A Note on CEO Compensation, Elimination Tournaments and Bankruptcy Risk

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Abstract. We investigate an economy in which firms have different risks to go bankrupt. We observe two things: first, workers in firms with higher bankruptcy risk (bad firms) always work less than workers in good firms. Second, the CEOs of bad firms may nonetheless receive larger wages.

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1. Introduction

The compensation of chief executive officers (CEOs) is among the few economic topics that are capable of exciting the broad public. The Daily Telegraph (September 28, 2002) writes that "in America over the past 30 years or so, the average CEO's compensation has grown from 42 times that of the average workers to more than 400 times as much." Many people believe that CEOs do not deserve their oftentimes astronomic wages. They find it particularly appalling when the very firms that pay the highest CEO wages end up in financial trouble. This nurtures the belief that CEOs are awarded for poor performance. The recent case of the Swedish-Swiss multinational ABB provides an interesting example. The company paid 136 million USD worth of pensions as deferred compensation to two top managers when they left the firm. Not much later, company performance declined; the stock price fell by 80%. It appears that the company took excessive risks, and Percy Barnevik, the former CEO, has been blamed for it. The company now asks the managers to pay back their compensation (Economist, 2002).

Is it possible that CEOs get high compensation for bad work? We argue that there may be some truth in this perception, but that it needs some qualification.

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Our point of departure is that the hierarchy of a firm and the career paths within can be understood as a tournament in which lower-level workers compete with each other for promotion. The final prize is to become CEO. A substantial literature on tournaments and contests, (Rosen 1986, Lazear and Rosen 1989, Knoeber and Thurman 1994, Ehrenberg and Bognanno 1998, Moldovanu and Sela 2001), investigates one tournament by the time and asks how the performance of agents (for instance, workers in firms, players in tennis tournaments) depends on the prize structure in the tournament. Our setting is different: we consider a number of competing tournaments and consider that each of these tournament is a firm. Firms are heterogenous in their risk to go bankrupt and workers are indifferent about which firm to enter. In this framework we investigate the performance (effort) of workers.

We show that, first, workers in bad (high bankruptcy risk) companies always exert less life-time effort than workers in good (low bankruptcy risk) companies. Second, CEOs of bad companies may, indeed, receive higher wages than CEOs in good companies. However, this is only true concerning the *ex post* realized wages, not concerning the expected life-time income of workers, who compete for the CEO position. In our model, when the CEO of a bad firm receives better pay than the CEO of a good firms, a given worker's odds to become CEO in a bad firm are also smaller than his or her odds in a good firm.

The intuition for these observations is simple. Consider the simplest elimination tournament in which there are only two tiers in the firm's hierarchy: workers, and CEO. Agents are risk-neutral. They compete for the prize of becoming the CEO of the firm. The firm pays zero wages to workers, while the CEO receives a strictly positive wage. A worker's odds of winning and thus becoming CEO increases in her own effort, and decreases in the efforts of competing workers. In symmetric equilibrium, any worker has a chance of 1/N to win the tournament. Here, N is the number of workers competing for the prize of becoming CEO.

In order to understand the first observation, consider what happens when a firm goes bankrupt. Then, it defaults on CEO wage payments. Thus, a worker anticipates that in addition to the risk of losing the tournament, there is an exogenous risk of not receiving the winner's prize when the firm goes bankrupt. The higher this bankruptcy risk, the lower the marginal benefit of exerting effort. Hence, it follows that workers in more risky, that is, less good firms, will exert less effort.

The second observation — CEOs in bad firms may receive larger wages than CEOs in good firms — requires the labor market (and product market) to be competitive. Then, firms make no profit and the participation constraints of agents entering any given firm are binding. Consequently, the expected utility from working in a more or in a less risky firm (or for not working at all) must be the same. It can then readily be shown that situations exist in which CEOs in bad firms receive higher pay, although their worker exert less effort than their colleagues in good firms. As workers receive zero wages and firms make zero profits, the CEO receives the total output of the firm, that is, the sum of workers' outputs. The expected utility of any agent entering a firm is defined as the probability to win the tournament (1/N) times the compensation of the CEO. In equilibrium only the expected chance of winning the tournament and the exerted effort are fixed. However, there is a multitude of possible N's that satisfy the equilibrium conditions. In particular, it can occur that bad firms have more workers competing for the job of the CEO than good firms. Then, the probability to win the tournament is much lower, but the larger number of workers may overcompensate the lower effort in bad firms: CEOs in bad firms may receive higher wages than CEO's in good firms although their live-time effort is lower.

