Optimal Culpability in Research Teams

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Researcher Misconduct is a Serious Problem in Science

- Stanford president Marc Tessier-Lavigne resigned over flaws and potential misconduct.
- Duke University is investigating published work by Dan Ariely.
- Johns Hopkins University investigates research misconduct by Nobel laureate Gregg Semenza.
- Francesca Gino of Harvard is in a legal dispute over data manipulation.

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RESEARCH ARTICLE

How Many Scientists Fabricate and Falsify Research? A Systematic Review and Meta-Analysis of Survey Data

Daniele Fanelli

Published: May 29, 2009 • https://doi.org/10.1371/journal.pone.0005738

Article | Authors | Metrics | Comments | Media Coverage

Abstract

The frequency with which scientists fabricate and falsify data, or commit other forms of scientific misconduct is a matter of controversy. Many surveys have asked scientists directly whether they have committed or know of a colleague who committed research misconduct, but their results appeared difficult to compare and synthesize. This is the first meta-analysis of these surveys.

To standardize outcomes, the number of respondents who recalled at least one incident of misconduct was calculated for each question, and the analysis was limited to behaviours that distort scientific knowledge: fabrication, falsification, "cooking" of data, etc… Survey questions on plagiarism and other forms of professional misconduct were excluded. The final sample consisted of 21 surveys that were included in the systematic review, and 18 in the meta-analysis.

Economic Inquiry WEAI

Full Access

Academic economists behaving badly? A survey on three areas of unethical behavior

JA List, CD Bailey, PJ Euzent, TL Martin

First published: 26 March 2007 | https://doi.org/10.1111/j.1465-7295.2001.tb00058.x | Citations: 25

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Abstract

This article measures the degree to which academic economists have engaged in unethical behavior and the degree to which academic economists believe the profession as a whole engages in unethical behavior. Three main types of unethical behavior are examined: (1) falsification of research; (2) expropriation of graduate student research or including an undeserving co-author on a research paper; and (3) exchange of grades for gifts, money, or sex. Using a unique data set gathered at the 1998 American Economic Association (AEA) meetings, we find that there is a significant amount of misconduct, particularly in the second category.

The New York Times

Harvard Scholar Who Studies Honesty Is Accused of Fabricating Findings

Questions about a widely cited paper are the latest to be raised about methods used in behavioral research.

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The Current Landscape in Research

- Increasing average size of research teams, associated with more impact.
  - (Lariviere et al., 2015).
- In genetics and neuroscience, larger consortia needed to address low power.
  - Poldracket al. (2017)
- Hall et al. (2018): “. . . *rapid increases in the demand for scientific collaborations have outpaced changes in the factors needed to support teams in science, such as institutional structures and policies, scientific culture, and funding opportunities*.”
- Issues of authorship, credit and accountability come to forefront.

Approaches to Accountability

- Scientific community is considering different alternatives in assigning responsibility in science (Helgesson and Eriksson, 2018; Hussinger and Pellens, 2019). The main approaches can be categorized as follows:

Group accountability regime: everyone is responsible for any misconduct.

Partial group accountability regime: anyone in the team is responsible if they knew about misconduct.

Individual accountability regime: only those committing misconduct are responsible.

Guarantor regime: an overall coordinator of the project is accountable for all aspects.

Roadmap

- We build a simple model of research and misbehavior.
- Misbehavior can be checked by external monitoring and punishment, but also by internal monitoring which leads to possibly aborting the project.
- We examine the relative performance of the different regimes in terms of total research conducted and the fraction of fraudulent research.
- We find that **group accountability** can induce monitoring and achieve better social outcomes.

Related Literature

- Misconduct attributed to culture and structural/psychological factors. Accountability policies have primary role in explaining misbehavior evidence (Fanelli et al., 2015).
- Lacetera and Zirulia (2011) study incentive structures for regulating and punishing. Reduction in fraud verification costs only leads to change in type of conducted research.
- Marx and Squintani (2009) model individual accountability in teams. Delegated monitoring can be efficiency-enhancing – even in absence of group penalty.
- Miceli and Segerson (2007): when is group punishment preferred to individual punishment under uncertainty about perpetrator? If goal is ex-post fairness, group punishment is preferred.
- Kiri et al. (2018) examine incentives to conduct verification activities in science. They find that a positive fraction of low-quality research characterizes any equilibrium of the game. Society needs to tolerate some level of misbehaviour or low-quality research.

