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

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15 September 2014

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Acknowledgments: We are grateful to Max Albert, Rainer Kuehl, and Kerstin Pull for their detailed comments. We would like to thank the participants at the 2013 Tuebingen Brown Bag Seminar on Economics, the 2013 Giessen Brown Bag Seminar on Food Economics, the 2014 Hohenheimer Oberseminar in Ilmenau, the 2014 Doctoral Colloquium at the EURAM in Valencia, and the 2014 IMPRS Uncertainty Summer School in Jena for their useful suggestions.

Mihael Duran gratefully acknowledges the financial support by the Friedrich Naumann Foundation.

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Abstract: A monopolist is treated as a nexus of contracts with team production. It has one owner-manager who 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 managerial hotshot and managerial lemon are found to make profit. Therefore, managerial slack can exist in our monopoly market. Whereas the employer has the incentive to improve management capability in principle, the employees have the incentive to keep management capability low. Moreover, the cost of improving management capability may be prohibitively high. Consequently, managerial slack can persist. The predicted behavior of the monopolist contradicts the neoclassical prediction of market performance in both cases.

Keywords: firm organization, market structure, property rights

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

INTRODUCTION

In neoclassical economics, firms are regarded as single decision makers. Just as households (individuals) maximize their utilities, firms also maximize their profits. In industrial organization (IO), firms are typically assumed to be large, especially in terms of monopoly theory. Although large firms always have a nontrivial organizational structure, they are usually treated in the neoclassical manner (see, e.g., Tirole 1988, 4; Scherer and Ross 1990, 38, 52; Shy 1995, 71). For example, the neoclassical monopoly model is part of the literature on IO (see also West 2008) as well as that on microeconomic theory (see, e.g., Kreps 1990; Varian 1992; Schotter 1994; Mas-Colell et al. 1995). The theory is taught in almost all areas, including agribusiness management and business administration.

However, we do not feel comfortable with the neoclassical monopoly model for two reasons. First, a violation of methodological individualism is committed if organizational problems are present.[1] For instance, the profit-maximizing behavior of a firm, which is predicted by the neoclassical monopoly model, is not grounded on individual behavior under the assumption of utility maximization. The actual behavior of the firm, which is observed, is X-inefficient (see Leibenstein 1966).[2] 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 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. Therefore, they need knowledge and motivation.

In the following, we focus on (a) and (b). A production function is given and known. Competing firms are not given.[3]

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 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 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 who 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 for solving the team production problem). As the cost of managerial effort is assumed to be constant, the question of capability and cost is only 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).[4]

As a result, both managerial hotshot and managerial lemon are found to make profit. Therefore, managerial slack can exist in our monopoly market. In the case of a managerial lemon, the optimal revenue share is higher, and the profit level is lower than those in the case of a managerial hotshot. However, the employees' utility level is higher. Whereas the employer has the incentive to improve management capability in principle, the employees have the incentive to keep management capability low. Moreover, the cost of improving management capability may be prohibitively high. Consequently, managerial slack can 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 on individual behavior under the assumption of utility maximization. It contradicts the neoclassical prediction of market performance in both cases of managerial lemon and managerial hotshot. This reason is why we should teach the neoclassical theory of the firm with caution.

MODEL

Market Structure

In our model, a monopolist produces a homogeneous good.[5] The monopolist faces a linear inverse demand function relating price p to quantity q with intercept a and slope b:

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

As $a > b\,q > 0$, 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 who 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 as follows:

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

The quantity is observable and verifiable. The effort levels are observable in principle but not verifiable. Effort complementarities exist because of the multiplicative nature of the production function. In sum, we assume “real” team production (see Lazear 1999), that is, team production with nonseparability (see Alchian and Demsetz 1972).

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 the following linear effort cost function:

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

The employer offers an overall revenue share to the employees:

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

As 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 sum, we assume the outside option for the employees to be zero. Therefore, employees will accept wages with a fixed salary of zero if the employees' utility is nonnegative.

