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The role of managerial work in market performance: A monopoly model with team production

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A Monopoly Model with Team Production**

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**The Role of Managerial Work in Market Performance:
A Monopoly Model with Team Production ***

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December 18, 2013

Abstract: A monopolist is treated as a nexus of contracts with team production. It has one owner-manager. The owner-manager is the employer of two employees. A team production problem is present if the employer is a “managerial lemon”. If the team production problem is solved, the employer is a “managerial hotshot”. Both a managerial hotshot and a managerial lemon are found to make profit. Managerial slack can therefore exist in our monopoly market. In the case of a managerial lemon, the profit level is lower. However, the employees’ utility level is higher. Whereas the employer has an incentive to improve management capability in principle, the employees have an incentive to keep management capability low. Moreover, the cost of improving management capability may be prohibitively high. Managerial slack can therefore persist. The predicted behavior of the monopolist is grounded in individual behavior under the assumption of utility maximization.

Keywords: firm organization, market structure, property rights

Journal of Economic Literature classification codes: C7, D2, D4, L1, L2

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INTRODUCTION

In neoclassical economics, firms are regarded as single decision makers. Just as households (individuals) maximize their utilities, so they maximize their profits. In industrial organization (IO), firms are typically assumed to be large, especially when it comes to monopoly theory. Although large firms always have a nontrivial organizational structure, they are usually treated in the neoclassical way (see, e.g., Tirole 1988, 4; Scherer and Ross 1990, 38, 52; Shy 1995, 71). For example, the neoclassical monopoly model is part and parcel of every textbook on IO (see also West 2008) and, of course, of almost every textbook on microeconomic theory (see, e.g., Kreps 1990; Varian 1992; Schotter 1994; Mas-Colell et al. 1995). It is taught everywhere. We also teach it in agribusiness management and business administration classes. However, we do not feel comfortable with it for two reasons. First, a violation of methodological individualism is committed if organizational problems are present. In this instance, the profit-maximizing behavior of a firm, which is predicted by the neoclassical monopoly model, is not grounded in individual behavior under the assumption of utility maximization. The actual behavior of the firm, which is observed, is X-inefficient (see Leibenstein 1966).¹ Second, if the behavior of a firm is X-inefficient, the neoclassical monopoly model does not allow for an examination of this matter. This situation appears to be problematic, because X-inefficiency due to managerial slack is especially expected in monopoly markets as a result of no competitive pressure (see, e.g., Hicks 1935; Machlup 1967; Posner 1975).

Leibenstein (1966, 407) lists “four reasons why given inputs cannot be transformed into predetermined outputs: (a) contracts for labor are incomplete, (b) not all factors of production are marketed, (c) the production function is not completely specified or known, and (d) interdependence and uncertainty lead competing firms to cooperate tacitly with each other in some respects, and to imitate each other with respect to technique, to some degree.” For Leibenstein, organizational problems are caused by these reasons, and managers are problem solvers (see also Mintzberg 1973). Managers have to solve organizational problems by choosing a suitable organizational structure. Thereto, they need knowledge and motivation.

In the following, we focus on (a) and (b). A production function will be given and known. There will be no competing firms.²

Holmstrom and Tirole (1989) discuss institutional theories of the firm. They show how the behavior of a firm is affected by the organizational structure (see also Arrow 1974, 45-60; Furubotn and Richter 2005, 361-469). In institutional economics, the organizational structure is seen as a nexus of contracts (contractual view). In the light of the contractual view, the profit-maximizing behavior of a firm can be interpreted as a consequence of the organizational structure transforming utility-maximizing behavior in the firm into profit-maximizing behavior in the market (see Albert and Hildenbrand 2012; also Hildenbrand 2013). The role of managerial work is then to create a suitable contractual nexus. Depending on the level of capability and the cost of managerial effort, managers are either capable or not capable of choosing and either willing or not willing to choose such an organizational structure.

