



Are tournaments optimal over piece rates under limited liability for the principal?

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ARTICLE INFO

Available online 10 December 2012

JEL classification:

D82

D21

Keywords:

Tournaments

Contests

Piece rates

ABSTRACT

A highly acclaimed result is that tournaments are superior to piece rates when the agents are risk averse and their production activities are subject to a relatively large common shock. The reason is that tournaments allow the principal to trade insurance for lower income to the agents. Our analysis shows that this celebrated result does not carry over to the case when a limited liability (bankruptcy) constraint limits the payments the principal can make, provided that the liquidation value of the firm is sufficiently small. This finding has important implications for the vast number of limited liability firms. Even though limited liability becomes an issue for different ranges of liquidation values under the two schemes, tournaments are still superior when the liquidation value of the firm is intermediate or large, even though the limited liability constraint is still binding for intermediate values. Surprisingly, uncertainty in the price of output strengthens the need for tournaments by expanding the range of liquidation values over which tournaments are dominant, because price uncertainty introduces additional bankruptcy risk. These findings provide insight into policy implications in the contracting out of services by state and local governments, in procurement, in rent-seeking contests and in tournaments used by HMOs.

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1. Introduction

Following the seminal work of Lazear and Rosen (1981), Holmström (1982), Green and Stokey (1983) and Nalebuff and Stiglitz (1983),² a significant part of the current literature on relative performance evaluation has focused on two-part piece rate (cardinal) tournaments that include a base payment and a bonus or penalty based on an agent's performance relative to the group average, and contrasted these schemes with standard linear piece rates that include a base payment and a variable payment based on the agent's absolute performance.³ The latter are sometimes expressed as “fixed performance standards” when an agent's performance is evaluated against a fixed standard instead of the average output obtained. Note that Lazear and Rosen focused on rank-order (ordinal) tournaments,

however, these tournaments are informationally wasteful by ignoring the agents' cardinal performance (see Holmström (1982)).⁴ Cardinal tournaments are popular in several occupations or industries where cardinal data are available (e.g., contracts for salesmen, contracts for physicians contracting with HMOs, agricultural contracts, promotion tournaments and annual salary raises for faculty), partly because they are simple to design and easy to implement and enforce. To some extent, the non-linearity of the theoretically optimal contract is due to the fact that contracts accommodate all possible events. Holmström and Milgrom (1987), however, have argued that schemes that adjust compensation to account for rare events may not provide correct incentives in ordinary high probability circumstances. For the most part, this literature has overlooked the implications of limited liability for the firm (principal), an issue of importance for the vast number of limited liability firms. The focus of this paper is the implications of limited liability in contrasting tournaments (relative performance evaluation) to piece rates (absolute performance evaluation).

Absent limited liability for the principal, tournaments constitute a move closer to the First Best. This is because relative performance evaluation partially alleviates the agents' moral hazard problem by providing information about the value of common shocks. The principal filters away common shocks from the responsibility of agents and charges a premium for this insurance. The move from absolute

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¹ Theofanis Tsoulouhas was not the editor of this paper.

² An associated literature is the one on contests, often based on contest success functions. See Tullock (1980) for rent-seeking contests, Pérez-Castrillo and Verdier (1992) for a more recent discussion of rent-seeking games, Skaperdas (1996) for an axiomatization of contest success functions, Wärneryd (2003) for uncertain prizes, Konrad and Kovenock (2009) for contests with multiple rounds, and Riis (2010) for an extension of the Lazear and Rosen efficiency result to heterogeneous agents.

³ See Knoeber (1989), Knoeber and Thurman (1994, 1995), Tsoulouhas (1999), Tsoulouhas and Vukina (1999, 2001), Levy and Vukina (2004), Wu and Roe (2005, 2006), Tsoulouhas and Marinakis (2007), Vandegrift et al. (2007) and Marinakis and Tsoulouhas (2012).

⁴ Moreover, Tsoulouhas (2012) shows that switching from ordinal to cardinal tournaments improves efficiency.

performance schemes to tournaments is Pareto improving because the principal's expected profit increases without hurting the agent.

The dominance of tournaments is less clear when the principal is subject to limited liability, and bankruptcy is an issue because the firm's liquidation value is small or because it is possible for the output state to be quite unfavorable. When switching from absolute performance schemes, such as piece rates, to tournaments, the risk premium the principal charges for insurance against common shocks reduces the base payment the agent receives. Further, the filtering of common uncertainty enables the principal to implement a higher-power incentive scheme. However, because higher effort by the agent reduces his utility, the base payment will need to adjust to ensure the participation of the agent. Thus, under a tournament, the agent will receive better insurance but he will have to exert more effort, and even though the bonus factor under tournament should increase, the direction in the adjustment of the base payment is not clear a priori. Because the total wage bill under tournament is related to the base payment, the direction of the change in the total wage bill under tournament is also ambiguous a priori.⁵ Because it is not clear if total payments go up or down when moving from piece rate schemes to tournaments, tournaments may or may not be better than piece rates under limited liability. Section 2 develops the model we will use to investigate this question.

