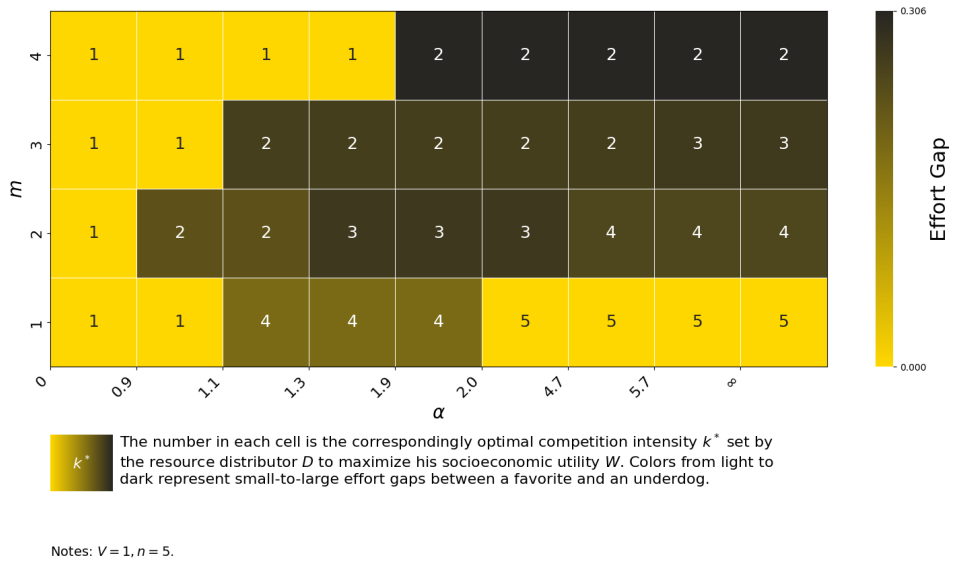


Figure 4 Competition Intensity, Authority Capital and Effort Gaps

As shown in Figure 4, effort gaps emerge only when the superior chooses an intermediate competition rule, $1 < k^* < n$. When competition is maximally intense ($k^* = 1$), favoritism cannot operate and loyal and disloyal subordinates exert identical effort. When competition is fully relaxed ($k^* = n$), promotion outcomes depend solely on identity rather than performance, leading both types to optimally slack off and eliminating effort differences.

Proposition 3 (Political origin of effort gaps)**.** *Effort gaps are political in origin: they can arise from authority maintenance within organizations rather than from market-based differences in productivity or skills.*

Specifically, effort gaps arise when the superior optimally chooses an intermediate competition rule that allows loyalty-based prioritization to operate. Authority capital m *and legal strength* α *shape the magnitude and incidence of effort inequality only indirectly, through their effect on the endogenous choice of competition intensity.*

Therefore, effort inequality in equilibrium is not a monotone function of institutional strength, but a political outcome generated by authority-preserving competition design.

Remark 3 (Effort Gaps and Productivity Are Not Monotonically Linked)**.** *Figure 4 highlights that equilibrium effort gaps and aggregate productivity need not move together. High productivity can coexist with minimal effort gaps (e.g., under strict tournaments with $k^* = 1$), but also with substantial effort gaps under intermediate competition rules. Conversely, low productivity may arise both in environments with negligible effort gaps ($k^* = n$) and in settings with pronounced gaps.*

This absence of a monotonic relationship reflects the fact that productivity is governed primarily by the intensity of competition, whereas effort gaps depend on how favoritism interacts with competition through authority capital and legal enforcement. As a result, similar levels of productivity can be associated with very different distributions of effort across subordinate types.

Practical Implication

The model yields several practical implications for understanding productivity, inequality and the political nature of hierarchical organizations, ranging from firms to states.