In our model, a monopolist is treated as a nexus of contracts with team production (see Alchian and Demsetz 1972). It has one owner-manager. The owner-manager is the employer of two employees. If a team production problem is present, we call the employer a “managerial lemon”. If the team production problem is solved, the employer is called a “managerial hotshot” (see also Holmstrom 1982). Because the cost of managerial effort is assumed to be constant, the question of capability and cost is just a question of capability. The team production problem is solved if the employer is capable of solving it. The employer holds the residual claim and offers an overall revenue share to the employees. Regardless of whether the employer is a managerial hotshot or a managerial lemon, he/she is capable of calculating the optimal revenue share. In other words, a managerial lemon is boundedly rational in the sense that he/she takes an organizational structure as given (see also Simon 2008).

As a result, both a managerial hotshot and a managerial lemon are found to make profit. Managerial slack can therefore exist in our monopoly market. In the case of a managerial lemon, the optimal revenue share is higher, and the profit level is lower. However, the employees’ utility level is higher. Whereas the employer has an incentive to improve management capability in principle, the employees have an incentive to keep management capability low. Moreover, the cost of improving management capability may be prohibitively high. Managerial slack can therefore persist. As another result, no violation of methodological individualism is committed regardless of whether organizational problems are absent or present. The predicted behavior of the monopolist is grounded in individual behavior under the assumption of utility maximization.

MODEL

Market Structure

In our model, a monopolist produces a homogeneous good.³ The monopolist faces a linear inverse demand function relating price p to quantity q with intercept a and slope b :

$$p(q) = a - b q, a > b q > 0.$$

Because $a > b q > 0$, the price is positive for all market conditions.

The linear inverse demand function is continuous and differentiable. The higher the quantity is, the lower the price will be:

$$\frac{dp(q)}{dq} = -b.$$

Organizational Structure

The monopolist has one owner. The owner is the employer of two employees. Employee $j = 1, 2$ chooses effort level $e_j \in \mathbb{R}_+$. The employees act simultaneously. Both effort levels determine the quantity:

$$q(e_1, e_2) = \sqrt{e_1} \sqrt{e_2}.$$

For the inverse demand function given above, it follows that $p[q(e_1, e_2)] = a - b \sqrt{e_1} \sqrt{e_2}$.

Employee j has a linear effort cost function:

$$c(e_j) = c e_j, c > 0.$$

The employer offers an overall revenue share to the employees:

$$s \in (0,1).$$

Because the employees are assumed to be identical, they are assumed to divide the overall revenue share equally (see, e. g., Homans, 1961):

$$s_j = \frac{s}{2}.$$

Moreover, the employees are assumed to be already employed. Therefore, we can neglect a fixed salary in addition to the variable payment. In a nutshell, we assume the outside option for the employees to be zero. Therefore, employees will accept a wage with a fixed salary of zero if the employees' utility is nonnegative.

It follows that employee j 's wage is

$$w_j(e_1, e_2, s) = (s/2) p[q(e_1, e_2)] q(e_1, e_2),$$

and he/she achieves utility

$$u_j(e_1, e_2, s) = w_j(e_1, e_2, s) - c(e_j).$$

The overall utility is $u(e_1, e_2, s) = u_1(e_1, e_2, s) + u_2(e_1, e_2, s)$.

The employer's profit is

$$\pi(e_1, e_2, s) = (1 - s) p[q(e_1, e_2)] q(e_1, e_2).$$

MARKET PERFORMANCE WITH A MANAGERIAL LEMON

A managerial lemon is not capable of solving the organizational problem. Here, the organizational problem manifests itself in a team production problem:

$$\frac{\partial^2 q(e_1, e_2)}{\partial e_1 \partial e_2} > 0.$$

If the employer is a managerial lemon, the team production problem will not be solved, because he/she is not capable of solving it. Employee j maximizes $u_j(e_1, e_2, s)$:

$$\max_{e_j} \{(s/2) (a - b \sqrt{e_1} \sqrt{e_2}) (\sqrt{e_1} \sqrt{e_2}) - c e_j\}.$$