2. The Model

Suppose that there are many firms in the economy. Each firm has two levels: one CEO and a group of workers. Individuals are risk-neutral and live two periods. An individual chooses a firm in the first period of her life. If she wins the tournament among workers in the first period, she is promoted to be a CEO in the second period. When contracts contingent on output are infeasible, workers do not earn wages. Rather, their expected compensation consists of the CEO wage multiplied by the probability to win the tournament. All firms have the same production technology. They live infinitely and can commit themselves to pay the CEO wage unless they go bankrupt. Bankruptcy risk differs across firms. Firms hire new workers from the young generation at every time period.

Assume that there is perfect competition on the market and all firms earn zero profit. We also make the following assumption about the disutility of effort e:

$$A1.\ C(e) \geq 0,\ C'(e) > 0,\ C''(e) > 0,\ C'''(e) > 0.$$

Individual k, who works in firm i, solves the following problem

$$\max_{e_k} u(e_k) = \max_{e_k} \frac{f(e_k)}{\sum_{l=1}^{N_i} f(e_l)} \delta_i W_i - C(e_k). \tag{1}$$

The first term is individual k's expected probability to win the tournament times the probability that firm i will survive until the next period ($0 \leq \delta_i \leq 1$) times the CEO wage. A good firm has a higher δ then a bad firm. The second term is the cost to exert effort e_k. N_i is the total number of workers on the lower level in firm i. N_i and e_k are to be determined in equilibrium. For simplicity we assume that there is no time discount.

The first-order condition of the worker is

$$\frac{f'(e_k)\sum_{l\neq k} f(e_l)}{\left[\sum_{l=1}^{N_i} f(e_l)\right]^2}\delta_i W_i = C'(e_k).$$

In symmetric equilibrium, it must be that all workers in firm i exert the same effort $e_k = e_i^*$

$$\frac{(N_i - 1)}{N_i^2}\delta_i \frac{f'(e_i^*)}{f(e_i^*)} W_i = C'(e_i^*). \tag{2}$$

Firm i produces output $\sum_{l=1}^{N_i} e_l$ at the normalized market price 1. Assume that the labor market is competitive. Then, firms earn zero profits, and the wage in firm i is:

$$W_i = \sum_{l=1}^{N_i} e_l,$$

In symmetric equilibrium:

$$W_i = N_i e_i^*.$$

Inserting into equation (2) yields:

$$\frac{(N_i - 1) f'(e_i^*)}{N_i^2 f(e_i^*)}\delta_i N_i e_i^* = C'(e_i^*),$$

or

$$\left[\frac{(N_i - 1)}{N_i}\delta_i\right]\frac{f'(e_i^*)}{f(e_i^*)} e_i^* = C'(e_i^*). \tag{3}$$

Note that the term in square brackets is a constant. We introduce an additional assumption ensuring that there exists a unique solution (greater than zero) of this equation as an intersection of concave function on the left-hand side and convex function on the right-hand side of equation (3):

A2. $f(x) = Ae^{\alpha x^\beta}$, where $A,\ \alpha > 0,\ \beta \in (0, 1]$.[1]

Workers' individual rationality (IR) constraint must be satisfied in all firms:

$$u(e_i^*, W_i) \geq 0.$$

Assuming that there is perfect competition on the supply side of the labor market, the (IR) is binding:

$$u(e_i^*, W_i) = 0.$$

[1] This assumption about function $f(x)$ is consistent with the standard assumptions about contest success functions, see, for example, Skaperdas (1996).

A worker's expected payoff in symmetric equilibrium, given that firm i breaks even, is:

$$\frac{\delta_i N_i e_i^*}{N_i} - C\left(e_i^*\right) = \delta_i e_i^* - C\left(e_i^*\right) = 0. \tag{4}$$

Moreover, given that individuals are indifferent among firms to choose, they must have the same expected utility by entering any firm:

$$\delta_i e_i^* - C\left(e_i^*\right) = \delta_j e_j^* - C(e_j^*). \tag{5}$$

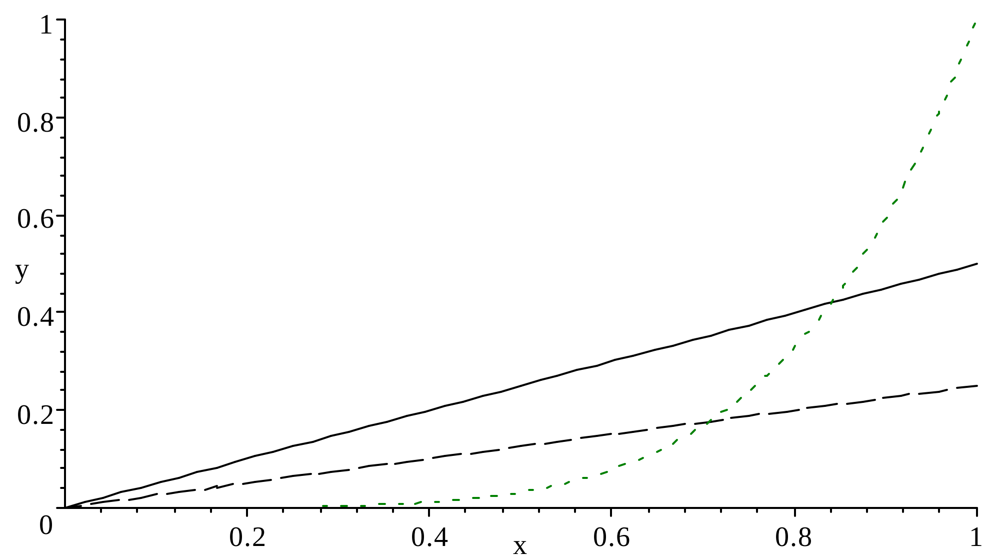
This involves that if firm i is "more risky" (less good) than firm j ($\delta_i < \delta_j$), it must be true that:

$$e_i^* < e_j^*,$$

because $\delta e - C\left(e\right)$ is a concave function $(A1)$. We have thus proven the following proposition.

Proposition 1. *Under assumptions A1 and A2, workers exert more effort in less risky firms, in symmetric equilibrium.*

The intuition for this result follows from the following graph which plots the equation (4) for firms i and j. Consider the intersections $\delta_i e_i^* = C\left(e_i^*\right)$ and $\delta_j e_j^* = C\left(e_j^*\right)$:



$C(e)$ - dotted line; $\delta_i = 0.25$ - dashed line; $\delta_j = 0.5$ - solid line.

We have shown that workers in more risky firm *always* work less than in less risky firms. We now turn to the second observation: What can be said about number of workers and wages in two firms that have different bankruptcy risks?

Notice first that one can plot equation (3) in a similar graph as the one above by substituting $C'(e)$ for $C(e)$ (both are convex functions). As we have shown above, $e_i^* < e_j^*$. This implies that:

$$\frac{(N_i - 1)}{N_i}\delta_i < \frac{(N_j - 1)}{N_j}\delta_j, \tag{6}$$

because a larger coefficient $\frac{(N_i-1)}{N_i}\delta_i$ must correspond to the higher curve in the graph.

However, condition (6) does not fix the relationship between number of workers and difference in salaries in two firms. The two conditions, (6) and

$$\delta_i < \delta_j$$

can be satisfied for both $N_i < N_j$ and $N_i > N_j$. If a more risky firm i has less workers than a less risky firm j ($N_i < N_j$), it must be true that $W_i = N_i e_i^* < N_j e_j^* = W_j$. This is a situation in which workers exert less effort in the more risky firm, less workers want to enter that firm, and the CEO gets a smaller wage. If a more risky firm employs more workers ($N_i > N_j$), it may or may not pay a higher wage to the winner of the tournament. Actually, $W_i > W_j$ holds if the positive effect of employing more workers outweighs the negative effect of lower per-capita effort. This observation is summarized in the second proposition.

Proposition 2. *Suppose that assumptions A1 and A2 hold. Then, in symmetric equilibrium the following is true:*

- *If a less risky firm employs more workers than a more risky firm, the CEO wage in a less risky firm is always higher wage than the CEO wage in a more risky firm.*

- *If a less risky firm employs less workers than a more risky firm, the CEO in a less risky firm may have a lower wage than the CEO in a more risky firm.*

Consider the following example which shows that a CEO in a more risky firm i may have a higher wage than in a less risky firm j.

Example. Suppose that $f(x) = e^x$, $C(x) = \frac{1}{3}x^3$. Suppose further that the bad firm's bankruptcy risk is 80% ($\delta_i = 0.2$), the good firm's bankruptcy risk is 50% ($\delta_j = 0.5$), and that the employment in the good and bad firm respectively is

$N_i = 100$, $N_j = 10$. Under these assumptions it is ensured that conditions (3) and (6) hold. Plugging in all values yields

$$e_i^* = \left[\frac{(N_i - 1)}{N_i}\delta_i\right] = \frac{198}{1000},\ e_j^* = \left[\frac{(N_j - 1)}{N_j}\delta_j\right] = \frac{9}{20},$$

and

$$e_i^* < e_j^*.$$

It immediately follows that

$$W_i = N_i e_i^* = 19.8 > 4.5 = N_j e_j^* = W_j,$$

as stated in the second part of Proposition 2.

3. Conclusion

We have shown in a simple model that workers exert lower life-time effort in bad firms than in good firms. They may nonetheless receive higher wages when reaching the top. This is, however, always accompanied by a smaller chance of becoming CEO. We have here chosen a simple two-round elimination framework, but, nonetheless, believe that our results capture some interesting features of the structure of firms, worker life-time effort and CEO compensation.

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