A central implication is that differences in productivity need not originate from differences in technology, culture, or regime type per se, but can arise endogenously from how internal competition is designed under authority constraints. When superiors rely heavily on loyalty-based authority, they may strategically adjust competition intensity to preserve authority rents, even at the cost of weaker incentives for effort. As a result, otherwise similar organizations may exhibit sharply different productivity outcomes simply because authority capital and legal enforcement shape different competition rules.

This perspective helps reconcile long-standing disagreements in the literature on political regimes and economic performance. Rather than attributing growth differences to democracy or autocracy as such, the model suggests that both democratic and non-democratic systems can sustain either high or low productivity, depending on how authority concerns interact with internal competition. Weak legal environments do not mechanically imply low productivity: when authority capital is sufficiently strong, superiors may still enforce intense internal competition, sustaining high levels of effort and output. Conversely, even formally democratic systems may experience declining productivity if authority concerns lead to relaxed competition.

The same logic applies at the organizational level. Firms with similar technologies may display large productivity gaps if leaders differ in their authority capital or reliance

on loyalty-based authority (legal strength) and therefore choose different competition rules for promotion and advancement. In this sense, competition intensity emerges as an institutional outcome shaped by authority considerations rather than a purely technological or market-driven parameter.

The model also offers a new interpretation of economic inequality within organizations. Effort gaps between favored and disfavored subordinates do not arise as a direct consequence of low productivity or weak competition. Instead, they are a political byproduct of authority-preserving competition design. Severe effort inequality may coexist with high productivity under intermediate competition rules, while minimal inequality can accompany both the most intense and the weakest forms of competition. This helps explain why economic inequality is observed across a wide range of organizational and institutional environments without a stable monotonic relationship to aggregate performance. While the model is developed in an organizational setting, its logic naturally extends to state-level governance. States, like large hierarchical organizations, rely on authority rather than prices to coordinate behavior. When political authority is maintained through identity-based favoritism, incentive structures become uneven across groups. As a result, inequality emerges not primarily from differential market returns, but from systematically induced differences in effort and participation. Economic inequality, in this view, is a downstream consequence of politically generated effort inequality. This implication complements political science theories of social cleavages by identifying an incentive-based mechanism through which identity divisions translate into persistent economic inequality (Lipset and Rokkan 1967; Alesina and Glaeser 2004; Padgett and McLean 2006).

Taken together, these implications highlight that productivity and inequality are jointly shaped—but not mechanically linked—by how authority is maintained through internal competition. Institutional reforms that focus solely on strengthening formal rules or increasing competition may therefore have limited effects unless they also account for the authority structures that govern how competition is implemented in practice.

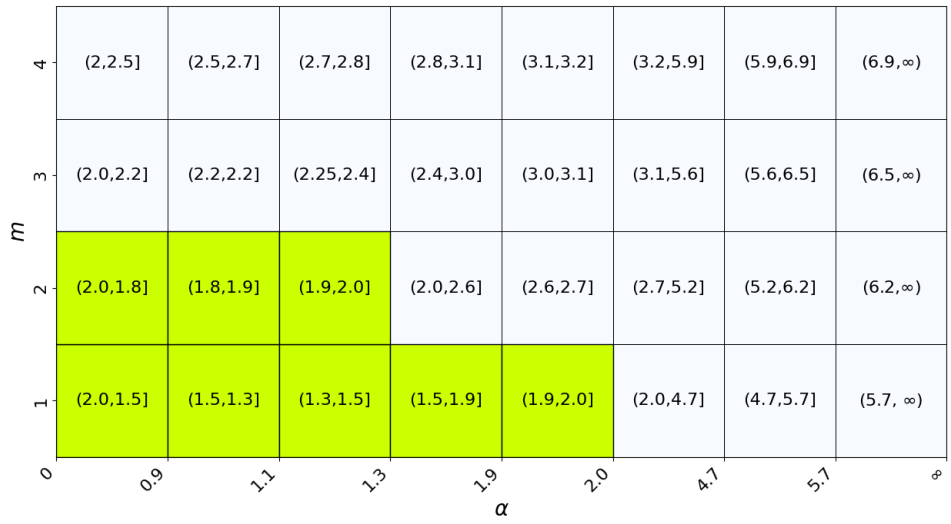
Model Extension: Endogenous Authority Capital and Tipping Points

Our baseline analysis treats the choice of competition intensity k^* as the sole strategic margin available to the superior S, taking authority capital m and legal strength α as exogenously given. This formulation captures environments in which organizational and institutional constraints are slow-moving.