The Model

- Two researchers, $S1$ and $S2$

- $S1$ moves first and chooses action in $\{F, H\}$

$p \in [0,1]$ is prob. of F

- $S2$ moves second and chooses action in $\{WA, NM, M\}$

$q_1, q_2 \geq 0$ are probs. of WA, NM respectively.

- Monitoring: if $S2$ has opted for M, she then chooses monitoring intensity

$z \in (0, \frac{1}{2}]$

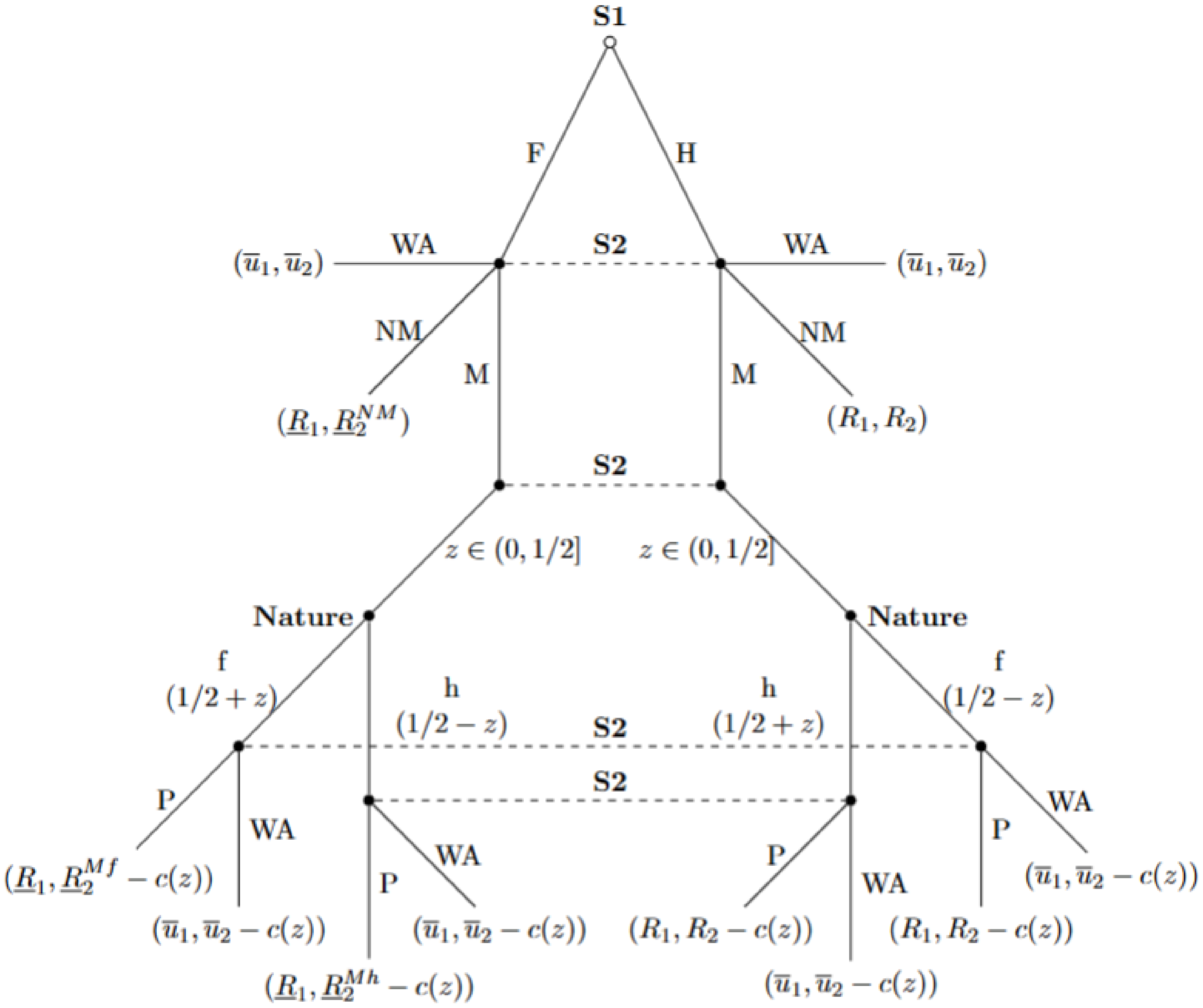
Payoffs

- $\overline{u_1}, \overline{u_2}$ outside options if project is aborted.
- R_1, R_2 payoffs from completing honest project.
- $\frac{1}{2} + z$ is probability of signal corresponding to truth if monitoring intensity is z.
- $c(z)$ cost of monitoring with intensity z for $S2$.

