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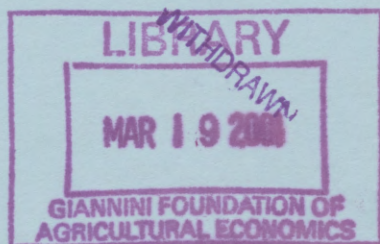
Department of Economics
UNIVERSITY OF CANTERBURY
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ISSN 1171-0705



THE UNDERLINING GAME

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Discussion Paper

No. 2001/01

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THE UNDERLINING GAME

by

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Abstract

Academic institutions may go beyond observing lexicographic ordering of authors in attempting to determine relative contributions to joint research. The present article examines incentive issues arising when applicants for promotion are requested to underline the name of any principal author(s). This mechanism is not generally incentive compatible. Recognizing the generally sequential nature of contribution reporting, a scheme which induces global truthful revelation is developed. Punishment is imposed on prior movers making claims of authorship seniority which are contradicted by subsequent movers. Where applications are simultaneous, contradicted claims of seniority lead to group punishment in that no author is promoted.

JEL classification: C720, D820

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I wish to underline the importance of the helpful suggestions made by Jeremy Clark and Paul Walker (in lexicographic order) in the preparation of this article without attaching the blame that accompanies co-authorship.

December 2000

1. Introduction

Given that the number of applications for promotion in academic institutions in a given year appears to systematically exceed the number of successful applicants, it would appear that salary and academic status are close to the heart of many academics. Particularly in universities, research performance is frequently an important criterion in determining the success or failure of a given application. Promotion encourages those who contribute more rather than less in terms of quantity and quality of published research. Quantity is relatively easily verifiable. Quality may also be able to be monitored at relatively low cost by using the services of qualified disinterested outside agents. This process, however, cannot easily be extended to determining the respective contributions of the joint authors of a particular article, say, whichever journal publishes the article.

In the absence of mechanisms which require academic staff to reveal their relative contributions to joint research outputs, how are contributions assessed? According to McAfee and McMillan (1991, p. 571), equal credit is usually assigned to each author of a co-authored paper, and this assignment rule is not optimal from the perspective of the employer. Authors, however, have an opportunity to voluntarily signal relative contributions via authorship ordering on title pages. Engers et al. (1999) suggest that as far as articles in economics are concerned, there is an overwhelming tendency for the ordering to be lexicographic rather than on the basis of relative contributions. This pattern is also discernible if less emphatic among a number of other social science fields, but is less common in physical and medical sciences.¹ As a signal, alphabetical ordering is mixed, since the prominence of Dr Aaron Aardvark, say, in an article

¹ See Engers et al. (1999) and Zuckerman (1968) for evidence on this issue.

written in conjunction with Dr Zena Zigo, may be due either to luck (or design) or to Dr Aardvark's superior contribution. While it may be thought that Dr Aardvark is fortunate in lexicographic primacy, it is not so since employers must discount Dr Aardvark's primacy as possibly arising from chance rather than superior productivity, whereas a paper authored by Zigo and Aardvark presumably sends a deliberate message signalling the superior contribution of Dr Zigo.² Engers et. al. examine conditions under which either ordering rule might constitute an equilibrium in a cooperative Nash bargaining context. They show that relative contribution ordering cannot be an equilibrium, partly because this rule signals strongly who is the main contributor and a Nash-bargained surplus yields a more even distribution of rewards than would a market allocation. A lexicographic ordering, however, can be an equilibrium and, under some circumstances, may be the only one. Since name reversals penalize authors whose names occur early in the alphabet and these authors are undercompensated by their primacy in a lexicographic ordering, an equilibrium may well involve authors sending murky signals even though the effect is to induce a lower quality of research where employers place a high weight on the likelihood of lexicographic ordering compared to relative contribution ordering.³

If lexicographic orderings produce mixed signals, organisations may respond by imposing requirements that attempt to raise the signal to noise ratio. For example, Spiegel and Keith-Spiegel (1970) found that attitudes among psychologists were largely consistent with those laid down in the *Ethical Standards of Psychologists* of the American Psychological Association

² Of course, this could also be a mixed signal, arising from a convention involving "ladies first". This particular convention, however, does not appear to apply in academic authorship.

³ Engers et al. (1999) argue that less effort will be applied since individual effort spillovers on to the payoffs of other authors will not be accounted for under lexicographic orderings.