In practice, however, authority capital and legal strength are often shaped, at least

in part, by strategic actions of the superior (Zingales 2017). Through organizational restructuring, selective promotion, coalition-building, or political contestation, a superior may expand or contract the pool of loyal subordinates, thereby influencing authority capital m. Similarly, legal strength α may be indirectly affected by discretionary enforcement, institutional reform, or deliberate weakening of formal constraints.

This section extends the model by allowing the superior to exercise limited discretion over authority capital and legal strength, and examines how these additional margins interact with competition design and equilibrium outcomes.



Notes: The interval in each cell represents the range for *max*(*W*), the maximized socioeconomic utility of the resource distributor *D* within the specified range of *α* and the value of *m*.
Notes: $V = 1, n = 5$.

Figure 5 Superior's Maximized Utility Ranges

Figure 5 illustrates the superior's maximized utility U_S^* across combinations of authority capital m, legal strength α, and the induced optimal competition intensity k^* in a numerical example with $n = 5$ and $V = 1$. We first examine the superior's preference over authority capital m for a given α, and then turn to the choice of α conditional on m.

Proposition 4 (Authority Capital Expansion)**.** *Holding legal strength α fixed, the superior's maximized utility U_S^* is weakly increasing in authority capital m. As a result, expanding the pool of loyal subordinates is a dominant strategy whenever feasible.*

The intuition is as follows. An increase in authority capital m raises the likelihood that loyal subordinates enter the eligible set, thereby improving the promotion probability structure in favor of authority reinforcement, even if the superior does not adjust the competition rule.

This structural shift expands the superior's payoff-relevant choice set. With a larger pool of loyal subordinates, the superior can intensify competition by selecting a smaller

k without sacrificing authority payoffs. In fact, stricter competition simultaneously raises aggregate output while preserving—or even enhancing—the probability that promotion outcomes reinforce authority.

As a result, an increase in authority capital unambiguously raises the superior's maximized utility. This generates a fundamental incentive for superiors to expand authority capital whenever feasible, reflecting an intrinsic tendency of hierarchical organizations to accumulate political authority.

Remark 4 (Tipping Points in Legal Strength)**.** *Figure 5 reveals that the relationship between legal strength α and the superior's maximized utility U_S^* is non-monotonic when authority capital m is small. For sufficiently low levels of α, marginal increases in authority reliance reduce the superior's payoff. Beyond a threshold value $\alpha_{tp}(m)$, further increases in α strictly raise U_S^*.*

When authority capital is small, the probability of rewarding a loyal subordinate is limited. In this region, marginal increases in α amplify authority concerns without generating sufficient authority rents, leading to a decline in U_S^*. Once authority reliance exceeds a tipping point α_{tp}, the superior optimally relaxes competition by increasing k^*, which raises the probability of rewarding loyal subordinates and turns expected authority gains positive.

Remark 5 (Disappearance of Tipping Points)**.** *As authority capital m increases, the tipping point $\alpha_{tp}(m)$ decreases and eventually disappears. For sufficiently large m, the superior's maximized utility U_S^* becomes monotonically increasing in α.*

A larger authority capital increases the baseline likelihood of rewarding loyal subordinates. As a result, even small increases in authority reliance (weaker legal strength) generate positive expected authority rents, making intensified competition less sustainable. Consequently, the superior's preference for strong legal strength and strict competition vanishes as m grows.

