The Allocation of Power in Organizations

by

Timothy Perri[†]

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Abstract

I model the allocation of power in organizations when individuals value power. Among the results is a greater value for power by individuals suggests that firms should share power more, moving away from either most power for bosses or most power for subordinates. Also, an increase in the number of subordinates tends to decrease power for a boss, at least when the boss has more power than subordinates, which explains observed behavior.

[†] Department of Economics, Appalachian State University, Boone, NC 28608. E-mail: perritj@gmail.com. I thank Mike Gibbs for extensive comments on earlier drafts. I thank Imran Arif, Dave Bruner, Dave McEvoy, Nat Wilcox, and participants in an economics department workshop at Appalachian State University for comments.

1. Introduction

Labor economists and industrial relations specialists have considered the gains to a firm from worker empowerment---managers shifting power or authority to subordinates. Gibbs *et al*. (2010) note the evidence of a trend in recent decades towards more multi-tasking, which implies more worker discretion and productivity. Gibbs (2022) considers how worker autonomy enhances learning, and how that relates to intrinsic motivation. Lazear (2012) argues that leaders choose the right direction for an organization, and then delegate authority. Freeman and Lazear (1995) analyze the effect on profit from power sharing with workers. The question then is how much power should be given to workers over decisions that affect the entire firm (Lazear, 1995).

U.S. evidence suggests workers have a great deal of autonomy. Maestas *et al*. (2017) describe the results of the 2015 American Working Conditions Survey. They find that 75% of workers can choose the order of their tasks, 72% can change methods of their work, 78% can choose the speed of their work, and 82% say their main job is solving unforeseen problems on their own.

In the social psychology literature, Hackman and Oldham (1974) suggest there are five key job dimensions, one of which is autonomy, which is defined as "…discretion of the employee in scheduling the work and in determining the procedures…in carrying it out."[1] Their autonomy is what I call power. A subordinate with discretion in performing his or her job has autonomy. I view this as more power for the subordinate, and less power for the subordinate's boss. Subordinates presumably value their power/autonomy, but a boss may value having control (power) over the subordinate.

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[1] Hackman and Oldham (1974), p. 9.

The first analysis of which I am aware of the value power by economists is Becker (1991).[2] Becker assumes individuals value power. He analyzes promotion tournaments in which power is fixed and rises at higher levels in a firm. I propose to treat power as a choice variable, and I do not consider a tournament. Prendergast and Topel (1996) argue that supervisors value their power to affect the welfare of their subordinates. They do not consider the allocation of power in an organization

Two recent experimental papers that deal with what can be called power are those of Owens *et al*. (2014) and Bartling *et al*. (2014). The former paper finds evidence individuals prefer to control their own payoffs, and will sacrifice earnings to maintain control. The latter paper finds that principals value decision rights. Neither paper considers that all agents (in particular managers and subordinates) value power, and that firms take account of subordinates' value for power when they decide how to allocate it.

Dessein and Holden (2021) consider a hierarchy when power or authority is valued and may be delegated. They are interested in how the value of power affects hierarchical structure, and when managers inefficiently hold on to power. Neither of those issues is considered in this paper. Also, Dessein and Holden assume that managers and workers do not respond to monetary incentives, and care only about power and the performance of the organization. In contrast, the tradeoff between power and monetary compensation is integral to my analysis of power sharing.

Finally, economists have considered job satisfaction. A recent example is the paper by Nikolova and Cnossen (2020). Job satisfaction may come from power, but it also comes from other aspects of the job. The allocation of power affects firm output and thus profit. If individuals

[2] Becker's paper was unpublished, and apparently was not distributed to others. It will be published in a volume of his unpublished papers (Elias *et al*., forthcoming).

value power, the allocation of power can affect profit via how much individuals must be paid. The more power they have, the lower their monetary compensation can be.

I do not argue that a value for power is the most important factor in determining how power is allocated in an organization. Rather, I simply assert that a value for power is an additional factor in determining the allocation of power, one that can help explain some observed behavior. I will show how a value for power affects how power is allocated between a boss and subordinates. Also, I will analyze how the number of employees affects the allocation of power. As best as I can tell, the latter issue has not been considered theoretically except in terms of span of control.