Therefore, 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 obtains the following 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 $u_j(e_1, e_2, s)$ as follows:

$$u_j^{ml}(s) = \max_{e_j}\{(s/2)\,(a - b\,\sqrt{e_1}\,\sqrt{e_2})\,(\sqrt{e_1}\,\sqrt{e_2}) - c\,e_j\}.$$

His/her reaction function is given by

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

Each employee’s effort choice is dependent on the other employee’s effort choice. As 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

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

If $s > (4\,c)/a$, then $e_j^{ml}(s) \in \mathbb{R}_+$. Therefore, the higher the marginal cost of effort is, the higher the overall revenue share will be. As $s \in (0,1)$, $e_j^{ml}(s) \in \mathbb{R}_+$ 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 the marginal cost of effort. In other words, the market size has to be sufficiently large.

The corresponding quantity and price are given by

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

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

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

The corresponding profit level is given by

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

The employer maximizes $\pi^{ml}(s)$ as follows:

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

The optimal revenue share is given by

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

In the same way that the optimal price is independent of the slope parameter, 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, as shown in Figure 1 for $a = 10$.

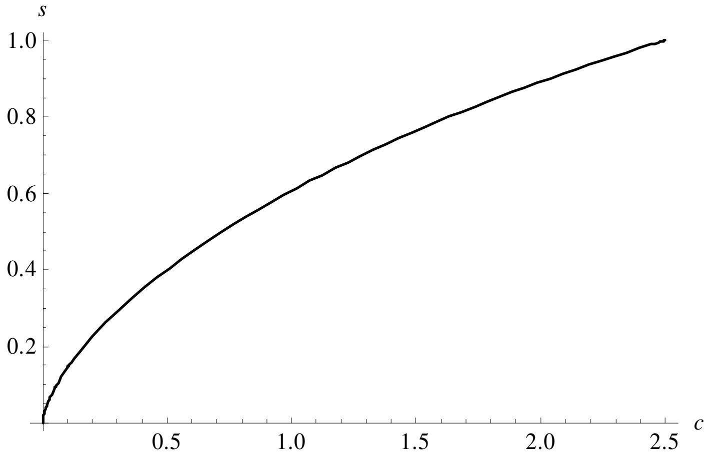

Figure 1: Optimal revenue share as a function of marginal cost of effort for $a = 10$.

The corresponding profit level is given by

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

For the 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, as shown in Figure 2 for $a = 10$ and $b = 1/2$.

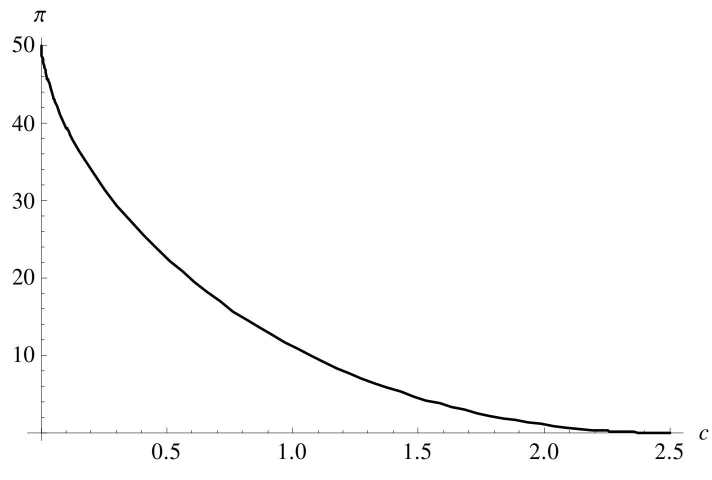

Figure 2: Profit level as a function of marginal cost of effort for $a = 10$ and $b = 1/2$.

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

For $a = 10\ c$, $b = 1/2$, and $c = 1$, the optimal revenue share and the corresponding profit level can be easily calculated.[6]

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

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

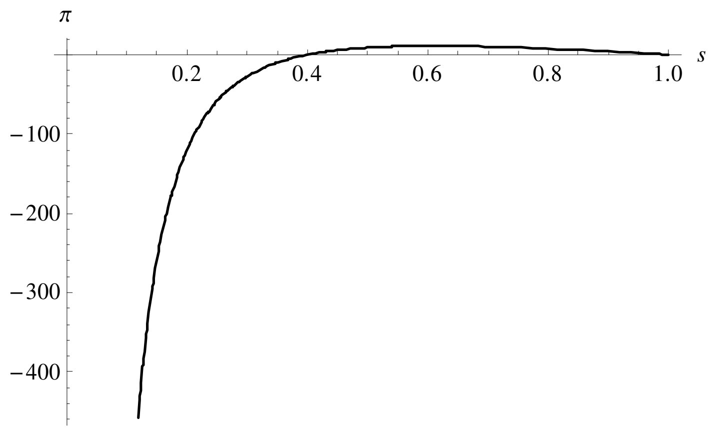

Figure 3: Profit level as a function of the overall revenue share for $a = 10$, $b = 1/2$, and $c = 1$.