Implications: Authority Accumulation, Institutional Stability and Reform

The extension yields two central implications regarding the internal logic of hierarchical organizations and the long-run stability of institutional arrangements.

First, hierarchical organizations endogenously generate incentives for political authority accumulation—not as a distortion, but as a consequence of probability-based competition design. Whenever the superior is able to influence the composition of loyal subordinates, she strictly prefers to expand authority capital. This preference is not

incidental, but rooted in the organizational structure that underpins the political nature of hierarchical organizations. Authority accumulation emerges as an endogenous adaptive response that allows organizations to maintain coordination and operational efficiency even under volatile or weak legal environments.

Crucially, this preference is robust across legal regimes. Increasing authority capital not only strengthens political control, but also expands the feasible set of internal competition designs that can sustain high organizational performance across heterogeneous levels of legal enforcement. Political authority accumulation is therefore not traded off against efficiency; rather, it enlarges the institutional space in which authority and productivity remain compatible.

This mechanism applies broadly—from firms and public bureaucracies to nation-states—wherever hierarchical structure and internal competition coexist.

Second, the model highlights why high levels of legal enforcement are difficult to sustain unless institutional reforms are sufficiently comprehensive. When legal strength is sufficiently strong and authority capital is small, marginal decline in legal strength may reduce the superior's utility, creating a region in which weakening legal strength is temporarily unattractive. However, this region is bounded by a tipping point. Once authority capital expands beyond a threshold, the superior's incentives reverse: weakening legal strength becomes privately optimal, even though high legal enforcement remains socially efficient.

This result implies that partial legal reforms may be inherently fragile. If reforms fail to push legal strength sufficiently far below the tipping point—or fail to constrain the superior's ability to expand authority capital—then the institutional environment cannot sustain itself endogenously. Over time, private incentives reassert themselves, and legal enforcement erodes.

Third, these dynamics provide a structural explanation for persistent institutional backsliding. Even when high legal enforcement and low inequality are initially achieved, they are not self-enforcing equilibria if superiors retain discretion over authority accumulation. Once the system crosses the tipping point, the superior has strong incentives to weaken legal constraints and expand political authority, despite full awareness that strong rule of law is socially beneficial.

From this perspective, democratic backsliding and rule-of-law erosion need not reflect cultural regression or technological stagnation. Instead, they may arise endogenously from the interaction between hierarchical authority, discretionary power, and probability-based competition. Sustaining a stable, high-rule-of-law equilibrium therefore requires institutions that simultaneously limit both political authority expansion and discretionary erosion of legal enforcement.

Conclusion

A central premise of organizational economics is that organizations allocate resources through authority rather than prices. Existing theories, however, have largely equated such authority with contractual authority—authority enforced by formal contracts and third-party legal enforcement. This abstraction obscures a fundamental feature of real organizations: contractual enforcement varies widely across countries and institutional environments, and is often incomplete even within advanced legal systems. When contractual authority is weak or imperfectly enforced, organizations face a basic problem—how to sustain sufficient internal authority to coordinate activities and ensure compliance.

This paper argues that organizations respond to this problem by endogenously maintaining political authority within their hierarchies. Political authority operates through personnel selection and promotion, where loyalty and obedience become relevant criteria alongside performance. By adjusting internal competition intensity and shaping who is hired, promoted, and rewarded, superiors can preserve effective authority even when formal enforcement is limited.

We show that the productivity consequences of authority maintenance are inherently institutional-contingent. When legal enforcement is strong, contractual authority is reliable, and superiors have little need to rely on political authority. In such environments, promotion decisions place greater weight on performance rather than loyalty, leading to more intense internal competition and higher aggregate output.