The outline of the rest of the paper is as follows. In Section 2, I consider a model in which power affects output and is valued by individuals. I show that a greater value for power tends to move a firm away from either little or a great deal of power sharing. The model is extended in Section 3 to consider the number of workers. This analysis provides an explanation for the observed relation between the number of employees and power sharing. Results are summarized in Section 4.

2. A model of a firm

A. The model with identical values for power

I consider a firm with a boss and one subordinate. In the next section, I extend the model to allow for multiple subordinates. There are likely decisions that cannot be delegated. Rosen (1982) suggests management involves what to produce and how to produce it. The boss may have to decide what to produce. Then delegating power to the subordinate would involve how to produce. I only deal with output that depends on how power is shared between the boss and the subordinate. The boss's total output is not considered.

I first describe the assumptions of the model. Later I discuss some of the assumptions. Let q equal the firm's output that depends on how power is shared. Product price is the numeraire. Let x equal power. Suppose the boss and the subordinate have the same value for power, v, with $v = \mathrm{v}(x)$, $v' > 0$, and $v'' \leq 0$, where primes denote partial derivatives. Let the boss's power equal p, and the subordinate's power equal $1–p$. Then $v(x) = v(p) \equiv v_B$ for the boss, and $v(x) = v(1\text{-}p) \equiv v_S$ for the subordinate.

Additionally, there is a common element in output of the boss and the subordinate, y, with $y(x)$, $y' > 0$, $y'' < 0$. Thus, for, a boss $y(x) = y(p) \equiv y_B$, and, for the subordinate, $y(x) = y(1\text{-}p) \equiv y_S$. I assume output equals $q = \alpha y_B + (1\text{-}\alpha)y_S$, where $0 \leq \alpha \leq 1$.

The boss is paid w_B, and the subordinate is paid w_S. Thus, profit, π, is given by:

$$\pi = q - w_B - w_S. \tag{1}$$

Let $\widehat{w}$ and $\widetilde{w}$ equal alternative earnings for the subordinate and the boss respectively. The application constraints for the subordinate and the boss are then:

$$w_S + v_S \geq \widehat{w}, \tag{2}$$

$$w_B + v_B \geq \widetilde{w}. \tag{3}$$

I assume the application constraints hold as equalities. Then I assume the firm chooses p to maximize profit, π,

$$\pi = q - w_B - w_S = q + v_S + v_B - \widehat{w} - \widetilde{w}, \tag{4}$$

using *eqs.* (2) and (3).

Consider two of the assumptions in the model. First, I assume the boss and subordinate have identical preferences for power. Dessein and Holden (2021) have the same assumption. Later, I consider the possibility all may not have the same taste for power. Second, the assumption of a separable production function does not change how the value for power affects the allocation of power. This assumption allows a straightforward analysis of how differences in the effect of power in production affect the allocation of power.[3] A multiplicative production function—Cobb-Douglas, for example---has ambiguous effects of differences in power in production. Since my focus is on how a value for power changes how power is allocated, I chose a simple production function.

Maximizing π with respect to p, we have:

$$\alpha y_B' - (1-\alpha) y_S' = v_S' - v_B'. \text{ (FOC)} \tag{5}$$

$$\alpha y_B'' + (1-\alpha) y_S'' + v_B'' + v_S'' < 0. \text{ (SOC)} \tag{6}$$

[3] Lazear (2019, p. 64) uses a separable production function in examining technological change.

The SOC holds because $y'' < 0$ and $v'' \leq 0$. When $p > ½$, the RHS of the FOC is positive. Thus, the LHS of the FOC is the net gain in output from a one unit increase in power for the boss. The RHS of the FOC is the net addition in wages that must be paid because reduced power of the subordinate is valued by v_S', and the increase in power to the boss is valued by v_B'. When $p < ½$, the RHS of the FOC is negative, so the LHS of the FOC reflects the net loss in output as p increases, and the RHS of the FOC is the net reduction in wages that must be paid as p increases.