His/her reaction function is given by

$$r_j(e_{3-j}, s) = \frac{a^2 s^2 e_{3-j}}{4 (2c + b s e_{3-j})^2}.$$

Each employee's effort choice is dependent on the other employee's effort choice. Because the employees are identical, they will choose identical effort levels. If $r_1(e_2, s)$ and $r_2(e_1, s)$ are simultaneously solved, the Nash equilibrium effort choices are obtained. They are given by

$$e_j^{ml} = \frac{a s - 4 c}{2 b s}.$$

If $s > (4 c)/a$, then $e_j^{ml} \in \mathbb{R}_+$. Therefore, the higher the marginal cost of effort is, the higher the overall revenue share must be. Because $s \in (0,1)$, $e_j^{ml} \in \mathbb{R}_+$ if $a > 4 c$. Condition $a > 4 c$ holds if the intercept parameter of the inverse demand function (market size) is greater than four times marginal cost of effort. In other words, the market size has to be sufficiently large.

The corresponding quantity and price are given by

$$q^{ml} = q(e_1^{ml}, e_2^{ml}) = \frac{a s - 4 c}{2 b s} \text{ and } p^{ml} = p(q^{ml}) = \frac{a s + 4 c}{2 s}.$$

The optimal price is independent of the slope parameter. The higher the marginal cost of effort is, the lower the quantity and the higher the price will be.

The Nash equilibrium utility levels are given by

$$u_j^{ml} = u_j(e_1^{ml}, e_2^{ml}, s) = \frac{a^2 s - 4 a c}{8 b}.$$

The corresponding profit level is given by

$$\pi(e_1^{ml}, e_2^{ml}, s) = (1 - s) \left(a - b \sqrt{e_1^{ml}} \sqrt{e_2^{ml}} \right) \left(\sqrt{e_1^{ml}} \sqrt{e_2^{ml}} \right) = \frac{(1-s)(a s - 4 c)(a s + 4 c)}{4 b s^2}.$$

The employer maximizes $\pi(e_1^{ml}, e_2^{ml}, s)$:

$$\max_s \left\{ \frac{(1-s)(a s - 4 c)(a s + 4 c)}{4 b s^2} \right\}.$$

The optimal revenue share is given by

$$s^{ml} = \frac{2 \cdot 2^{1/3} [2 \cdot 6^{1/3} a^2 c^2 - (\sqrt{81 a^8 c^4 + 48 a^6 c^6 - 9 a^4 c^2})^{2/3}]}{3^{2/3} a^2 (\sqrt{81 a^8 c^4 + 48 a^6 c^6 - 9 a^4 c^2})^{1/3}}.$$

Just as the optimal price is independent of the slope parameter, so the optimal revenue share does not depend on b . For a given value of a , s^{ml} increases with c : The higher the marginal cost of effort is, the higher the optimal revenue share will be. This is shown in Figure 1 for $a = 10$.

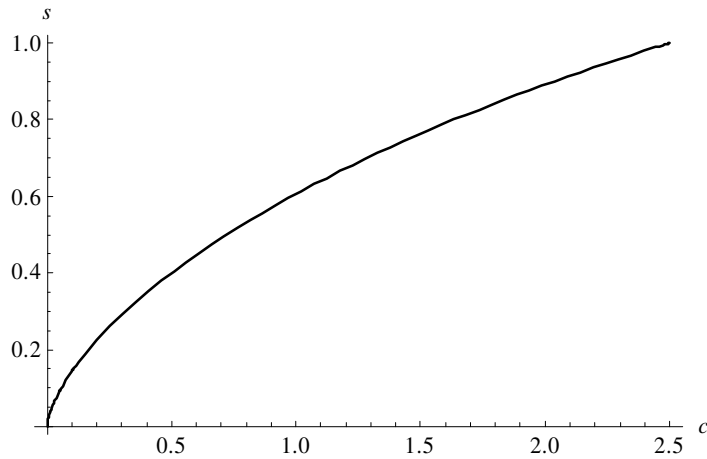


Figure 1: Optimal revenue share as a function of marginal cost of effort for $a = 10$.