When legal strength is weak, contractual authority becomes fragile, and superiors must rely more heavily on political authority to maintain basic organizational control. This reliance increases the incentive to favor loyal subordinates and to relax internal competition by expanding the eligibility threshold. Importantly, weak legal enforcement is not, by itself, sufficient to generate low productivity. When authority capital is sufficiently strong—because a large pool of loyal subordinates already exists—superiors can maintain strict competition while still securing authority, thereby sustaining high organizational output even under weak legal institutions.

These results reconcile two seemingly conflicting observations. They are consistent with the conventional view that strong legal institutions promote economic efficiency, but they also explain why high productivity can persist in weak legal environments. In such cases, political authority substitutes for contractual authority, allowing organizations to preserve both control and performance through endogenous competition design.

Our model extension shows that authority accumulation is intrinsic to hierarchical organization rather than a distortion. Instead, it constitutes a core mechanism through which organizations maintain stable operation and sustain high productivity, even un-

der weak or volatile legal enforcement—an aspect largely overlooked in the existing literature.

Appendix

Theories of Winning Likelihood

The mathematical expression of the winning likelihood applied in this paper is based on Berry's (1993) Multi-winner Success Function. To understand Berry's (1993) Multi-winner Success Function and the extension of the winning likelihood function applied in our paper, it is necessary to introduce the Contest Success Function (CSF) and the Tullock Success Function (TSF) as the baseline.

The CSF is a core component of a contest situation, which depicts each competitor's winning likelihood given others' level of effort. Let $x = (x_1, x_2, ..., x_n)$ denote a vector of efforts for n players. Each player i's winning probability is denoted by $Prob^i(x)$ ($Prob^i(x) : [0, X]^n \to \mathbb{R}$ where $X > x_i$ for all $i \in N$). For a contest that only has one winner, each player's winning probability should meet the following three properties (Skaperdas 1996):

(1A)$\sum_{i \in N} Prob^i(x) = 1$ and $Prob^i(x) \geq 0$ for all $i \in N$ and all x; if $x_i > 0$ then $Prob^i(x) > 0$.

(2A) For all $i \in N$, $Prob^i(x)$ is increasing in x_i and decreasing in x_j for all $j \neq i$.

(3A) For any permutation π of N (i.e., a bijection $\pi : N \to N$), it has

$$Prob^{\pi(i)}(x) = Prob(x_{\pi_1}, x_{\pi_2}, ..., x_{\pi_n}) \forall i \in N.$$

Tullock Success Function (TSF) is expressed below,

$$Prob^i(x) = \frac{x_i^r}{x_1^r + x_2^r + ... + x_n^r} \tag{17}$$

TSF is a special type of CSF that meets the above three properties. It depicts the winning likelihood for an individual competitor in a single-winner contest. In the mathematical expression of TSF, the nominator only includes information relating to competitor i's effort level x_i because competitor i is the only winner in the contest. The denominator $\sum_{i=1}^{n} x_i^r$ is the sum of all information about each competitor's effort levels, and r refers to an index of external uncertainty/ the marginal cost of influencing the probability of winning (Rai and Sarin 2009). In a single-winner contest setting, the ratio of nominator and denominator of TSF is the winning likelihood for competitor i, given other competitors' effort level $x_{\bar{i}}$ and the uncertainty level r.

TSF functions as the baseline for Barry's Multi-winner Success Function. In a con-

test with k winners ($1 < k \leq n$), each player's winning probability would be more significant than when there is one winner. Hence, to describe the winning probability for each competitor in a multi-winner contest, Berry (1993) made some adjustments to TSF while keeping the three properties of CFS.

Let $Prob_k^i(x)(i = 1, 2, ...n)$ denote competitor i's probability to get into the top k. In other words, $Prob_k^i(x)(i = 1, 2, ...n)$ depicts competitor i's winning likelihood in a k-winner contest. We have the expression of $Prob_k^i(x)$ below.