Note, if power is not valued, then $\text{RHS}_{\text{eq.}(5)} = 0$, and the FOC yields $\frac{y_B'}{y_S'} = \frac{1-\alpha}{\alpha}$. Then we have $p \gtrless ½$ if $\alpha \gtrless ½$. Conversely, if power does not affect output, but is valued by individuals, then the $\text{LHS}_{\text{eq.}(5)} = 0$, so the FOC implies that $v_S' = v_B'$: power is equally shared ($p = ½$) because it is equally valued. For further insights, consider Propositions One and Two, which illustrate how and when a value for power affects a firm's allocation of power.

Proposition One. Valuing power does not affect the allocation of power unless $\alpha \neq ½$ and $v'' \neq 0$.

Proof. With $v' > 0$ but $v'' = 0$, the $\text{RHS}_{\text{eq.}(5)} = 0$ as long as the boss and subordinate have the same value for power. Again, for the FOC to hold, $\frac{y_B'}{y_S'} = \frac{1-\alpha}{\alpha}$.

Now suppose individuals value power and $v'' < 0$. If $\alpha = ½$, suppose $p = ½$. Then the $\text{LHS}_{\text{eq.}(5)} = ½(y_B' - y_S') = 0$. The FOC holds because the $\text{RHS}_{\text{eq.}(5)} = 0$.[4] Only if

[4] With $\alpha = ½$, could we have $p \neq ½$ and have the FOC hold if $v'' < 0$? No. If $p > ½$, the $\text{LHS}_{\text{eq.}(5)} < 0$ and the

$\alpha \neq ½$ and $v'' < 0$ does how much individuals value power affect p. This will be further demonstrated in the proof of Proposition Two. ☐

Proposition Two. If $v'' < 0$, $p \gtreqless ½$ if $\alpha \gtreqless ½$, *but a greater value for power lowers (raises) p when* α *exceeds (is less than) ½.*

Proof. Rewrite $v(x)$ as $\theta u(x)$, with $u' > 0$, $u'' < 0$, and $\theta > 0$. Also, rewrite $y(x)$ as $\psi z(x)$, with $z' > 0$, $z'' < 0$ and $\psi > 0$. Now the FOC is:

$$\psi[\alpha z_B' - (1-\alpha)z_S'] + \theta(u_B' - u_S') = 0. \tag{5'}$$

Totally differentiate *eq*.(5'):

$$\text{SOC}dp + (y_B' + y_S')d\alpha + [\alpha z_B' - (1-\alpha)z_S']d\psi + (u_B' - u_S')d\theta = 0. \tag{7}$$

Then we have:

$$\frac{dp}{d\alpha} = \frac{y_B' + y_S'}{-SOC} > 0, \tag{8}$$

$RHS_{eq.(5)} > 0$ with $v'' < 0$: it is optimal to lower p. If $p < ½$, the $LHS_{eq.(5)} > 0$ and the $RHS_{eq.(5)} < 0$: it is optimal to raise p.

$$\frac{dp}{d\theta} = \frac{u_B' - u_S'}{-SOC}, \tag{9}$$

$$\frac{dp}{d\psi} = \frac{\alpha z_B' - (1-\alpha) z_S'}{-SOC}. \tag{10}$$

I have shown that $p = ½$ if $\alpha = ½$. Thus, with $\frac{dp}{d\alpha} > 0$, we have $p > ½$ if $\alpha > ½$, and $p < ½$ if $\alpha < ½$. Now $\frac{dp}{d\theta} > 0$ if $u_B' > u_S'$, or if $p < ½$. Similarly, $\frac{dp}{d\theta} < 0$ if $\alpha > ½$ and $p > ½$. Thus, a greater value for power ($d\theta > 0$) reduces (increases) p when α exceeds (is less than) ½, meaning a greater value for power implies more sharing of power.[5] This result is due to the concavity of the value of power function. ☐

Consider an increase in power to the boss when $p > ½$. With no value for power by anyone, all that would be considered is the effect on output and thus profit. Now assume a positive value for power with the marginal value of power decreasing in power. The marginal value of power is greater for the subordinate than it is for the boss when $p > ½$. Thus, increasing power to the boss requires an increase in the wage for the subordinate that exceeds the increased value of power to the boss. Via the application constraints, the higher wage for the subordinate would mean the boss's wage is reduced more than the increased value of power to the boss. This effect attenuates the incentive to increase power for the boss. The opposite happens if $p < ½$ and the subordinate's power increases. Thus, an increased value for power tends to reduce the incentive to give either the boss or the subordinate a lot of power.