Payoffs

- Payoffs of fraudulent project depend on whether ‘you get away with it’.
- $\widehat{R_1}$, $\widehat{R_2}$ researchers’ payoffs if they ‘get away with it’.
- Random edit by external authority with probability π.
- Punishment τ_1, τ_2 respectively if caught in fraudulent project.
- $\underline{R_1}$, $\underline{R_2}$, expected payoffs from completing fraudulent project.

$$\underline{R_1} = (1 - \pi)\widehat{R_1} + \pi(R_1 - \tau_1)$$
$$\underline{R_2} = (1 - \pi)\widehat{R_2} + \pi(R_2 - \tau_2)$$



S1
F
H
S2
WA
WA
$(\overline{u}_1, \overline{u}_2)$
$(\overline{u}_1, \overline{u}_2)$
NM
NM
M
M
$(\underline{R}_1, \underline{R}_2^{NM})$
(R_1, R_2)
S2
$z \in (0, 1/2]$
$z \in (0, 1/2]$
Nature
Nature
f
$(1/2 + z)$
h
$(1/2 - z)$
h
$(1/2 + z)$
f
$(1/2 - z)$
S2
S2
P
WA
WA
P
P
WA
P
WA
$(\underline{R}_1, \underline{R}_2^{Mf} - c(z))$
$(\overline{u}_1, \overline{u}_2 - c(z))$
$(\underline{R}_1, \underline{R}_2^{Mh} - c(z))$
$(\overline{u}_1, \overline{u}_2 - c(z))$
$(R_1, R_2 - c(z))$
$(\overline{u}_1, \overline{u}_2 - c(z))$
$(R_1, R_2 - c(z))$
$(\overline{u}_1, \overline{u}_2 - c(z))$

Regime 1: Individual Accountability

- Punishment for $S2$ is restricted only to lost value of project: $\tau_2 = R_2$.
- Therefore, NM is strictly dominant strategy for $S2$.
- Unique equilibrium is $(Fraud, Not\ Monitor)$.
- The worst outcome from the social planner's perspective.

Regime 2: Partial Group Accountability

- $S1$ is culpable if he commits fraud: $\tau_1 > R_1$.
- $S2$ is also culpable, but only if she knew about the fraud: she faces larger-than-minimal punishment only if she gets a signal about the fraud: $\tau_2 > R_2$.
- If she does not monitor, or if she monitors but does not detect the fraud, she merely loses the value of the project: $\tau_2 = R_2$.
- Again, NM strictly dominant strategy for $S2$ and unique equilibrium is $(Fraud, Not\ Monitor)$.
- The worst outcome from the social planner's perspective.

Summing Up

- The capacity of research members to monitor others does not improve quality of research under individual accountability and partial group accountability regimes.
- Unless $S2$ is unconditionally culpable, she has no incentive to monitor.
- Alternative regimes need to be considered.

Regime 3: Group Accountability

- Both $S1$ and $S2$ are culpable, regardless of $S2$'s choice of monitoring and the observed signal.
- Sizes of the punishments for the two scientists are not necessarily equal, we only specify that $\tau_1 > R_1$ and $\tau_2 > R_2$.
- Furthermore, assume that $\underline{R_2} < 0 < R_2$, $\mathrm{c(z)} = \frac{z^2}{2}$ and $\overline{u_1} = \overline{u_2} = 0$

Preliminaries

- First, any strategy where $S2$ does not follow her signal is strictly dominated.
- Second, the EU of $S2$ conditional on having chosen M and believing that $S1$ has committed fraud with probability p is given by:

$$EU_2(z|p,M) = p\left[\left(\frac{1}{2} - z\right)\underline{R}_2\right] + (1-p)\left[\left(\frac{1}{2} + z\right)R_2\right] - \frac{1}{2}z^2$$

- The above function is strictly concave in z for all $z \in \left(0, \frac{1}{2}\right]$, thus it attains a unique maximum within that range.