The corresponding profit level is given by

$$\pi^{ml} = \pi(e_1^{ml}, e_2^{ml}, s^{ml}).$$

For given values of a and b , π^{ml} decreases with c : The higher the marginal cost of effort is, the lower the profit level will be. This is shown in Figure 2 for $a = 10$ and $b = 1/2$.

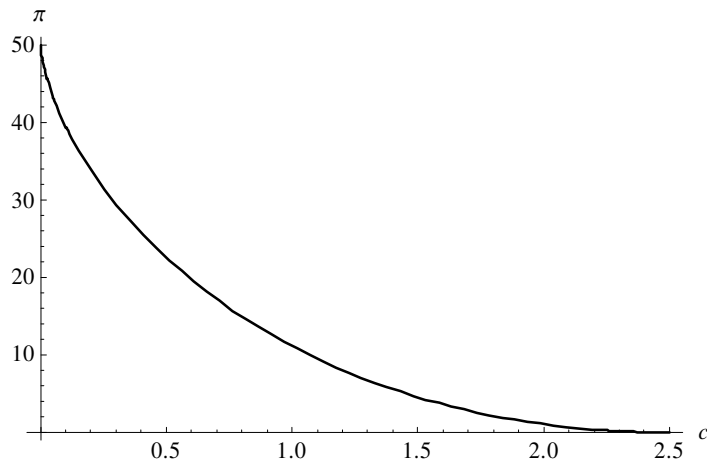


Figure 2: Profit level as a function of marginal cost of effort for $a = 10$ and $b = 1/2$.

Only if $c < 5/2$, the employer earns a positive profit: $\pi^{ml} = 0$ if $c = 5/2$.

For $a = 10$, $b = 1/2$, and $c = 1$, the optimal revenue share and the corresponding profit level can be easily calculated.⁴

In the example, the employer maximizes $\pi(e_1^{ml}, e_2^{ml}, s)$ with $e_j^{ml} = \frac{10s-4}{s}$ (see Figure 3):

$$\max_s \left\{ 50 - \frac{8}{s^2} + \frac{8}{s} - 50s \right\}.$$

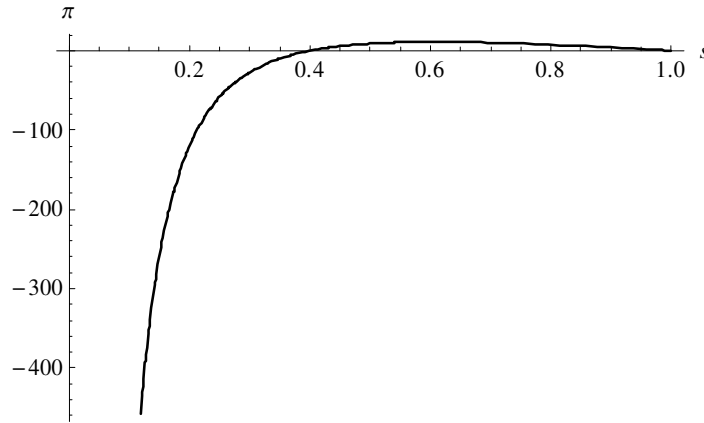


Figure 3: Profit level as a function of overall revenue share for $a = 10$, $b = 1/2$, and $c = 1$.

The optimal revenue share is given by

$$s^{ml} \approx 0.61.$$

The corresponding overall utility level and profit level are given by

$$u^{ml} = u(e_1^{ml}, e_2^{ml}, s^{ml}) = 10.32 \text{ and } \pi^{ml} = \pi(e_1^{ml}, e_2^{ml}, s^{ml}) \approx 11.12.$$

To sum up, the optimal revenue share is about 61 percent. The managerial lemon earns about 11 monetary units.