(1970) whereby the major contributing author is required to be first listed and credit is to be assigned only to those who have contributed to the publication, in proportion to their contribution.⁴ On the other hand, Over and Smallman (1970) reported that for some journals, alphabetical ordering is a requirement for publication. Employing organisations, however, if not insisting on a uniform ordering practice, may go beyond observing ordering of authors on publications in attempting to determine relative contributions. The present article examines some of the incentive issues created by one such attempt at the University of Canterbury in New Zealand.

In an attempt to obtain otherwise private information on the relative contributions to co-authored research for purposes of assessing applications for either promotion or study leave, the University of Canterbury adopted a policy in 1997 whereby applicants are requested to provide additional information concerning their published research. Where published research bears the name of more than one author, the standard application forms request applicants to "underline the name of any principal author(s)". If no author is underlined, applicants are advised that "it will be assumed that all authors contribute equally to the publication".⁵ A major incentive problem arises because this mechanism is not incentive compatible in the sense that it is generally not the case that a self-interested applicant will send truthful messages to an employer concerning their research contributions.⁶ It is possible in some circumstances, however, to devise incentive compatible revelation schemes which induce truthful revelation by co-authors regarding

⁴ In the 1999 *Calendar* of the University of Canterbury, 80 percent of the Department of Psychology's listed publications were jointly authored, but only 28 percent of these exhibited alphabetical ordering of authors.

⁵ See <http://regyweb.canterbury.ac.nz/section/doc/staff/leave.doc>, p. 2, condition C and Application form99 academic promotions.doc (June 1999), p. 3, condition C.

⁶ As a disclaimer, the reader should note that I make no allegations of untruthful revelations by any of my colleagues at the University of Canterbury.

authorship seniority.

The essence of the problem is that joint research involves team production where the employer (the principal) is unable to observe the efforts of individual team members (the agents) except at prohibitive cost. Consequently, the employer may face excess claims of credit for joint production. This is a generic problem of moral hazard in teams, addressed by Holmstrom (1982). There, the principal could only observe the group's output, and individual team members had an incentive to shirk and free ride on the efforts of their colleagues. The problem is resolved in this context by the principal sharing the value of output among the team members such that each member's share exceeds their respective costs of input supply if output is no smaller than some target level, otherwise the entire group is penalized in that all agents receives a zero payoff.

Group penalties have received considerable attention in related problems. For example, Meran and Schwalbe (1987) demonstrated that either pollution emission standards or efficient effluent tax policies can be implemented as a Nash equilibrium even where firms' individual effluent discharges are unobservable. Collective penalties which are independent of the discharges of individual firms inflict punishment on all firms if total discharges exceed a given standard. Alternatively, all firms face a penalty which drives each firm's profits to zero if observed aggregate emissions exceed the sum of reported emissions under an emission tax system where firms are taxed on the basis of their reported emissions, and where an incentive to under-report is otherwise evident.⁷ Group penalties have also been suggested by Shavell (1985, 1987) for

⁷ A related approach is the two-stage *compensation mechanism* of Varian (1994), where individual firms are required to pay taxes based on the marginal social costs of the externalities they generate as reported by the remaining affected firms, and where affected firms receive compensation on the basis of the externalities reported by their producers. Varian also applies his compensation mechanism to the provision of pure public goods, the problem of inducing a monopolist to produce the socially optimal output level, the regulation of duopoly, and inducing co-operation in Prisoner's Dilemma games.

resolving incentive problems in the economic analysis of torts involving uncertainty of causation. In such cases, the courts cannot determine with certainty which of a group of potential tortfeasors (including Nature as a potential contributing 'party') is at fault. A group penalty whereby each potential injurer is liable to fully compensate the victim induces each potential injurer to take due care in order to avoid liability, whereas a rule which involves liability-sharing would dilute the incentive of each to take due care. While potential injurers are penalized for injuries they may not have caused (emphasizing the apparently harsh nature of group penalties), the critical point is that penalties are not required to be enforced in equilibrium, since they optimally induce the behaviour required to prevent the necessity of their enforcement.

In the present article, group penalties will be adopted in a modified sense, although it is evident they could be applied more generally. Unlike the typical contributions to the literature on group incentives, I emphasize the generally sequential nature of contribution reporting, concluding that punishment should be imposed on prior movers making claims of authorship seniority which are not supported by subsequent movers but which lead to their promotion. The group is punished in such situations since a prior claim of seniority effectively removes the promotion prospects for subsequent applicants. Where applications for promotion are simultaneous, contradicted claims of seniority lead to group punishment in that no author will receive promotion.