The numerator displays all possible combinations of winner i and the other $k-1$ winners, which are denoted as $j \neq i$. The expression in each bracket $(x_{j_q^1}^r + x_{j_q^2}^r + ... + x_{j_q^{k-1}}^r)$, where $q = 1, ..., \binom{n-1}{k-1}$ represents the qth set of different combinations of the other winner j 's efforts.

In a k-winner contest of n players, there are $\binom{n-1}{k-1}$ possibilities for player i ($i = 1, ..., n$) to get into top k qualified, where $\binom{n-1}{k-1}$ represents the combination of $n-1$ objects taking $k-1$ at a time. $(x_{z_p^1}^r + x_{z_p^2}^r + ... + x_{z_p^k}^r)$, $p = 1, ..., \binom{n}{k}$ in the denominator denotes the pth combination of any players that is possible to win the contest. Similarly, there are $\binom{n-1}{k-1}$ winning combinations in total. The ratio between the numerator and the denominator is calculated as the winning probability for competitor i in a multi (k)-winner competition.

$$
\begin{aligned}
Prob_k^i(x) &= \frac{\begin{array}{c} x_i^r + (x_{j_1^1}^r + x_{j_1^2}^r + ... + x_{j_1^{k-1}}^r) + x_i^r + (x_{j_2^1}^r + x_{j_2^2}^r + ... + x_{j_2^{k-1}}^r) \\ +... + x_i^r + \left(x_{j^1_{\binom{n-1}{k-1}}}^r + x_{j^2_{\binom{n-1}{k-1}}}^r + ... + x_{j^{k-1}_{\binom{n-1}{k-1}}}^r \right) \end{array}}{\begin{array}{c} (x_{z_1^1}^r + x_{z_1^2}^r + ... + x_{z_1^k}^r) + (x_{z_2^1}^r + x_{z_2^2}^r + ... + x_{z_2^k}^r) \\ +... + \left(x_{z^1_{\binom{n}{k}}}^r + x_{z^2_{\binom{n}{k}}}^r + ... + x_{z^k_{\binom{n}{k}}}^r \right) \end{array}} \\
&= \frac{\binom{n-1}{k-1} x_i^r + \binom{n-2}{k-2} \sum_{j \neq i} x_j^r}{\binom{n-1}{k-1} \sum_{z=1}^n x_z^r}
\end{aligned}
$$

Where $j \neq i$, $j, i \in N$.

Calculation Details for Section III

When $n - m \geq k$,

$$
\begin{aligned}
\frac{\partial P_{l_i}}{\partial x_{l_i}} &= \frac{\begin{array}{l}\sum_{i=1}^{\min(m,k)} \frac{1}{i}\binom{m-1}{i-1}\binom{n-m}{k-i}[x_{l_i}+(m-1)x_{l_i}+(n-m)x_{d_j}] \\ -\Bigg[x_{l_i}\sum_{i=1}^{\min(m,k)} \frac{1}{i}\binom{m-1}{i-1}\binom{n-m}{k-i}+(m-1)x_{l_i}\sum_{i=2}^{\min(m,k)} \frac{1}{i}\binom{m-2}{i-2}\binom{n-m}{k-i} \\ +(n-m)x_{d_j}\sum_{i=1}^{\min(m,k)} \frac{1}{i}\binom{m-1}{i-1}\binom{n-m-1}{k-i-1}\Bigg]\end{array}}{\binom{n-1}{k-1}[x_{l_i}+(m-1)x_{l_i}+(n-m)x_{d_j}]^2} \\
&= \frac{(\binom{n-m}{k-1}+\sum_{i=2}^{\min(m,k)} \frac{1}{i}\binom{m-2}{i-1}\binom{n-m}{k-i})(m-1)x_{l_i}+(n-m)x_{d_j}\sum_{i=1}^{\min(m,k)} \binom{m-1}{i-1}\binom{n-m-1}{k-i}}{\binom{n-1}{k-1}[x_{l_i}+(m-1)x_{l_i}+(n-m)x_{d_j}]^2} \\
&= \frac{x_{l_i}\sum_{i=1}^{min(m,k)} \binom{m-1}{i}\binom{n-m}{k-i}+\frac{n-m}{m}x_{d_j}\sum_{i=1}^{min(m,k)} \binom{m}{i}\binom{n-m-1}{k-i}}{\binom{n-1}{k-1}[mx_{l_i+(n-m)x_{d_j}}]^2}
\end{aligned}
\tag{19}
$$