MARKET PERFORMANCE WITH A MANAGERIAL HOTSHOT

A managerial hotshot is capable of solving the organizational problem.

If the employer is a managerial hotshot, the team production problem will be solved, because he/she is capable of solving it.⁵ The employees maximize $u(e_1, e_2, s)$:

$$\max_{e_1, e_2} \{ s (a - b \sqrt{e_1} \sqrt{e_2}) (\sqrt{e_1} \sqrt{e_2}) - c e_1 - c e_2 \}.$$

The equilibrium effort choices are given by

$$e_j^{mh} = \frac{a s - 2 c}{2 b s}.$$

If $s > (2 c)/a$, then $e_j^{mh} \in \mathbb{R}_+$. Again, the higher the marginal cost of effort is, the higher the overall revenue share must be. Because $s \in (0,1)$, $e_j^{mh} \in \mathbb{R}_+$ if $a > 2 c$. Condition $a > 2 c$ holds if the market size is greater than two times marginal cost of effort. Again, the market size has to be sufficiently large. However, this condition is not as strict as the condition in the case of a managerial lemon. Therefore, a managerial hotshot is able to operate in markets, which are too small for a managerial lemon.

The corresponding quantity and price are given by

$$q^{mh} = q(e_1^{mh}, e_2^{mh}) = \frac{a s - 2 c}{2 b s} \text{ and } p^{mh} = p(q^{mh}) = \frac{a s + 2 c}{2 s}.$$

The optimal price is independent of the slope parameter. The higher the marginal cost of effort is, the lower the quantity and the higher the price will be. In comparison to the case of a managerial lemon, the quantity is higher, and the price is lower. Therefore, the welfare loss is smaller.

The equilibrium utility levels are given by

$$u_j^{mh} = u_j(e_1^{mh}, e_2^{mh}, s) = \frac{(a s - 2 c)^2}{8 b s}.$$

The corresponding profit level is given by

$$\pi(e_1^{mh}, e_2^{mh}, s) = (1 - s) \left(a - b \sqrt{e_1^{mh}} \sqrt{e_2^{mh}} \right) \left(\sqrt{e_1^{mh}} \sqrt{e_2^{mh}} \right) = \frac{(1-s)(a s - 2 c)(a s + 2 c)}{4 b s^2}.$$

In the case of a managerial lemon, both the profit level and the overall utility level are lower for all the same revenue shares. In other words, if a managerial lemon and a managerial hotshot provided the same revenue share, the employer and the employees would be always better off. However, because a managerial hotshot provides a lower revenue share, the employees are worse off.

The employer maximizes $\pi(e_1^{mh}, e_2^{mh}, s)$:

$$\max_s \left\{ \frac{(1-s)(a s - 2c)(a s + 2c)}{4 b s^2} \right\}.$$

The optimal revenue share is given by

$$s^{mh} = \frac{2 \cdot 6^{2/3} a^2 c^2 - 2^{2/3} (\sqrt{81 a^8 c^4 + 12 a^6 c^6 - 9 a^4 c^2})^{2/3}}{3^{2/3} a^2 (\sqrt{81 a^8 c^4 + 12 a^6 c^6 - 9 a^4 c^2})^{1/3}}.$$

Just as the optimal price is independent of the slope parameter, so the optimal revenue share does not depend on b . For a given value of a , s^{mh} increases with c : The higher the marginal cost of effort is, the higher the optimal revenue share will be. This is shown in Figure 4 for $a = 10$.