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%. 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 and managerial effort has no cost. For example, an incentive-compatible contract can be used (see Holmstrom 1982).[7] The team production problem can be solved if the employer (1) investigates how a trouble-free production looks like (by maximizing the overall utility), (2) derives the optimal revenue share (by maximizing the profit), and (3) contracts the optimal quantity. The optimal quantity can be contracted because the quantity is observable and verifiable. As the effort levels are not verifiable, they cannot be contracted.

In the model, the employer maximizes $u(e_1, e_2, s)$as follows:

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

The equilibrium effort choices are given by

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

If $s > (2\ c)/a$, then $e_j^{mh}(s) \in \mathbb{R}_+$. Again, the higher the marginal cost of effort is, the higher the overall revenue share will be. As $s \in (0,1)$, $e_j^{mh}(s) \in \mathbb{R}_+$ if $a > 2\ c$. Condition $a > 2\ c$ holds if the market size is greater than two times of the 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 can operate in markets, which are too small for a managerial lemon.

The corresponding quantity and price are given by

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

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. Unlike in the case of a managerial lemon, the quantity is higher and the price is lower in the case of a managerial hotshot. Therefore, the welfare loss is smaller.

The equilibrium utility levels are given by

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

The corresponding profit level is given by

$$\pi^{mh}(s) = \pi\left(e_1^{mh}, e_2^{mh}, s\right) = (1-s)\left(a - b\sqrt{e_1^{mh}}\sqrt{e_2^{mh}}\right)\left(\sqrt{e_1^{mh}}\sqrt{e_2^{mh}}\right) =$$

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

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

The employer maximizes $\pi^{mh}(s)$ as follows:

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

The optimal revenue share is given by

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

In the same way that the optimal price is independent of the slope parameter, 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, as shown in Figure 4 for $a = 10$.

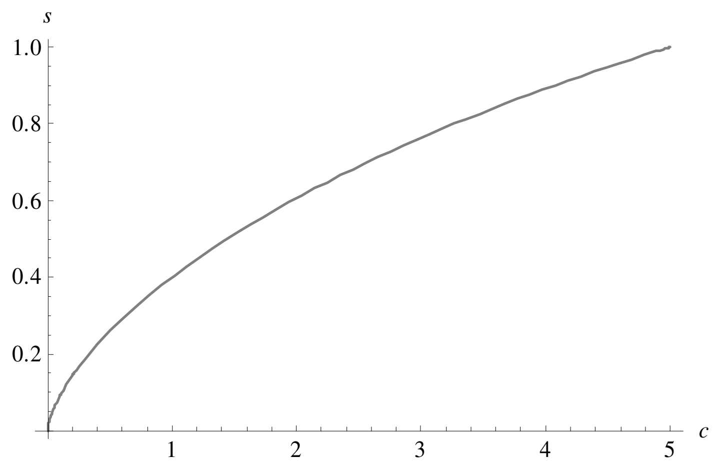

Figure 4: Optimal revenue share as a function of the marginal cost of effort for $a = 10$.

The corresponding profit level is given by

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

This profit level is feasible if the following incentive-compatible contract is implemented (see also Holmstrom 1982):

$$w_j = \begin{cases} w_j(e_1^{mh}, e_2^{mh}, s^{mh}) & \text{if} \quad q \geq q^{mh}(s^{mh}) \\ 0 & \text{if} \quad q < q^{mh}(s^{mh}) \end{cases}.$$

The equilibrium effort choices constitute a subgame-perfect Nash equilibrium because they are mutual best replies. If employee $3 - j$ chooses e_{3-j}^{mh}, employee j receives a nonnegative wage by choosing e_j^{mh}. Otherwise, he/she receives a wage of zero.

For the 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, as shown in Figure 5 for $a = 10$ and $b = 1/2$.

