

Job Insecurity in Academic Research Employment: An Agent-Based Model

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Why model academia?



The life of an academic is less and less secure these days:

- In the UK, only 3.5% of PhD graduates end up with a permanent academic post
- 68% of researchers are on short-term contracts
- 21% of academics have trouble putting food on the table
- In the US, 75% of academic posts are adjunct positions – a tenfold increase since 1975

Why model academia?



Evidence suggests competitive funding isn't efficient:

- Canadian funding councils found that impact is a decreasing function of funding
- Studies in the UK found that funding increased publication output but impact factor/citations much less so

Why model academia?



Funding competitions also lead to wasted time:

- In the UK most councils fund 15-25% of submitted proposals – but each bid is the product of many hours of research effort
- In some universities, academics report spending >50% of their time chasing funding

Why model academia?



We're left with big questions:

- Are competitive funding + postdocs an efficient way to use our research money?
- If not, what do we do instead? If so, can we make it better and reduce these issues?

Modelling Research Funding

Geard and Noble (2010) built a simple model of academic research funding as a resource allocation problem:

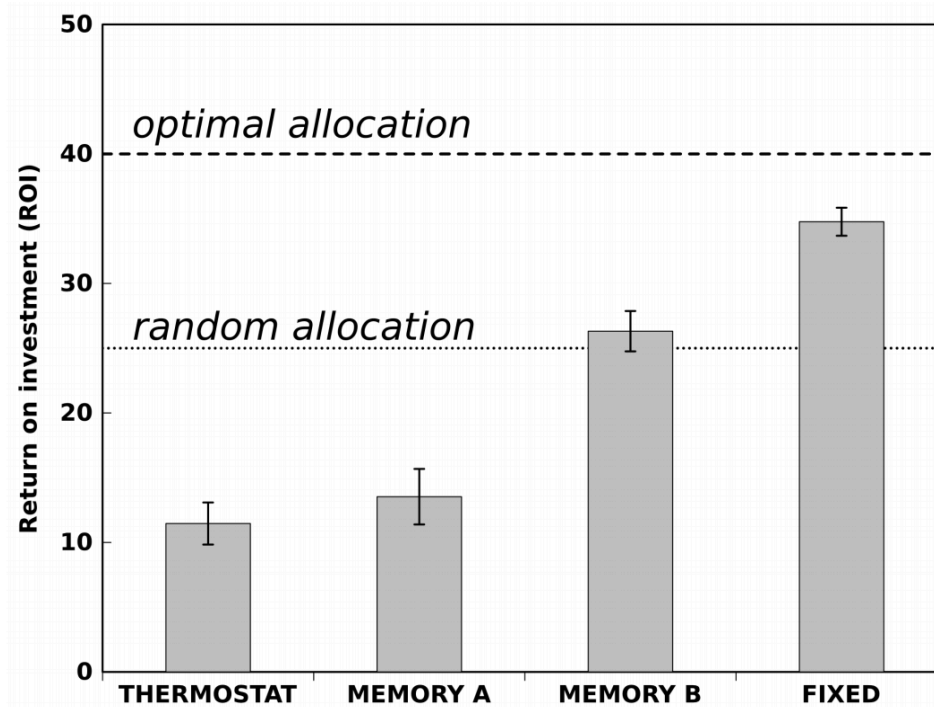
- 100 academic agents compete for limited funding by submitting grants
- Agents have individual 'Research Quality' ratings, and must dedicate time to producing bids
- Bids are rated and funded according to quality, and grant-holding agents gain a bonus to research output
- Agents dynamically allocate their time according to their successes/failures in the recent past
- At the end of each semester, agents produce research according to their productivity, grant-holder status and time allocation for research

Time Allocation Strategy

Our research careers model includes the funding model from Geard and Noble (2010), and agents use the Memory strategy for time allocation:

1. If I've been successful in my last bid, but not in the recent past, keep my efforts the same
2. If I'm consistently getting money, reduce my efforts slightly
3. If I just failed, but got money in the recent past, increase my efforts slightly
4. If I keep failing consistently, drop out and focus on my own research

Modelling Research Funding



The most efficient method for disbursing money was fixed allocation – all agents dedicate 10% of their time. Competitive funding allocation leads to wasted time and reduced research output.

