

# Understanding the Reward System of Science

An Economic Approach

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# Historical eras

## AMATEUR ERA

- Individual scientists pursuing their own curiosity
- No central authority for the provision of credit
- No central funding or approval process

## PROFESSIONAL ERA

- Central authority who provides credit for success
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## MODERN ERA

- Central authorities for credit, funding, and approval

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## Scientist's concerns

[T]oday's free intellects ... find themselves tethered to national goals for health, defense, economic competitiveness, and the like.

Colleges, universities, and research institutes have come to depend on federal research support, a dependence that is transmitted (and perhaps amplified along the way) to the scientists and scholars they employ, further limiting intellectual "free play." New ideas must pass through the filter of peer review, which stimulates opposition and encourages applicants to be cautious, if not conservative, in their proposals. (Chubin and Hackett 1990, p. 10)

## Scientist's concerns

If you look at most cancer research journals you will see that our focus remains on finding smaller cancers, doing less surgery and radiation and developing new drugs to add to the old ones in an attempt to treat the cancers we detect. This approach ... hasn't changed since I was a resident in training 30 years ago. ... There is little chance, much less financing, for the wild idea that might prove revolutionary. ...

[Our peer review system for financing research] works well at eliminating poor investments, but it squelches innovation and fosters the old boy network. ... And our academic and research institutions reward projects with clearly defined objectives that have a good chance of quickly leading to publications and tenure. (Love 2007)

## Two concerns

### SCIENTIFIC FREEDOM

To what extent are scientists free to choose their own projects?

### SCIENTIFIC DIVERSITY

How many different projects are pursued by a community of scientists?

# Central research questions

To what extent are scientific diversity and scientific freedom assisted or hampered by the three different eras of scientific incentives?

## Our model

Set of hypotheses (H)  
Set of experiments (E)  
Set of experimental outcomes (O)  
Probability distribution over  $H \times E \times O$   
Utility function over O

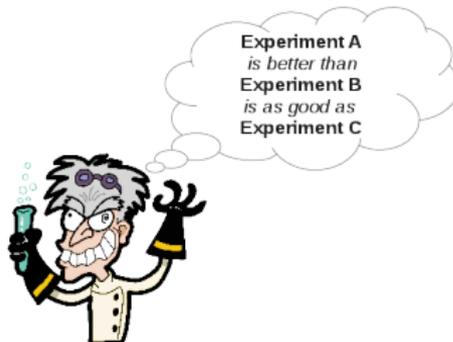


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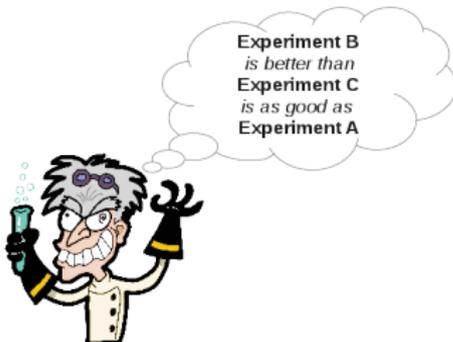
**Experiment A**  
*is better than*  
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Experiment C  
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# Different eras

## AMATEUR ERA

Each scientist chooses to maximize her own probability/utility functions – she has only herself to answer to

## PROFESSIONAL ERA

Each scientist utilizes her own probability function and a common utility function – everyone gets credit from the same institution

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# Freedom

## Definition

One era exhibits more freedom than another, if it allows for *strictly* more community profiles than another

## Theorem

The amateur era exhibits more freedom than the professional era which exhibits more freedom than the modern era.

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Critical experiment	Theory A accepted	Theory B accepted
Incremental project	Incremental progress	

- *Scientist One:* Critical experiment  $\succ$  Incremental project
  - Accepting A  $\succ$  Incremental progress  $\succ$  Accepting B
  - State 1 is more likely than state 2
- *Scientist Two:* Critical experiment  $\prec$  Incremental project
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# Conclusions

- The modern era exhibits less diversity and freedom than does the earlier eras
- Prizes exhibit more freedom and diversity than does the peer-reviewed grant system
- Should we switch?
  - Are diversity and freedom desirable?
  - Disallowing them comes at a cultural worth paying (e.g., reduction of public trust)
- Much future work to do...

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- Prizes exhibit more freedom and diversity than does the peer-reviewed grant system
- Should we switch?
  - Are diversity and freedom desirable?
  - Do we have them? (e.g., culture, world, money, etc.)
  - How do we measure public trust?
- Much future work to do...

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