Expected Utilities

- So, for scientist $S2$ we have that:

$$EU_2(M|p) = p\left[\left(\frac{1}{2} - z^*(p)\right)\underline{R}_2\right] + (1-p)\left[\left(\frac{1}{2} + z^*(p)\right)R_2\right] - \frac{1}{2}\left[z^*(p)\right]^2$$

$$EU_2(NM|p) = p\underline{R}_2 + (1-p)R_2$$

$$EU_2(WA|p) = 0$$

- And for scientist $S1$ we have that:

$$EU_1(H|q_1, q_2, z) = q_2 R_1 + (1 - q_1 - q_2)\left(\frac{1}{2} + z\right)R_1$$

$$EU_1(F|q_1, q_2, z) = q_2 \underline{R}_1 + (1 - q_1 - q_2)\left(\frac{1}{2} - z\right)\underline{R}_1$$

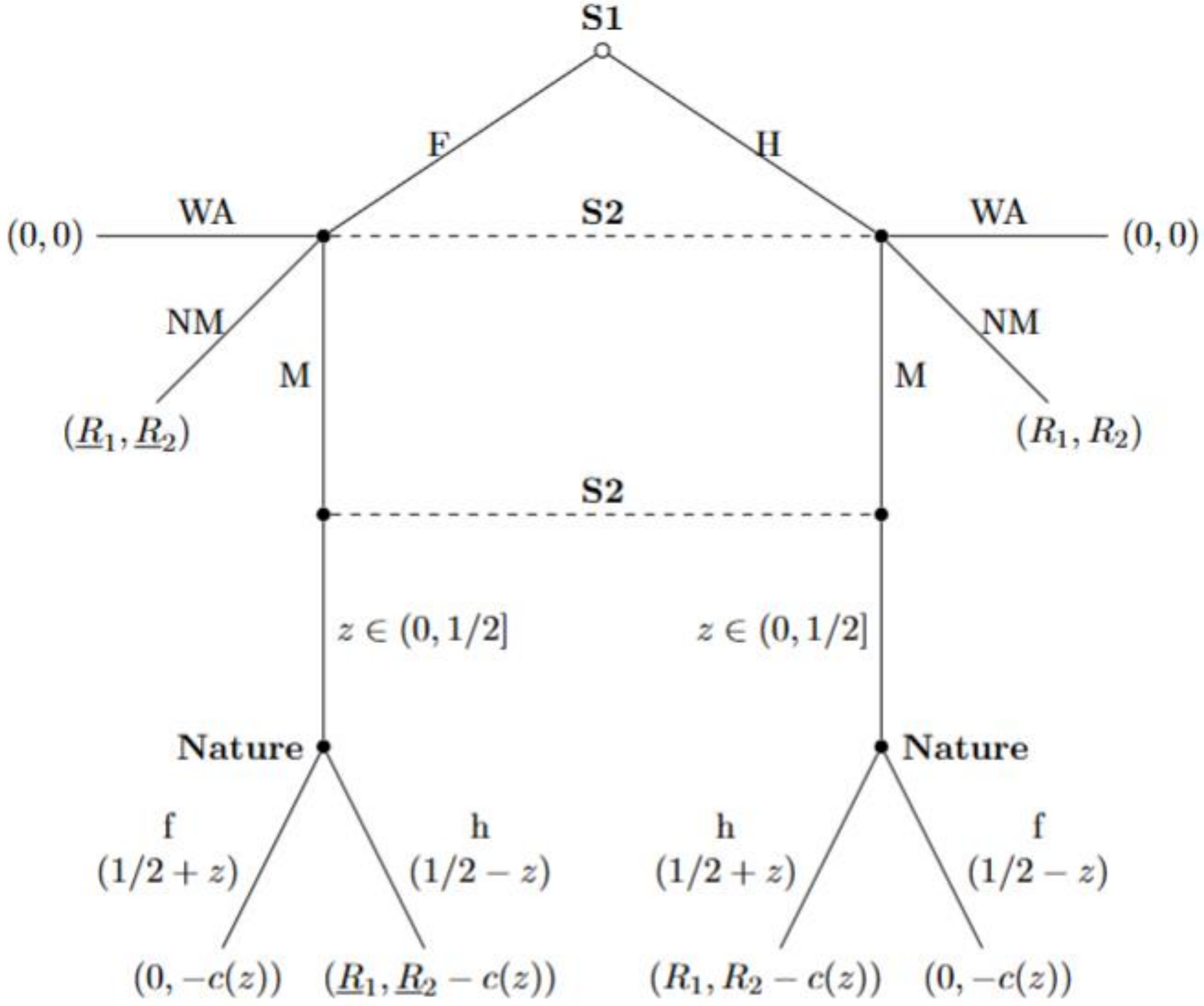


Figure 2: Reduced Game Tree under Group Accountability

Perfect Bayesian Equilibrium

- Equilibrium is characterized by a triplet (p^*, q_1^*, q_2^*) and $z^*(p^*)$