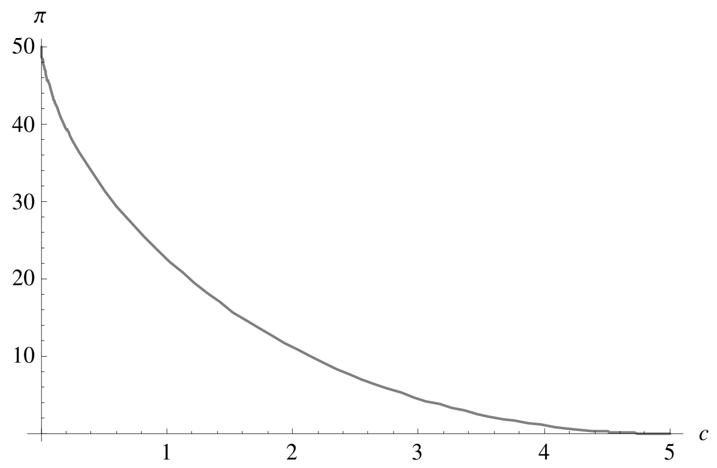

Figure 5: Profit level as a function of the marginal cost of effort for $a = 10$ and $b = 1/2$.

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

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

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

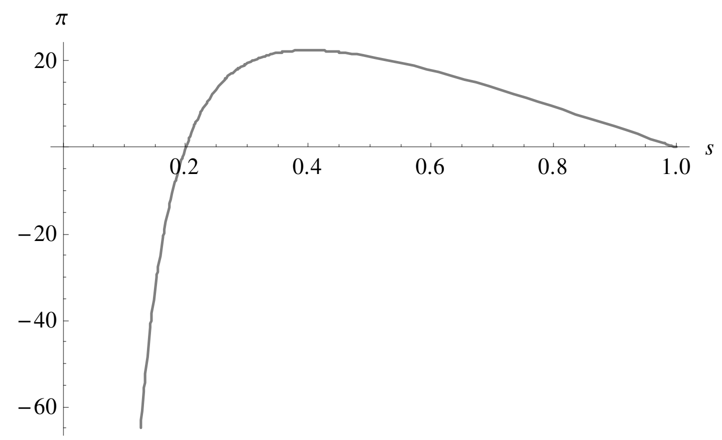

Figure 6: Profit level as a function of the overall revenue share for $a = 10$, $b = 1/2$, and $c = 1$.

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%. The managerial lemon earns about 23 monetary units. Compared with a managerial lemon, a managerial hotshot offers a lower revenue share and earns more profit. The employees are worse off.

CONCLUSION AND DISCUSSION

As a result, both managerial hotshot and managerial lemon are found to make profit. Therefore, managerial slack can exist in our monopoly market as long as the market size is not too large. However, a managerial hotshot earns more profit than a managerial lemon, as shown in Figure 7 as an example. Profit levels are expressed as functions of overall revenue shares. In the case of a managerial lemon (denoted by the black curve in Figure 7), the profit level is low for all the same revenue shares. However, because both managerial hotshot and managerial lemon are capable of calculating the optimal revenue share, equilibrium revenue shares differ. As a managerial hotshot offers a lower revenue share than a managerial lemon, he/she earns all the more profit. The employer is better off if he/she is a managerial hotshot.

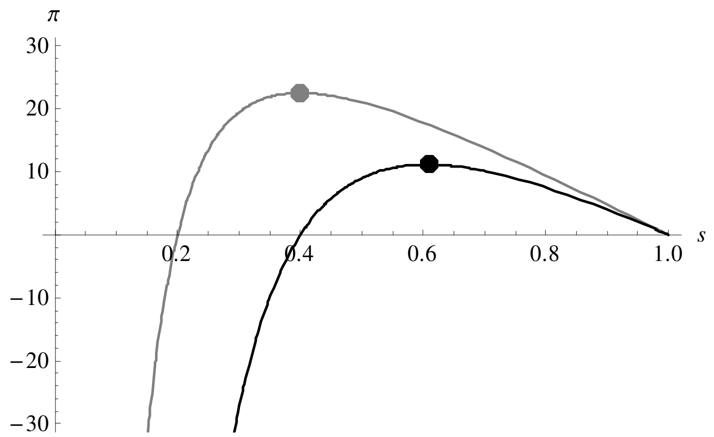

Figure 7: Profit levels as functions of the overall revenue share

for $a = 10$, $b = 1/2$, and $c = 1$.

