



# Sequential teamwork in competitive environments: Theory and evidence from swimming data



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## ARTICLE INFO

### Article history:

Received 9 July 2012

Accepted 10 July 2013

Available online 25 July 2013

### JEL classification:

C70

D20

D70

H40

### Keywords:

Team production

Contest

Intergroup competition

Sequential contribution

Free-riding

## ABSTRACT

Many tasks require the input by more than one person very often with members of the team contributing sequentially. However, team production is plagued by disincentive problems. We investigate individual incentives to team production with sequential contributions and competing teams. We show that earlier contributors free-ride on team members contributing later on. We test our predictions on sports data using an athlete's performance in the individual race as a natural control for his relay performance. Our empirical findings strongly support the theoretical claims.

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## 1. Introduction

It is widely acknowledged that team production is plagued by disincentive problems because individuals free-ride on the contributions of other team members (Alchian and Demsetz, 1972; Holmstrom, 1982). Yet, little seems to be known on the structure of such disincentives when there is between-team competition and individuals' contributions build on previous work done by the other team members. In this paper we provide both a theoretical and an empirical investigation of the issue.

Sequential contributions to a team are indeed quite common in real-world production processes. For instance, in the era of globalization work is done around the clock, with computer programmers, planners and other workers producing output that can easily be sent electronically around the globe; at the end of the day they hand over their work to colleagues located in a country where the sun is about to rise. The problems involved are the same that occur when drafting a document: a bad draft requires more effort by the people working on it at later stages in order to achieve a certain level of quality. Another example is the training of students at universities. Colleagues who do a proper job teaching first year courses prepare students well for courses to be taught by other faculty in the second year. One may also think of mail delivery. In many

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countries, parcels or registered letters have to be delivered personally by the postman. It is a common perception that postmen sometimes do not even bother to ring the bell and just leave a notice on the door saying that the mail can be retrieved at some mail delivery center. Thus, they save on their time while increasing the workload at the center. Finally, in production processes organized along assembly lines a poor job by some worker at an early stage can increase the workload of subsequent workers in order to achieve the target quality. In all these examples it may be difficult or very expensive to track the responsibility for a poor final outcome down to the contributions of all the team members involved.

It is most natural to identify a team with an individual firm. In this interpretation, competition comes directly from market forces. However, having multiple teams performing the same task in a competitive environment might also be a strategy of internal organization within the firm, specifically targeted at reducing free-riding of employees. Whatever the interpretation, it is interesting to know a priori whether and to what extent there are incentives to free ride in a competitive environment, and whether such incentives change along the production process.

To this aim we develop a model where members of competing teams contribute sequentially to win a commonly shared prize. The main finding is that free-riding remains pervasive, with earlier contributors exploiting team members contributing later on.

For testing our predictions we turn to swimming data. This has several advantages. Typically, it is difficult to measure the performance of workers and their individual contribution to a team in standard work situations. Moreover, from a researcher's perspective it is usually infeasible to construct a convincing counterfactual that would allow to draw causal inference from the observations in an environment of an operating firm. In order to overcome these problems economists have increasingly turned to sports data recognizing that these environments provide a number of natural experiments which allow for the testing of the effects of incentives on labor market behavior (Ehrenberg and Bognanno, 1990; Kahn, 2000; Szymanski, 2003). Our comprehensive data-set covers swimming competitions from all over the world during the years 1972–2009 with a total of more than 300,000 observations. It seems to be particularly suited for our purposes as it allows us to construct a counterfactual for each individual's performance by comparing times swam in individual races with the same swimmer's performance in a relay at the same event typically taking place within a time period smaller than 2 days. This solves a major identification problem that arises because the team members starting order in a relay depends on individual ability, with better swimmers generally placed first or last. Moreover, the richness of the data allows us to exclude a series of other potentially confounding factors. The evidence supports the prediction that even competitive environments are characterized by substantial free-riding, with a marked first-mover advantage.

We proceed in the following way. After reporting on the related literature in the next section, in Section 3 we set-up the theoretical model. In Section 4 we provide some background on the rules and main characteristics of swimming competitions, describe the data that we use and present our empirical testing strategy. In Section 5 we present and discuss our empirical results. Section 6 offers our conclusions.

## 2. Related literature

Our paper builds a bridge between two separate strands of the literature. The first one looks at contributions to public goods. Varian (1994) argued that with sequential choice the free-riding problem is exacerbated with respect to the simultaneous contributions mechanism, and that there exists a first mover advantage with early contributors contributing less. While this contribution is akin to ours in the sense that agents make sequential choices, there is no competition between teams.

Experimental evidence by Andreoni et al. (2002) specifically tailored to test the predictions of Varian (1994) confirms the first mover behavior but also shows that the difference between simultaneous and sequential play vanishes to the end of the experiment. More recent experiments by Gaechter et al. (2009) support the prediction that the overall contribution is lower in sequential contributions but do not find evidence for the predicted first mover advantage. In another, earlier experimental study Erev and Rapoport (1990) compared sequential and simultaneous contributions to public goods showing that simultaneous choice is significantly less effective in solving the dilemma. However, we are not aware of an empirical assessment of free-riding with sequential contributions in natural work environments. Moreover, none of the studies reviewed above considers the effect of competition between groups on within-group performance.

This is the focus of the second strand of the literature we are relating to. Models of between-group competitions with simultaneous contributions have been developed in the vast literature on contests, which goes back to the seminal contribution of Tullock (1980).<sup>1</sup> Again, empirical analyses of between-group competition have mainly involved laboratory experiments. For instance, Bornstein et al. (1990) compared the performance of groups in a social dilemma situation under two conditions: one in which groups were not facing competition and another in which groups were competing for an additional reward. They found that between-group competition significantly increased the contributions of the simultaneously acting team members, a finding that was replicated by Erev et al. (1993) in a different work environment where subjects picked oranges, as well as by Gunnthorsdottir and Rapoport (2006). However, all these experiments involved simultaneous contributions. In summary, surprisingly, little seems to be known on whether competition between teams eliminates free-riding as team members contribute sequentially.

<sup>1</sup> See for instance Katz et al. (1990), Ursprung (1990), and Gradstein (1993). Two recent surveys are Corchòn (2007) and Konrad (2009).

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