- Define $a \equiv -\underline{R_2} > 0$ $\quad b \equiv R_2 > 0$ $\quad k \equiv \frac{\underline{R_1} - R_1}{\underline{R_1} + R_1}$

Loss of remaining in fraudulent project

Gain of being involved in honest project

Relative gain of committing fraud

Best Responses

- Optimal monitoring: $\frac{\partial EU_2}{\partial z} = pa + (1-p)b - z \Rightarrow z^*(p) = pa + (1-p)b$

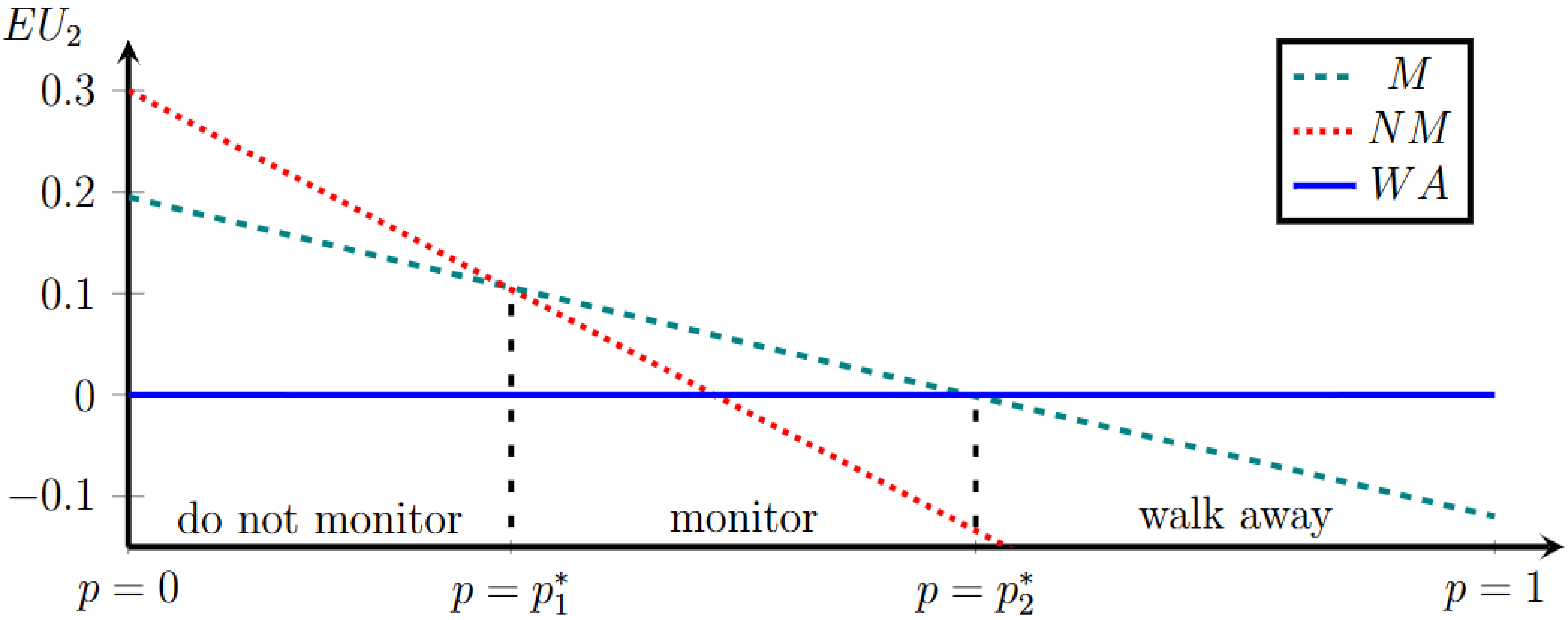
- Substituting we have that:

$$EU_2(M|p) = \frac{1}{2}\left[-pa + (1-p)b\right] + \frac{1}{2}\left[pa + (1-p)b\right]^2$$

$$EU_2(NM|p) = -pa + (1-p)b$$

$$EU_2(WA|p) = 0$$

Best Responses of $S2$



Best Responses of $S1$

- Optimal decision of $S1$ depends on whether the incentives to commit fraud are sufficiently high given (q_1, q_2) and z.