Modelling Postdoc Careers

Changes to the core funding model:

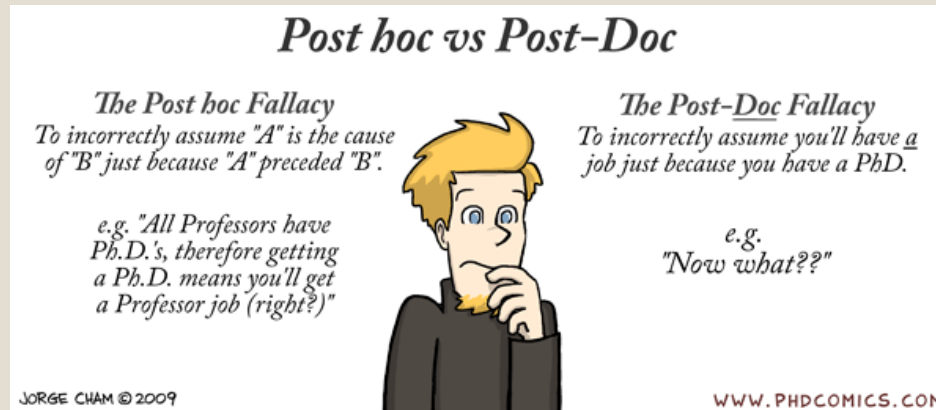
1. Agent population is now *dynamic*: postdocs are added to the population as grants are funded
2. Agents' memory strategy had to be adjusted to account for this newfound instability (their memory 'window' increased to 12, from 5)
3. *Postdoc agents* added, they differ from permanent academics in several respects

Postdoc Agents

Postdoc agents were based on UK norms:

1. 100% research
2. Unable to apply for grants
3. *Fixed-term contracts*, ranging from 4 – 10 semesters
4. New postdocs experience a slight reduction in research quality
5. During the final two semesters of their contract postdocs are *stressed* and experience a larger reduction in research quality