Organisation is as follows. Section 2 examines incentive problems in a basic version of what seems natural to call the *underlining game* where only two co-authors are present. Section 3 proposes a method of inducing truthful revelation when applications are sequential and the parties are in agreement as to who is the true principal co-author. Section 4 discusses the issue of mechanism design when applications are simultaneous. Section 5 considers mechanism design when the parties agree that no principal author exists, while the possibility of bargained solutions are discussed in Section 6. Section 7 discusses some implications of further relaxation of the

assumptions, and recommendations and concluding remarks are contained in Section 8.

2. The Underlining Game

Consider an article involving two co-authors employed by the same organization and that seniority is not in dispute.⁸ If applicants always made truthful disclosures, applicants would underline their name only when they are the true senior author, or else they would underline the name of the true senior author (ie, their co-author), or else they would fail to underline either name when authors truly make equal contributions. Promotion prospects would be enhanced for truly senior authors in that higher (expected) payoffs would be associated with higher reported (and true) contributions to output, which is presumably the organization's objective. The question is whether or not applicants will report truthful messages. If costs of verification are zero, applicants could do no better than reveal truthfully, since untruthful disclosures would always be discovered. It is likely that some form of penalty would be attached to a verified untruthful disclosure, and since detection is certain, there is no compensating positive expected return to falsehood. Verification costs, however, are likely to be prohibitive, and are so assumed in what follows.

For simplicity, consider applicants for promotion who are certain they will receive promotion by their university if identified as the senior author of a particular piece of work, and

⁸ I follow Engers et. al. (1999) in assuming that individual effort cannot be detected by an inspection of the joint article but that the two authors can identify their relative contributions. This contrasts with approaches in the literature dealing with self-reporting requirements whereby false reports can be detected by costly auditing; see, for example, Alm et al. (1992), Malik (1993), Kaplow and Shavell (1994), and Livernois and McKenna (1999).

who are equally certain that they will not be promoted if not identified as senior author.⁹ Further, suppose that they assume (correctly) that their co-author is not also applying for promotion at the same time. There is a strong incentive for a junior author to claim to be a senior author if there is a significant prospect that such a claim will be accepted.

Should the university accept claims of seniority in such circumstances? If it were confident that its employees always revealed the truth, claims should always be accepted. But if employees do not always reveal the truth, the university will soon face a set of inconsistent claims whereby, over time, more than one author will claim seniority. While such claims may result from genuine mistake, the university is likely to become suspicious if inconsistent claims are frequent rather than isolated. Genuine mistakes might only result when the contributions of each author are approximately equal, but many articles may be co-authored by minor contributors. The university, while seeking to separate on the basis of merit rather than merely pool the applicants, cannot confidently separate applicants on the basis of their disclosures alone.

One possibility would be to inquire of a co-author whether an applicant's disclosure is truthful. For example, if A and B are co-authors, and A identifies him/herself as senior author, the university might inquire of B whether B agrees with this assessment. Since B is also an employee of the university, and if B never intends to apply for promotion (or for employment elsewhere), and B is the true junior author, B may as well reveal that fact. But if B intends to apply for promotion in the future, in the absence of a strong aversion to lying, B's best response is the denial of A's claim whether or not A's claim is truthful. If A has lied, B cannot gain by lying, ie, verifying that A has told the truth when A has actually lied, since a future claim of

⁹ More generally, a higher expected payoff for being identified as a principal author of a given article, and a lower expected payoff for being identified as junior contributor, could be assumed without appearing to alter the problem in any fundamental sense.

authorship seniority by B would not be believed even though it is at that later juncture a true claim. If A has told the truth, however, B's future prospects are diminished by telling the truth, so B will falsely claim to be senior author. Thus, B will fail to support A's claim whether or not A's claim is valid. 'Failure to support A' is a dominant strategy for B independently of the validity of A's claim. In spite of the fact that both A and B know the truth of their respective claims, their representations have no useful informational content in the circumstances. The university may as well suppose that the contributions of the authors are equal and pool the authors. This may mean providing promotion to both or neither but not to the 'deserving' party alone. In terms of mechanism design, the university may as well have saved time and ink by not requesting disclosure.¹⁰

To formalise in a one-shot game context, suppose that the true senior author ("TS") is first mover while the true junior author ("TJ") is second mover (ie, applies for promotion at a later date). TS is constrained to a feasible strategy triple $\{\underline{TS}, \underline{TJ}, \overline{TS}\}$, where \underline{TS} means that TS (truthfully) underlines his/her own name as senior author, \underline{TJ} means that TS underlines TJ's name as senior author, and where \overline{TS} means that TS does not identify either author as having seniority.¹¹ Further, suppose that TJ can either observe or correctly infer the message sent by TS, either because TJ is a member of the relevant department's internal assessment committee (or is advised by a committee member), or because the outcome of the message sent by TS (eg, a successful rather than a failed application) sends a unique signal which effectively identifies the contents of

¹⁰ If authors believe that employers will give credence to claims of seniority, such claims will be made voluntarily without any employer requirement to identify senior authors.