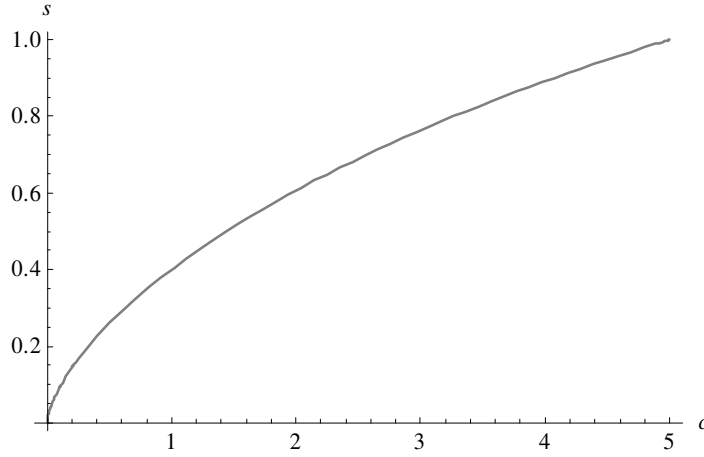


Figure 4: Optimal revenue share as a function of marginal cost of effort for $a = 10$.

The corresponding profit level is given by

$$\pi^{mh} = \pi(e_1^{mh}, e_2^{mh}, s^{mh}).$$

For given values of a and b , π^{mh} decreases with c : The higher the marginal cost of effort is, the lower the profit level will be. This is shown in Figure 5 for $a = 10$ and $b = 1/2$.

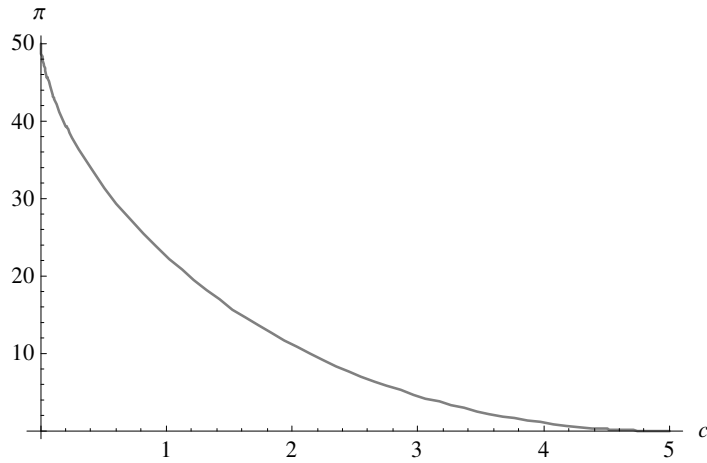


Figure 5: Profit level as a function of marginal cost of effort for $a = 10$ and $b = 1/2$.

Only if $c < 5$, the employer earns a positive profit: $\pi^{mh} = 0$ if $c = 5$. In comparison to the case of a managerial lemon, a managerial hotshot can better bear the marginal cost of effort.

For $a = 10$, $b = 1/2$, and $c = 1$, the employer maximizes $\pi(e_1^{mh}, e_2^{mh}, s)$ with $e_j^{mh} = \frac{10s-2}{s}$ (see Figure 6):

$$\max_s \left\{ 50 - \frac{2}{s^2} + \frac{2}{s} - 50s \right\}.$$

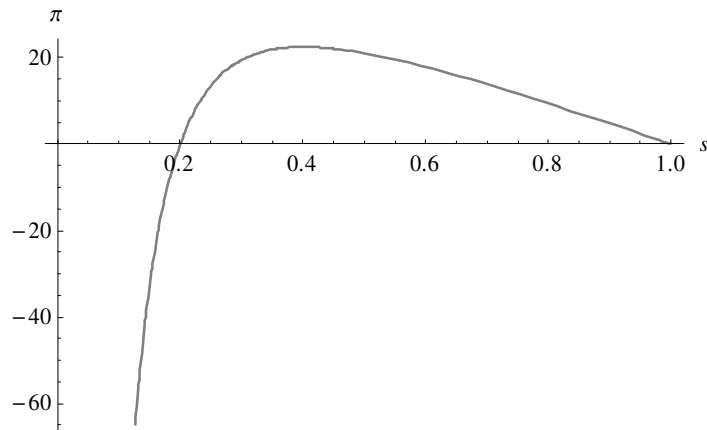


Figure 6: Profit level as a function of overall revenue share for $a = 10$, $b = 1/2$, and $c = 1$.