Promotions and Mentoring

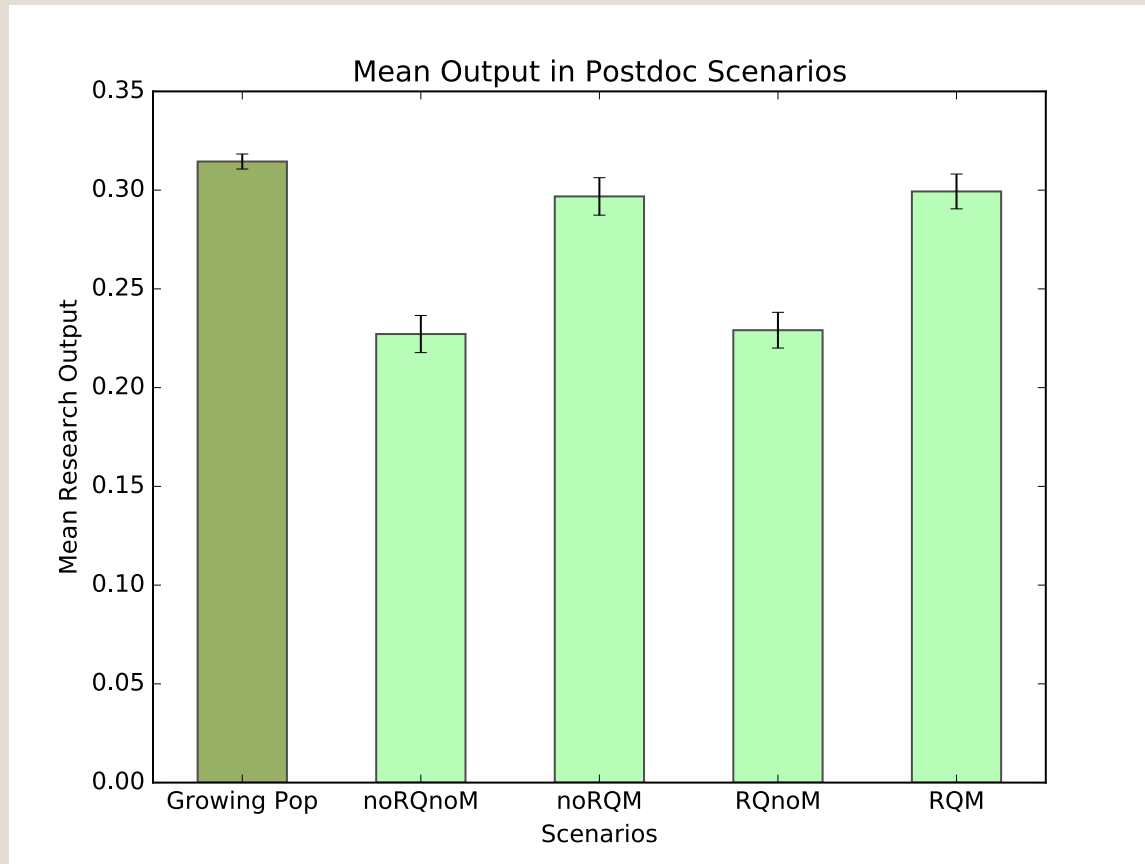


Postdocs reaching the end of their contracts have a 15% chance of being promoted into a permanent post (based on UK figures)