¹¹ The strategy \underline{TS} & \underline{TJ} is ruled out. Hopefully, the statutory requirement of being a "good employer" under s 77A of the State Sector Act 1988 does not require a university to consider promoting somebody who claims that there are two principal authors of a paper with two authors! Such inconsistency might 'be brought to the applicant's attention'.

the message.¹²

Regarding payoffs, I assume that if TS is promoted, TS receives a payoff net of effort costs $\alpha_s > 0$, while if TS is not promoted, TS receives a net payoff $\varphi_s < 0$. If TJ is promoted, TJ receives a net payoff $\alpha_j > 0$. If effort cost functions are similar across authors, it is reasonable to suppose that $\alpha_j > \alpha_s$.¹³ If TJ is not promoted, however, TJ receives a net payoff of zero.¹⁴ Further, it is assumed that any applicant reporting truthfully when truthful revelation fails to advance their material self-interest receives $\epsilon > 0$, otherwise truthful revelation *per se* yields nothing. Also, untruthful revelation which serves an applicant's material self-interest yields a payoff $\delta < 0$, otherwise lying *per se* yields nothing.¹⁵ It is assumed that the university's interests are served by the promotion of the senior author (as a reward for effort and to maintain incentives for additional future effort by prospective senior authors) but not by the promotion of the junior

¹² Thus, the resulting game involves complete information. It would clearly be interesting to extend the present analysis to cases involving incomplete information.

¹³ A more general approach would clearly treat the effort decision as endogenous. Strictly, the present analysis is probably more appropriate where the university unexpectedly introduces an authorship seniority reporting requirement, given that effort decisions have been made under a different set of incentives.

¹⁴ TJ must receive at least a zero net payoff in order to participate in research, but the assumption of a zero net payoff is effectively a simplifying normalization.

¹⁵ Thus, it is assumed that applicants may suffer some disutility from guilt if they lie to advance their own cause, but will not act maliciously or lie at random, while if the truth advances the cause of a co-author, they are assumed to be no worse off on account of their actions. These assumptions are necessary to allow the possibility that free riding by junior authors on senior authors will not (always) occur, consistent with the evidence from the experimental literature on public goods where general free riding is reported not to occur; see the survey in Ledyard (1995). General free riding, however, is often reported to be approached (if not reached) in studies which replicate one-shot experimental sessions, although Cadsby and Maynes (1999) recently find that in experiments with threshold public goods, convergence of contributions to the threshold occur if rewards are sufficiently large. In an experimental context involving group incentive programmes, however, Nalbantian and Schotter (1999) report that a shirking equilibrium is approached towards the end of their experiment when incentive plans provide strong incentives to shirk.

author (whom we assume receives rewards in another manner, say an annual salary increment or at least no decrement). The university, however, is assumed to prefer that both be promoted rather than neither being promoted when a senior author exists, although respective net payoffs are negative in each case. If no senior author exists, the university receives a positive net payoff only if neither co-author is promoted, and would prefer that only one be promoted to both being promoted in these circumstances. Finally, it is assumed that the differential net payoff to the university from promoting a true senior author rather than both co-authors exceeds the net payoff to the junior author less that author's losses resulting from lying. The university's net payoffs are as follows:

β_1 if TS exists and TS is promoted whereas TJ is not promoted.

β_2 if TS exists and both TS and TJ are promoted.

β_3 if TS exists and neither TS nor TJ are promoted.

β_4 if TS exists and TS is not promoted whereas TJ is promoted.

β_5 if TS does not exist and neither co-author is promoted.

β_6 if TS does not exist and one or other co-author is promoted.

β_7 if TS does not exist and both co-authors are promoted.

The following restrictions are imposed:

$$\beta_1 > 0 > \beta_2 > \beta_3 > \beta_4.$$

$$\beta_5 > 0 > \beta_6 > \beta_7.$$

$$\beta_1 - \beta_2 > \alpha_j - (\epsilon - \delta).$$

Consider in turn the resulting extensive form game tree illustrating the university's 'naive' revelation mechanism, where the true senior's direct payoffs precede those of the true junior, followed by the payoffs to the university. Figure 1 illustrates the case where TS is first mover, and Figure 2 illustrates the case where TJ is first mover.