- This depends on the sign of the expression $2q_2k + (1 - q_2 - q_2)(k - z)$.

Proposition 1 *For $a \in [a_{min}, a_{max}] \subset (0, 1/2)$, $b \in [b_{min}, b_{max}] \subset (0, 1/2)$, and $k \in [k_{min}, k_{max}] \subset (0, 1/2)$ the game has the following types of equilibria:*

[1] $(\forall\ a, b, k)$**:** $p^* \in [p_2^*, 1]$, $(q_1^*, q_2^*) = (1, 0)$, $z^* = p^*a + (1 - p^*)b.$

[2] $(a \neq b$ *and* $\frac{k-b}{a-b} \in [p_1^*, p_2^*])$**:** $p^* = \frac{k-b}{a-b}$, $(q_1^*, q_2^*) = (0, 0)$, $z^* = k.$

[3a] $(a \neq b$ *and* $\frac{k-b}{a-b} = p_2^*)$: $p^* = p_2^*$, $(q_1^*, q_2^*) = (\hat{q}, 0)$ *for* $\hat{q} \in (0, 1)$, $z^* = k.$

[3b] $(a = b = k)$**:** $p^* = p_2^*$, $(q_1^*, q_2^*) = (\hat{q}, 0)$ *for* $\hat{q} \in [0, 1)$, $z^* = k.$

[4a] $(a > b$ *and* $\frac{k-b}{a-b} \leq p_1^*)$**:** $p^* = p_1^*$, $(q_1^*, q_2^*) = \left(0, \frac{p_1^*a+(1-p_1^*)b-k}{p_1^*a+(1-p_1^*)b+k}\right)$, $z^* = p_1^*a + (1 - p_1^*)b.$

[4b] $(a < b$ *and* $\frac{k-b}{a-b} \geq p_1^*)$**:** $p^* = p_1^*$, $(q_1^*, q_2^*) = \left(0, \frac{p_1^*a+(1-p_1^*)b-k}{p_1^*a+(1-p_1^*)b+k}\right)$, $z^* = p_1^*a + (1 - p_1^*)b.$

[4c] $(a = b \geq k)$**:** $p^* = p_1^*$, $(q_1^*, q_2^*) = \left(0, \frac{a-k}{a+k}\right)$, $z^* = a.$

Discussion

- Eqm. 1 involves the uninteresting case where S2 always walks away and mutual trust between players fails.
- Eqm. 3 obtains for very specific parameters and is therefore of limited relevance.
- Eqm. 4 dominates Eqm. 2 in terms of efficiency.
- Given welfare advantage, we focus the analysis on Eqm. 4.

Regime 4: Guarantor Accountability

- Only $S2$ is held responsible for any fraud.
- In this case, $\tau_1 = R_1$ and $\tau_2 > R_2$.
- Equilibria found in Proposition 1 still hold: special case of group accountability regime.
- Preferred equilibrium is Eqm. 4 by Corollary 1.
- k is fixed at its maximum value in this case.

Efficiency and Welfare Measures

- a, b and k are relevant variables, some of which can be affected by policy.
- Equilibrium levels of total research (TR), fraudulent research (FR), and honest research (HR) as functions of a, b, and k.
- a and b appear implicitly in the expressions through p_1^* and z^*.

$$TR = q_2^* + (1 - q_2^*)\left(p_1^*\left(\frac{1}{2} - z\right) + (1 - p_1^*)\left(\frac{1}{2} + z\right)\right) = z^*\frac{1 + 2k(1 - 2p_1^*)}{z^* + k}$$

$$HR = (1 - p_1^*)\left(q_2^* + (1 - q_2^*)\left(\frac{1}{2} + z^*\right)\right) = z^*(1 - p_1^*)\frac{1 + 2k}{z^* + k}$$

$$FR = p_1^*\frac{z^*(1 - 2k)}{z^* + k}$$

Proposition 2 *In the space of parameters (a, b, k) where the mixed equilibrium of the Group Accountability Regime (Equilibrium 4 of Proposition 1) exists, the following results hold:*