Newly-minted academics are given *mentoring* in certain scenarios

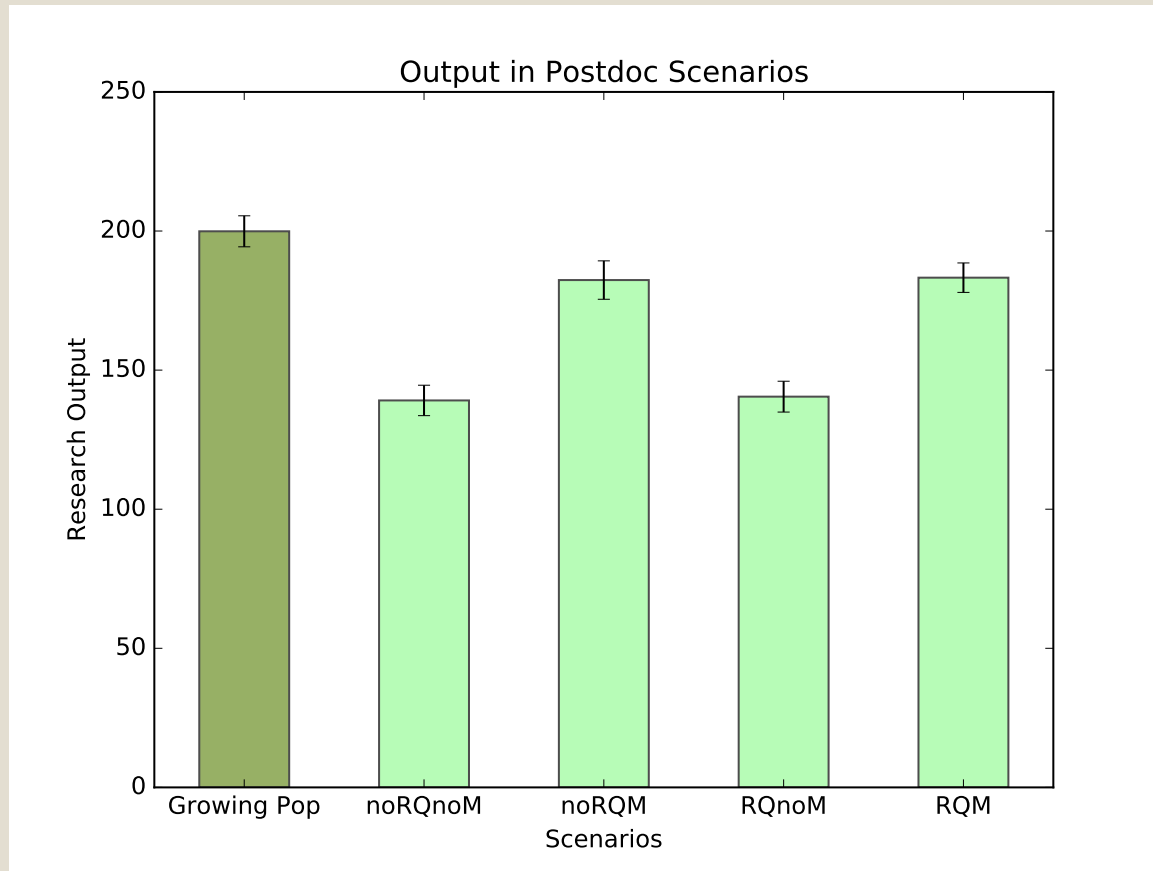
Postdocs not promoted leave the system

Results – Four Scenarios



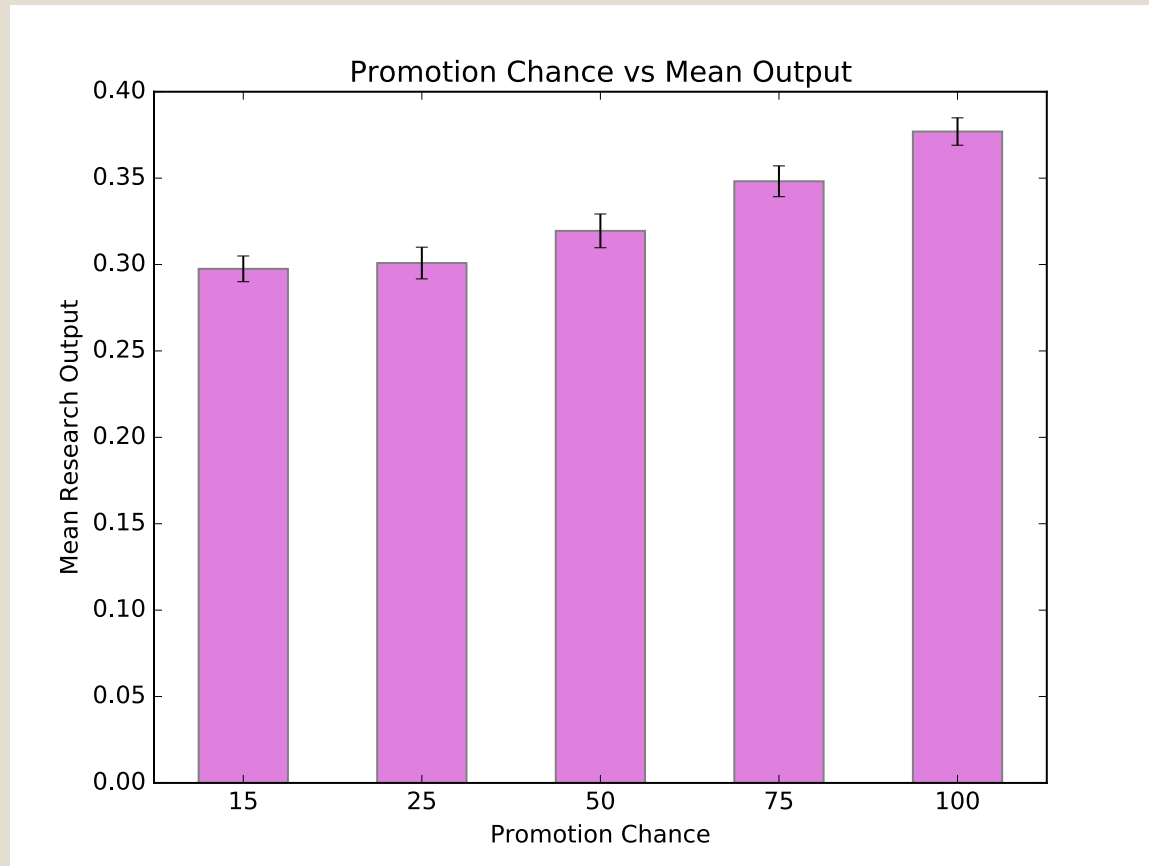
Comparison between no-postdoc scenario (far left) and different combinations of mentoring/no mentoring and RQ-based/non-RQ-based promotions – mean research output per agent