When $n-m<k$, we get:

$$
\begin{aligned}
\frac{\partial P_{l_i}}{\partial x_{l_i}} &= \frac{(m-1)x_{l_i}(\sum_{i=0}^{n-m} \frac{1}{k-i}\binom{n-m}{i}\binom{m-1}{k-i-1}-\sum_{i=0}^{n-m} \frac{1}{k-i}\binom{n-m}{i}\binom{m-2}{k-i-2})}{\binom{n-1}{k-1}[x_{l_i}+(m-1)x_{l_i}]^2} \\
&= \frac{(m-1)x_{l_i}\sum_{i=0}^{n-m} \frac{1}{k-i}\binom{n-m}{i}\binom{m-2}{k-i-1}}{\binom{n-1}{k-1}[x_{l_i}+(m-1)x_{l_i}]^2} \\
&= \frac{\sum_{i=0}^{n-m} \binom{n-m}{i}\binom{m-1}{k-i}}{\binom{n-1}{k-1}m^2x_{l_i}}
\end{aligned}
\tag{20}
$$

When $n-m\geq k$, the calculation of $\frac{\partial P_{d_j}}{\partial x_{d_j}}$ is:

$$
\begin{aligned}
\frac{\partial P_{d_j}}{\partial x_{d_j}} &= \frac{\binom{n-m-1}{k-1}[x_{d_j} + (n-m-1)x_{d_j} + mx_{l_i}] - [\binom{n-m-1}{k-1}x_{d_j} + \binom{n-m-2}{k-2}(n-m-1)x_{d_j}]}{k\binom{n-1}{k-1}[x_{d_j} + (n-m-1)x_{d_j} + mx_{l_i}]^2} \\
&= \frac{\binom{n-m-1}{k-1}[mx_{l_i} + (n-m)x_{d_j}] - [\binom{n-m-1}{k-1}x_{d_j}] + \binom{n-m-2}{k-2}(n-m-1)x_{d_j}}{k\binom{n-1}{k-1}[mx_{l_i} + (n-m)x_{d_j}]^2} \\
&= \frac{\binom{n-m-1}{k-1}mx_{l_i} + (n-m-1)\binom{n-m-2}{k-1}x_{d_j}}{k\binom{n-1}{k-1}[mx_{l_i} + (n-m)x_{d_j}]^2} \\
&= \frac{km\binom{n-m}{k}x_{l_i} + k\binom{n-m-1}{k}x_{d_j}}{k(n-m)\binom{n-1}{k-1}[mx_{l_i} + (n-m)x_{d_j}]^2} \\
&= \frac{\frac{m}{n-m}\binom{n-m}{k}x_{l_i} + \binom{n-m-1}{k}x_{d_j}}{\binom{n-1}{k-1}[mx_{l_i} + (n-m)x_{d_j}]^2}
\end{aligned}
\tag{21}
$$

By combining equation (9) and equation (10), we get the expression of x_{l_i} as a function of x_{d_j} when $n - m \geq k$ as follows:

$$
\begin{aligned}
\frac{x_{l_i}\sum_{i=1}^{\min(m,k)}\binom{m-1}{i}\binom{n-m}{k-i} + \frac{n-m}{m}x_{d_j}\sum_{i=1}^{\min(m,k)}\binom{m}{i}\binom{n-m-1}{k-i}}{x_{l_i}} &= \frac{\binom{n-1}{k-1}[mx_{l_i} + (n-m)x_{d_j}]^2}{V} \\
\Rightarrow \frac{mx_{l_i}\sum_{i=1}^{\min(m,k)}\binom{m-1}{i}\binom{n-m}{k-i} + (n-m)x_{d_j}\sum_{i=1}^{\min(m,k)}\binom{m}{i}\binom{n-m-1}{k-i}}{mx_{l_i}} &= \frac{m\binom{n-m}{k}x_{l_i} + (n-m)\binom{n-m-1}{k}x_{d_j}}{(n-m)x_{d_j}} \\
\Rightarrow x_{l_i} = \frac{\sum_{i=1}^{\min(m,k)}\binom{m-1}{i}\binom{n-m}{k-i} - \binom{n-m-1}{k} + \left[(\sum_{i=1}^{\min(m,k)}\binom{m-1}{i}\binom{n-m}{k-i} - \binom{n-m-1}{k})^2 + 4\binom{n-m}{k}\sum_{i=1}^{\min(m,k)}\binom{m}{i}\binom{n-m-1}{k-i}\right]^{\frac{1}{2}}}{\frac{2m}{n-m}\binom{n-m}{k}}x_{d_j}
\end{aligned}
\tag{22}
$$

Table 1 PARTIAL EQUILIBRIUM EXAMPLE WITH $n = 5$

E		k				
x_{l_i} / x_{d_j}		1	2	3	4	5
m	0	2 N/A 0.400	1.225 N/A 0.245	0.816 N/A 0.163	0.500 N/A 0.100	0 N/A 0
	1	2 0.400 0.400	1.225 0.408 0.204	0.816 0.350 0.117	0.500 0.250 0.063	0 0 0
	2	2 0.400 0.400	1.225 0.383 0.153	0.816 0.327 0.054	0.500 0.250 0	0 0 0
	3	2 0.400 0.400	1.225 0.350 0.087	0.816 0.272 0	0.500 0.167 0	0 0 0
	4	2 0.400 0.400	1.225 0.306 0	0.816 0.204 0	0.500 0.125 0	0 0 0
	5	2 0.400 N/A	1.225 0.245 N/A	0.816 0.163 N/A	0.500 0.100 N/A	0 0 N/A

E is the total output ($E = mx_{l_i} + (n - m)x_{d_j}$). x_{l_i} is loyal subordinate i's partial equilibrium effort level. x_{d_j} is disloyal subordinate j's partial equilibrium effort level. k is competition intensity. m is the number of loyal subordinates.

Charts and Figures

Table 2 THE SUPERIOR'S UTILITY

U_S		k				
		1	2	3	4	5
m	0	2	$\frac{\sqrt{6}}{2}$	$\frac{\sqrt{6}}{3}$	$\frac{1}{2}$	0
	1	$2 - \frac{3}{5}\alpha$	$\frac{\sqrt{6}}{2}$	$\frac{\sqrt{6}}{3} + \frac{3\alpha}{7}$	$\frac{1}{2} + \frac{3\alpha}{4}$	α
	2	$2 - \frac{\alpha}{5}$	$\frac{\sqrt{6}}{2} + \frac{5\alpha}{8}$	$\frac{\sqrt{6}}{3} + \frac{14\alpha}{15}$	$\frac{1}{2} + \alpha$	α
	3	$2 + \frac{\alpha}{5}$	$\frac{\sqrt{6}}{2} + \frac{13\alpha}{14}$	$\frac{\sqrt{6}}{3} + \alpha$	$\frac{1}{2} + \alpha$	α
	4	$2 + \frac{3\alpha}{5}$	$\frac{\sqrt{6}}{2} + \alpha$	$\frac{\sqrt{6}}{3} + \alpha$	$\frac{1}{2} + \alpha$	α
	5	2α	$\frac{\sqrt{6}}{2}\alpha$	$\frac{\sqrt{6}}{3}\alpha$	$\frac{1}{2}\alpha$	α

*

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