Therefore, the employer has the 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 will be present if a managerial lemon wants to become a managerial hotshot. The employees will be worse off, as shown in Figure 8. Overall utility levels are expressed as functions of overall revenue shares. In the case of a managerial lemon (denoted by the black line in Figure 8), the overall utility level is higher because a higher revenue share is offered. The employees will be better off if the employer is a managerial lemon.

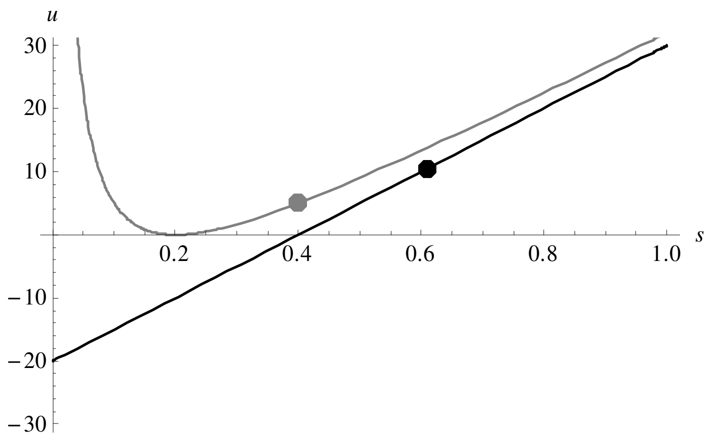

Figure 8: Overall utility levels as functions of the overall revenue share

for $a = 10$, $b = 1/2$, and $c = 1$.

Therefore, the employees are not interested in improving management capability. On the contrary, the employees have the incentive to keep management capability low. They have the willingness to pay for a managerial lemon. If the employees are well organized, managerial slack will persist even if the cost of training and development is not prohibitively high. This explanation can also give the reason why employers sometimes run into opposition from their employees if they try to improve management capability, especially when a separation of ownership and management exists (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%. As their outside option is assumed to be zero, the employees will terminate their contracts of employment if the overall revenue share is below 40% (denoted by the black line in Figure 8). As denoted by the black curve in Figure 7, the monopolist will earn a nonnegative profit only if the overall revenue share is at least 40% as well. Therefore, a managerial lemon will never incur a loss because revenue shares that 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.

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

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

The equilibrium effort choices will be given by

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

The corresponding quantity and price will be given by

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

The equilibrium profit level will be given by

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

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 will 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.[8]

However, no employer will offer such an overall revenue share. If the whole revenue is offered to the employees, nothing will be left for the employer. In this case, no employer or, generally speaking, third party will exist. However, if there is no third party, the team production problem will not be solved.

Consequently, the neoclassical prediction about the behavior of the monopolist will be incorrect again. No matter how one looks at it, the neoclassical way is problematic if organizational problems are present. This is the reason why we should teach the neoclassical theory of the firm with caution.

NOTES

1. In principle, neoclassical economics is based on methodological individualism, that is, the requirement that social phenomena can be explained by individual behavior. In practice, the neoclassical theory of the firm does not conform to this requirement. It assumes that firms maximize their profits on the basis of a given technology but ignores the question of how individual behavior within firms is coordinated to achieve profit maximization. The neoclassical theory of the firm is a kind of reduced form that does not give the conditions under which profit maximization is obtained.
2. We use the term "X-inefficiency" as a catch phrase to denote a deviation from the neoclassical prediction (see De Alessi 1983). Our argument is based on the more general property rights approach.
3. The literature on strategic delegation focuses on (d) (see, e.g., Gueth et al. 2011 for an approach similar to our model and Sengul et al. 2012 for a review).
4. This assumption suits the purpose of our model. It can be relaxed by assuming that the cost of managerial effort is higher for a managerial lemon than for a managerial hotshot.
5. A *Mathematica* file can be provided upon request.
6. Similar values of a, b, and c (as the marginal cost of production) are given in most textbooks on microeconomic theory.
7. The team production problem can also be solved by control (see Alchian and Demsetz 1972). How the solution to the team production problem appears does not matter.
8. See Jensen and Meckling (1976) for a similar solution in which the firm is completely sold to the manager. However, they focus on minimizing the agency cost in their model.

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