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[5] Could a large enough value for θ result in $p < ½$ when $\alpha > ½$, or $p > ½$ when $\alpha < ½$? No. Consider the FOC (*eq.*(5)). If $p \leq ½$ and $\alpha > ½$, the LHS > 0 and the RHS ≤ 0, implying it is optimal to raise p. If $p \geq ½$ and $\alpha < ½$, the LHS < 0 and the RHS ≥ 0, implying it is optimal to lower p. Thus a larger value for power pushes p towards ½, but it is always the case that $p > ½$ if $\alpha > ½$, and $p < ½$ if $\alpha < ½$

Dessein and Holden (2021) consider a case when the manager is also the designer of the organizational structure. They find that, for lower values of power, an increase in the value of power leads to less delegation of power to workers. At greater values for power, an increase in the value of power *often* leads to more delegation of power to workers. Thus, with a different model and focus, their predictions are roughly similar to mine.

Now consider an increase in the value of power in production, $d\psi > 0$. Concavity in production might suggest an effect for ψ similar to what was found for θ. Note that the [•] term in the FOC (*eq*.(5')) is the same as the numerator in $\frac{dp}{d\psi}$. If $p > ½$, the second term in the FOC is negative, so [•] is positive. If $p < ½$, the second term in the FOC is positive, so [•] is negative. Thus, when $p > ½$, $\frac{dp}{d\psi} > 0$, and, when $p < ½$, $\frac{dp}{d\psi} < 0$. A larger value of power in production optimally allocates more power to the agent for whom power is more valuable---the boss if $\alpha > ½$, and the subordinate if $\alpha < ½$. The weights α and $1-\alpha$ outweigh concavity, so that, other things equal, a greater value for power in production leads to more extreme allocations of power, away from $p = ½$.

B. Workers value power more than bosses do

In most of this paper I assume 1) a boss and subordinates have the same value for power, $v(x)$, with x = power, and 2) the marginal value for power does not increase with more power ($v'' \leq 0$). Consider the first point. One argument is that a subordinate may value power more than a boss, for the same value of power. The point is there is more value for controlling one's actions than for another controlling someone's actions. Thus, for any amount of power, suppose subordinates value power more than a boss: $v_S(x) > v_B(x)$.

Again suppose there is one subordinate. If $p > ½$, the RHS of the FOC (*eq*.(5)), $v_S' - v_B'$, is larger when $v_S(x) > v_B(x)$. Thus, for the FOC to hold, p must be even smaller than when $v_S(x) = v_B(x)$. This reinforces the previous argument that a greater value for power increases power for the subordinate ($dp < 0$) when $p > ½$.

If $p < ½$, we have two opposing effects. Concavity of v implies that $v_S' < v_B'$, but a greater value for power for subordinates, given the level of power, implies the opposite. If the first effect dominates, then the analysis in the text is unchanged: with one subordinate and $p < ½$, a greater value for power causes p to increase. If the second effect dominates, a greater value for power induces more power for the subordinate $\forall p$.[6]

C. Increasing marginal value for power

Now consider what happens if the value of power is the same for a boss and subordinates but $v'' > 0$. This might be the case if power is addictive. Although a complete analysis of addiction requires a multi-period model, one might consider an individual who is power hungry to be addicted: the more power the individual gets, the greater the individual's marginal value for power.

[6] A power-hungry boss might value power more than a subordinate. In that case, when $p > ½$, the boss's high value for power has the opposite effect of diminishing value of power, where the latter implies $v_B < v_S$. Thus, it is possible (*eq*.(9)) that an increase in the value of power (by boss and subordinate) might result in more power for the boss. When $p < ½$, the greater value of power for the boss reinforces diminishing marginal values of power, so an increase in the value of power still leads to more power for the boss.