1. *For all a, b, Total Research (TR), Honest Research (HR), and Fraudulent Research (FR) decrease in k.*

2. *For all a, b, the ratio HR/TR increases in k.*

3. *For all b, k, TR and HR increase in a.*

4. *For all b, (i) for all $k > \frac{\sqrt{29}-3}{10}$, FR decreases in a, whereas (ii) for all $k < \frac{\sqrt{29}-3}{10}$, there exists $\hat{a}(b) \in (0, b)$ such that FR increases in a for $a < \hat{a}$ and decreases for $a > \hat{a}$.*

5. *For all b, k, the ratio HR/TR increases in a.*

6. *For all a, k, FR increases in b.*

7. *For all a, k, the ratio HR/TR decreases in b.*

Comparative statics of main variables

- Higher incentive for $S1$ to commit fraud not necessarily detrimental. If k remains small compared to a and b, an increase in k is internalized by $S2$ via higher equilibrium probability of monitoring. This lowers FR and HR, but FR decreases proportionally more.
- Increasing b leads to more fraudulent research and to lower share of honest research. Increasing b leads to less monitoring and higher equilibrium probability of fraud.
- A decreased payoff of $S2$ from being involved in a fraudulent project has positive effect, leading to more total research. A higher punishment leads to lower equilibrium levels of fraud and to higher monitoring accuracy (albeit monitoring occurs less often).
- Payoffs from participating to fraudulent project depend on probability of detection by external monitor and punishment. So, this variable is affected by norms and policies.

Social Welfare Maximization

- The social planner is bound to tolerate some level of fraudulent research.
- Assume that the social planner maximises HR-FR.

Proposition 3 *In the space of parameters (a, b, k) where the mixed equilibrium of the Group Accountability Regime (Equilibrium 4 of Proposition 1) exists, there exists some $\hat{b} \in (0, 1/2)$ such that HR-FR is maximized for*

- $(a, k) = (a_{max}, k_{min})$ *if* $b \leq \hat{b}$, *and*
- $(a, k) = (a_{max}, k_{max})$ *if* $b > \hat{b}$.

- HR-FR is never maximized for intermediate levels of k, while for all k the objective function is increasing in a.

Discussion

- It is always beneficial for the planner to induce the maximum allowed punishment to the scientist who is responsible for monitoring.
- Planner leads $S2$ to increase her effort of preventing fraud, while still participating in the project.
- This leads $S1$ to commit fraud with a smaller probability.
- Optimal punishment for $S1$ is less clear. It may be optimal to eliminate completely the punishment for $S1$. This may raise ethical concerns.

Conclusions

- Trade-offs between ethical principles and efficiency of incentives are ubiquitous.
- If punishment of perpetrators is unbounded the first-best is achieved. However, can criminal prosecution be the solution to scientific misbehaviour?
- If punishment is bounded, most efficient regime involves group accountability, which can be ethically controversial. Is it correct to punish those who did not commit and were not aware of fraud?
- Policymaker has to accept some level of fraud.

APPENDIX

Overall, the best-response of **S2** to each p is as follows:

$$(q_1^*, q_2^*) = \begin{cases} (0,1), & \text{if } p < p_1^* \\ (0,0), & \text{if } p \in (p_1^*, p_2^*) \\ (1,0), & \text{if } p > p_2^* \\ (0, q_2^* \in [0,1]), & \text{if } p = p_1^* \\ (q_1^* \in [0,1], 0), & \text{if } p = p_2^* \end{cases}$$

where

$$p_1^* = \begin{cases} \frac{2b(b-a)-(a+b)+\sqrt{(a+b)^2-8ab(b-a)}}{2(b-a)^2}, & \text{if } a \neq b \\ \frac{1-a}{2}, & \text{if } a = b \end{cases} \qquad p_2^* = \begin{cases} \frac{2b(b-a)+(a+b)-\sqrt{(a+b)^2+8ab(b-a)}}{2(b-a)^2}, & \text{if } a \neq b \\ \frac{1+a}{2}, & \text{if } a = b \end{cases}$$