In the example, the optimal revenue share is given by

$$s^{mh} = 0.40.$$

The corresponding overall utility level and profit level are given by

$$u^{mh} = u(e_1^{mh}, e_2^{mh}, s^{mh}) = 5.00 \text{ and } \pi^{mh} = \pi(e_1^{mh}, e_2^{mh}, s^{mh}) = 22.50.$$

To sum up, the optimal revenue share is 40 percent. The managerial lemon earns about 23 monetary units. In comparison to the case of a managerial lemon, a managerial hotshot offers a lower revenue share and earns more profit. The employees are worse off.

COMPARISON AND DISCUSSION

As a result, both a managerial hotshot and a managerial lemon are found to make profit. Managerial slack can therefore exist in our monopoly market. However, a managerial hotshot earns more profit than a managerial lemon. This is shown in Figure 7 for the example. Profit levels are expressed as functions of overall revenue share. In the case of a managerial lemon (illustrated by the black curve in Figure 7), the profit level is lower for all the same revenue shares. However, because both a managerial hotshot and a managerial lemon are capable of calculating the optimal revenue share, equilibrium revenue shares differ. Because a managerial hotshot offers a lower revenue share, he/she earns all the more profit. The employer is better off if he/she is a managerial hotshot.

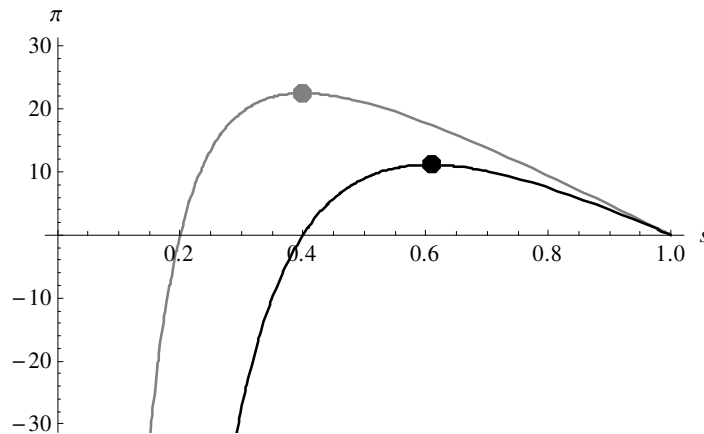


Figure 7: Profit levels as functions of overall revenue share for $a = 10$, $b = 1/2$, and $c = 1$.

Therefore, the employer has an incentive to improve management capability in principle. If the cost of training and development is not prohibitively high, a managerial lemon will, *ceteris paribus*, participate in training and development activities. In the example, the cost of improving management capability must not exceed 11.38 monetary units. However, the *ceteris paribus*

assumption may be critical, because an intra-firm conflict is present if a managerial lemon wants to become a managerial hotshot. The employees will be worse off. This is shown in Figure 8. Overall utility levels are expressed as functions of overall revenue share. In the case of a managerial lemon (illustrated by the black line in Figure 8), the overall utility level is higher, because a higher revenue share is offered. The employees are better off if the employer is a managerial lemon.

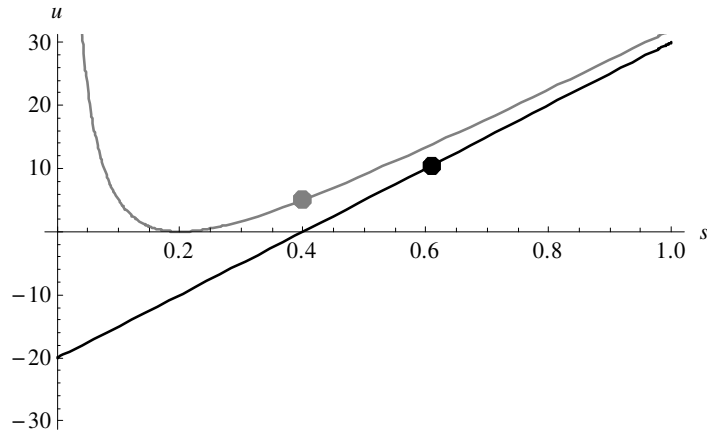


Figure 8: Overall utility levels as functions of overall revenue share for $a = 10$, $b = 1/2$, and $c = 1$.