There are two problems that occur if $v'' > 0$. First, the SOC may not hold. This condition (*ineq*.(6)) is $\alpha y_B'' + (1-\alpha)y_S'' + v_B'' + v_S'' < 0$. The SOC only holds if output is sufficiently concave. Second, in the model of a firm with multiple employees (Section 3), with *n* the number of employees, in one case we have $\frac{dp}{dn} = \frac{v_B' - v_S'}{-SOC}$ (*eq*.(11)). When, for example, $p > ½$, if $v'' > 0$, $\frac{dp}{dn} > 0$ which means there is less power sharing as the number of employees increases. This is the opposite of what has usually been found empirically (Section 3). Also, Horowitz *et al*. (2007) find strong experimental evidence for diminishing marginal value of goods. It is not clear why power should be any different.

3. Multiple Employees

A. Theory

I have considered a sole subordinate. Now consider multiple employees, *n*. If power can only be delegated to the next level, then, in the model herein, *n* represents the number of individuals who report to the boss----the span of control of the boss. Alternatively, if power can be delegated from the top to all levels, then *n* represents the number of employees in the firm.

Ignoring the value of power to individuals, an increase in *n* that means greater span of control for the boss means more time is taken by the boss in supervision.[7] This suggests more power should be delegated to the subordinates because it is more costly to supervise them as *n* increases. Suppose division heads report to the boss, and a new division is created with *m* individuals. Now the span of control for the boss has increased by one, with implications

[7] Lazear and Gibbs (2015), p. 146.

discussed above. However, the increase of m in the number of employees has no obvious effect on the allocation of power.

Suppose there are n employees and one boss. Previously, if $\alpha = p = ½$, output of the boss equaled output of the subordinates. To keep that the same, I now assume that output of each subordinate equals $\frac{(1-\alpha)}{n} y_S$, again with $y(1\text{-}p) \equiv y_S$. Thus, total output of subordinates is $(1\text{-}\alpha)y(1\text{-}p)$, the same as before, and q is the same as before. With this assumption, the number of subordinates does not affect the allocation of power via the production function.

Whereas a subordinate cares about the power he or she has, it is not clear if the value of power for the boss is positively related to n. A boss may have a strong preference for power, one in which the value of power is linear in the number of subordinates and equals $nv(p) = nv_B$. A moderate preference for power is one in which the marginal value for power is positive but decreasing in n. Finally, it is possible that the number of employees has no effect on a boss's value for power. In the latter case, a boss simply cares about how much he or she controls decisions, regardless of how many subordinates are affected by those decisions.

I begin with the case when the boss's power equals $nv(p) \equiv nv_B$. This specification means that, as before with one subordinate, with $p = ½$, the value of power for the boss equals that for the subordinates. The case when the power of the boss increases at a decreasing rate in n has similar results, but with some ambiguity, and is considered below.

Now the application constraint (*eq*.(2)) for subordinates is unchanged, but there are n of them. If the application constraints bind, profit equals $q + n(v_S + v_B - \hat{w} - \tilde{w})$. The FOC is $\alpha y_B' - (1\text{-}\alpha) y_S' + n[v_B' - v_S'] = 0$. Totally differentiating the FOC w.r.t. p and n:

$$\frac{dp}{dn} = \frac{v_B' - v_S'}{-SOC} . \qquad (11)$$

Clearly, $\frac{dp}{dn} < 0$ if $p > ½$, which is the case when $\alpha > ½$, and $\frac{dp}{dn} > 0$ if $p < ½$, which is the case when $\alpha < ½$. Thus, a larger number of employees implies more power sharing (p moves towards ½). The reason for this result is that a larger value for n increases the effect of concavity. If $p > ½$, $v_B' < v_S'$. Then an increase in p means the increase in wages that must be paid to the subordinates is nv_S', and the boss can be paid nv_B' less, so the net increase in wages is $n(v_B' - v_S')$. If $p < ½$, the opposite effect occurs. Thus, more employees mean moving closer to $p = ½$.

If n represents span of control for the boss, then a value for power reinforces the effect discussed above---more time taken by the boss in supervision suggests more power should be delegated by the boss. However, if n represents total employees at a firm, then a value for power offers an explanation for why more power would be delegated when $p > ½$ if the number of employees of a firm increases.

Now suppose the marginal value of power for a boss decreases in n. Then $v_B = v(np)$,

$v_B' = \frac{\partial v}{\partial (np)} > 0$, and $v_B'' < 0$. The FOC is the same as before: $\alpha y_B'$ - $(1-\alpha)y_S'$ + $n[v_B'$ - $v_S'] = 0$.