FIGURES 1 & 2 ABOUT HERE

Suppose TS is first mover. Independently of the choice of strategy by TS, TJ's best response is the truthful message TS if $\alpha_j + \delta \leq \epsilon$, otherwise TJ reports the untruthful message TJ. While a dominant strategy exists for TJ, which of TS or TJ will be reported is parameter-dependant. Absent a passion for the truth or severe feelings of guilt from lying so that $\delta, \epsilon \approx 0$, it will be in the junior author's self-interest to claim senior authorship in order to gain promotion.¹⁶ Note that TJ's promotion does not come at the expense of TS. Thus, if TS reports truthfully, TS is promoted as a result. Should TS falsely claim either that TJ is the senior author, or else deny the existence of a senior author, TS will not be promoted. TJ, however, will be promoted by reporting TJ, but not by reporting either TS or T \bar{S} . Under no circumstance will TJ claim that neither author is senior, since this falsehood yields a payoff of zero to TJ. Although TJ has misrepresented, TJ does not gain anything thereby, and must do better either to tell the truth and receive ϵ (if $\alpha_j + \delta \leq \epsilon$) or to lie in one's self interest and receive $\alpha_j + \delta$ (if $\alpha_j + \delta > \epsilon$). If TJ's dominant strategy is to report truthfully, TS will also report truthfully in order to receive α_s from promotion. Alternatively, if TJ reports TJ, TS will again report truthfully. Thus, independently of whether TJ will subsequently support a truthful claim by TS or not, a dominant strategy for TS is to claim senior authorship. The equilibrium of this game is either a sequence of reports {TS, TS} by TS and TJ, respectively, or a sequence {TS, TJ} by the two co-authors. The parameters α_s, δ , and ϵ will determine which of these two equilibria will emerge, while the magnitude of the payoffs α_s and ϕ_s to TS, and any of the payoffs to the university, are immaterial to this result.

The university is not indifferent between the competing equilibria given that TS reports truthfully. If TJ reports truthfully, the university's payoff is β_1 , whereas if it pays TJ to lie, the

¹⁶ I follow the usual convention of assuming that agents will report truthfully if they are indifferent between the outcomes produced by truth and falsehood.

university's payoff is β_2 ($0 < \beta_1$). Further, the social payoff is maximized by choice of the strategy pair $\{\underline{TS}, \underline{TS}\}$ since the social payoff is $\alpha_s + \varepsilon + \beta_1$ which exceeds the social payoff $\alpha_s + \alpha_j + \delta + \beta_2$ when the strategy pair $\{\underline{TS}, \underline{TJ}\}$ is chosen. For the latter, society loses the benefits of truth-telling *per se*, and suffers the costs of lying *per se*, while the monetary gains to inappropriately promoting TJ fail to compensate for the direct costs of promotion plus the costs in terms of diluted incentives for future joint research. The greater net payoff to being junior (as opposed to senior) yet both receiving promotion leads to a scramble to be the junior author, and both the quantity and quality of output is expected to suffer thereby. Unequal effort, however, may be a socially efficient allocation among the parties.

Turning to the case where TJ is first mover, it is clear that whatever TJ elects to report, a truthful report of \underline{TS} by TS yields a payoff of α_s to TS rather than the lower (negative) payoff of φ_s which occurs when TS fails to make a valid claim of seniority. Truth-telling is again a dominant strategy by TS. Knowing this, the first-moving TJ will report \underline{TS} if $\alpha_j + \delta \leq \varepsilon$, and \underline{TJ} if $\alpha_j + \delta > \varepsilon$. The two equilibria, and the conditions under which one or other will occur, is identical to the case where TS is first-mover. Again, only the full truth-telling equilibrium is socially optimal.

Although the university's reporting mechanism can produce efficient equilibria such that only a true senior author receives promotion, such an outcome is not the only possibility. Further, the efficient outcome relies on truthful reporting by individuals who have strong incentives to do otherwise. While truthful reporting in these circumstances may occur, it is unlikely that truthful reporting can be relied upon in all circumstances. Even if academic staff all look like a George Washington, regrettably, some of them may be a well-disguised Pinocchio with a capacity to check the growth of one's nose. Consequently, attention turns to a search for mechanisms which are incentive compatible in that they induce truthful revelation in all circumstances.