As another result, the predicted behavior of the monopolist is grounded in individual behavior under the assumption of utility maximization. No violation of methodological individualism is committed. If the monopolist were treated in the neoclassical way, the market performance would be completely different. The monopolist would maximize $\pi(e_1, e_2)$:

$$\max_{e_1, e_2} \{p[q(e_1, e_2)] q(e_1, e_2) - c(e_1) - c(e_2)\}.$$

The equilibrium effort choices would be given by

$$e_j^{nw} = \frac{a-2c}{2b}.$$

The corresponding quantity and price would be given by

$$q^{nw} = \frac{a-2c}{2b} \text{ and } p^{nw} = \frac{2+2c}{2}.$$

The equilibrium profit level would be given by

$$\pi^{nw} = \frac{(a-2c)^2}{4b}.$$

In comparison to both the case of a managerial lemon and the case of a managerial hotshot, the quantity is higher, and the price is lower. Therefore, the welfare loss would be underestimated. In the example, $q^{nw} = 8 > q^{mh} > q^{ml}$, $p^{nw} = 2 < p^{mh} < p^{ml}$, and $\pi^{nw} = 32 > \pi^{mh} > \pi^{ml}$. The result of the neoclassical way is equivalent to the result with a managerial hotshot, who offers an overall revenue share of 100 percent.⁶ However, no employer will offer such an overall revenue share. If the whole revenue were offered to the employees, nothing would be left for the employer. In this case, there would be no employer or, generally speaking, third party. However, if there were no third party, the team production problem could not be solved. Consequently, the neoclassical prediction about the behavior of the monopolist would be incorrect again. No matter how you look at it, the neoclassical way is problematic if organizational problems are present.

CONCLUSION

The employees are not interested in improving management capability, because they are better off with a managerial lemon. Quite the contrary, the employees have an incentive to keep management capability low. They have a willingness to pay for a managerial lemon. If the employees are well organized, managerial slack can persist even if the cost of training and development is not prohibitively high. This can also be an explanation why employers sometimes run into opposition to their employees if they try to improve management capability, especially when there is a separation of ownership and management (see also Rappaport 1998, 1-12). However, the analysis of such a separation is beyond the scope of this paper.

Further, the employees only achieve nonnegative utility levels in the case of a managerial lemon if the overall revenue share is at least 40 percent. Because their outside option is assumed to be zero, the employees will terminate their contracts of employment if the overall revenue share is below 40 percent (illustrated by the black line in Figure 8). As illustrated in Figure 7 (by the black curve), the monopolist will earn a nonnegative profit only if the overall revenue share is at least 40 percent, too. Therefore, a managerial lemon will never incur a loss, because revenue shares which lead to losses are blocked by the employees. No matter how “bitter” the managerial lemon is, he/she will be supported by his/her employees.

NOTES

1. We use the term “X-inefficiency” as a “catch phrase” to denote a deviation from the neoclassical prediction (see De Alessi 1983). Our argumentation is based on the more general property rights approach.
2. In the literature on strategic delegation, they focus on (d) (see, e.g., Gueth et al. 2011 for a similar approach as our model; Sengul et al. 2012 for a review).
3. A *Mathematica* file can be provided on request.
4. Similar values of a , b , and c (as marginal cost of production) are given in most textbooks on microeconomic theory.
5. The team production problem can be solved by control (see Alchian and Demsetz 1972) or an incentive-compatible contract (see Holmstrom 1982). It does not matter how the solution to the team production problem looks like.
6. See Jensen and Meckling (1976) for a similar solution, where the firm is completely sold to the manager. However, they focus on minimizing agency cost in their model.

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