With an identical function, $v(\bullet)$, for boss and subordinates for power, equal power for the boss and one subordinate requires that $np = 1-p$, or $p = \frac{1}{n+1}$.

Suppose $\alpha = ½$. If $p = \frac{1}{n+1}$, $v_B' = v_S'$, but $y_B' > y_S'$, so the FOC > 0, implying that p must increase. If $p = ½$, $v_B' < v_S'$, $y_B' = y_S'$, and the FOC < 0, implying that p must decease. Thus, if

$n > 1$ and $\alpha = ½$, we must have $\frac{1}{n+1} < p < ½$ for the FOC to hold, which means more power is allocated to subordinates than in the case when the boss's value for power is linear in power. This would be expected because power now has diminishing marginal value for a boss. Totally differentiating the FOC w.r.t. p and n yields:

$$\frac{dp}{dn} = \frac{v_B' - v_S' + npv_B''}{-SOC}, \tag{12}$$

which is negative if $\frac{1}{n+1} < p$. Then $\frac{dp}{dn} < 0$ even for some range of $p < ½$. This finding means it is more likely the amount of power given to subordinates is positively related to the number of a firm's employees.

Finally, if the boss's value of power is independent of n, then $\frac{dp}{dn} = \frac{v_S'}{SOC} < 0 \ \forall p$. In this case, it pays to deliver more power to subordinates as their number increases, regardless of the level of power, because there are more subordinates who can be paid less as each gets more power.

B. Discussion

Smeets (2017) summarizes evidence that suggests that, in the last thirty years, there has been greater span of control and more delegation of authority at firms. Also, managers at larger firms supervise more individuals, and decisions are less centralized at these firms. Whether more power sharing is due to a greater span of control, more employees, or both is not clear.

Thus, hierarchical layers appear to have been reduced in firms over time. This change may have been due to changes in information technology. My model does not explain *why* this change occurred. Rather, I show that 1) if span of control has increased due to flattened firm hierarchies, a value for power may be *a reason*---in addition to greater costs of supervision---for more power sharing with subordinates. Also, 2) *given* a firm's span of control, more employees may lead to more power given to subordinates. Both 1 and 2 should occur at least when the boss initially has more power than subordinates.

Rajan and Wulf (2006) consider U.S. firms that were leaders in their sectors in 1986 and 1998. They find that the number of managers reporting to the CEO grew from an average of 4.2 to an average of 8.2., meaning span of control increased. The number of positions between the CEO and division heads had fallen by 25% on average, with a tripling in the number of division heads reporting to the CEO. The evidence is that the authority of division heads increased. For these firms, average firm size did not increase over time, so the effect of n seems to be that of span of control.

Colombo and Delmastro (1999) examine Italian metal working plants. They find that plants had decentralized decision making over the period from 1975 to 1997. Decision making was more centralized the smaller the plant size. Bloom *et al*. (2012) use data from almost 4,000 firms in the U.S., Europe, and Asia. They find more delegation of authority as both plant and firm size increase. In Colombo and Delmastro, a larger n reflects neither more span of control nor a larger *firm* size, but *plant* size is closer to firm size than it is to span of control. My model predicts a larger firm size will result in more delegation of power, at least when the boss has the most power ($p > ½$), and possibly even when workers have the most power ($p < ½$), which is consistent with the results in Colombo and Delmastro and in Bloom *et al*. In contrast, McElhern

(2014) finds that allocation of authority in IT investments is not related to plant size, and larger firm size results in *less* delegation of authority.

4. Summary

There are two predictions based on my analysis of power. First, a greater value for power by individuals suggests that firms should share power more, moving away from either most power for bosses or most power for subordinates. This result is due to concavity in the value for power function. Second, an increase in the number of subordinates will tend to decrease power for a boss, at least when the boss has more power than subordinates. If the number of subordinates means the number directly controlled by a boss, my results reinforce other analysis.

Colombo and Delmastro (1999) and Bloom *et al*. (2012) find that a larger plant size implies more delegation of authority, and the latter find the same relation for firm size. My theoretical analysis shows that more workers increase the effect of concavity in the value for power function. This result only trivially requires increased span of control (Section 3 herein), and appears to be novel.

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