Our analysis of piece rate schemes in Section 3 and of tournaments in Section 4 shows that absent limited liability the base payment and, hence, the total wage bill increases under tournament (note that Section 5 briefly examines how the contractual parameters adjust to changes in the model parameters). This is so because the expected bonus payment in a tournament is zero, whereas with piece rate compensation it is positive. Therefore, agents expect to be compensated for effort through the base payment in a tournament.⁶ Thus, in the presence of a limited liability constraint which limits payments in unfavorable states, tournaments may not be dominant over piece rates. The intuition is that contracts with risk neutrality and limited liability for the principal look very much like those that would have been obtained with risk aversion. In other words, if the principal is concerned about the allocation of profit across states, he may no longer offer insurance against common shocks via tournaments and may resort to piece rate schemes or fixed performance standards. One might expect that limited liability for the principal would reduce the cost of bankruptcy to him and, hence, it would distort his incentives by encouraging risk-taking, thereby increasing the risk that bankruptcy arises. A Coasian criticism of this view is that contracts would adapt accordingly. It is true that limited liability makes bankruptcy tempting. It is also true that it encourages the principal to promise high payments in low states that he cannot really deliver, because he can only deliver the assets available to the firm in loss states. Following the footsteps of Sappington (1983), Farmer (1985) and Kahn and Scheinkman (1985), the approach taken in this paper is that rational agents (workers or input suppliers), knowing that limited liability prevents them from pursuing the assets of the principal, cannot be suckered by the prospect of payments that the principal clearly cannot deliver. Thus, they will sign a contract only if it stipulates that losses cannot exceed the firm's liquidation value. In this sense, the principal cares about the allocation of profit across states in order to satisfy the bankruptcy constraint required by the workers.

Thus, our analysis provides answers to the following questions: How should the piece rate and tournament schemes be modified to ensure that the firm will not be better off pleading bankruptcy? Is it possible to implement these schemes under a bankruptcy constraint? When both schemes can be implemented, which is better and why?

⁵ Specifically, the analysis below shows that the total wage bill is the number of agents multiplied by the base payment.

⁶ Under piece rate, the bonus also compensates the agents for their effort costs. In fact, the expected bonus exceeds the cost of effort and the base payment is negative.

Our comparison of piece rate schemes to tournaments in Section 6 shows that, surprisingly, when both schemes can be implemented, the liquidation value of the firm must be sufficiently small for tournaments to be inferior. In particular, we show that there exists a critical liquidation value above which tournaments are still superior even if the limited liability constraint is binding under tournaments. However, below the critical liquidation value, piece rate schemes are always superior. In a sense the limited liability constraint must be really tight for tournaments to be inferior. To the best of our knowledge, this result has never been obtained in the literature. Our finding is analogous to showing that if the principal were sufficiently risk-averse he would be unable to offer insurance against common shocks by using tournaments, and he would resort to piece rate schemes. By contrast, if the principal were less risk-averse than the agent, he would still provide insurance through tournaments.

At this point, a word of caution is in order. Given the form of the two compensation schemes the way they are used in practice, and the adjustment of the contractual parameters after adding the limited liability constraint, the range of liquidation values over which the constraint becomes binding differs for each scheme. The intuition is that the expected bonus under tournaments is zero, whereas that under piece rates is positive. Thus, the base payment is positive for tournaments and negative for piece rates, yielding no range of liquidation values over which the limited liability constraint is binding under both schemes. Moreover, given that by construction each contract reacts in an entirely different way to the addition of the constraint, to be precise, the piece rate under limited liability provides higher power incentives, while the tournament provides more insurance, our goal is to contrast the two schemes via the overall effects of limited liability. That is, we derive the reduction of expected profit for both contracts in the presence of limited liability but, more importantly, we aim at analyzing the range of liquidation values over which each contract is affected by the limited liability constraint. In our analysis, a scheme may be characterized as "superior" because it leads to higher profits or because, due to its structure, it is less vulnerable to limited liability, that is, limited liability is binding for a smaller range of liquidation values or for smaller liquidation values than in the other scheme. In all, we characterize the superior scheme at each liquidation value and the scheme which is superior because it is less vulnerable to limited liability. In this sense, the piece rate scheme is less vulnerable to limited liability (bankruptcy) because the bankruptcy constraint is only binding for negative liquidation values and because it is completely immune to bankruptcy when both schemes are implementable. Tournaments are not even implementable for negative liquidation values (meaning that the principal would not find it profitable to make an offer that the agent would accept).

The analysis also shows in Section 6.3 that the superiority of tournaments over piece rate schemes critically depends on the agent's risk aversion rate, as well as on the variance of common uncertainty. The more risk-averse the agent is or the higher the magnitude of common uncertainty, the more the agent is willing to pay for insurance or the more the principal can charge for insurance, which raises the principal's profit. As a result, the range of liquidation values over which tournaments are dominant increases with the agents' risk aversion and the magnitude of common uncertainty. The number of agents has a similar effect, in that a large number of agents is necessary to eliminate idiosyncratic noise from the average output obtained by the agents. Hence, more insurance is provided against common shocks when the number of agents is large.

In the main analysis, we take the number of agents to be fixed. Section 6.4 extends the analysis by letting the number of agents vary to make the point that the principal can affect the superiority of tournaments over piece rates, and therefore his profit, by adjusting the number of agents. In particular, even if the liquidation value of the firm is large, the principal may find it profitable to increase the number

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