Results – Four Scenarios



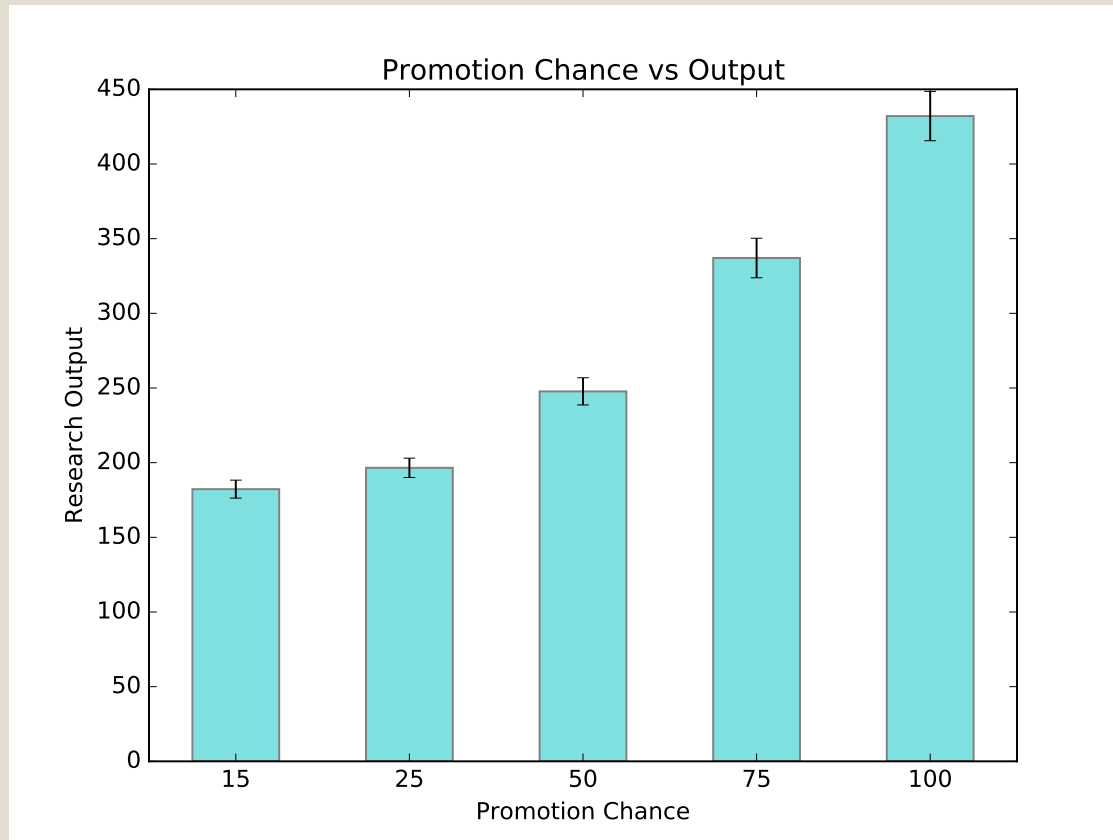
Comparison between no-postdoc scenario (far left) and different combinations of mentoring/no mentoring and RQ-based/non-RQ-based promotions – total output across the agent population

Results – Promotion Chance



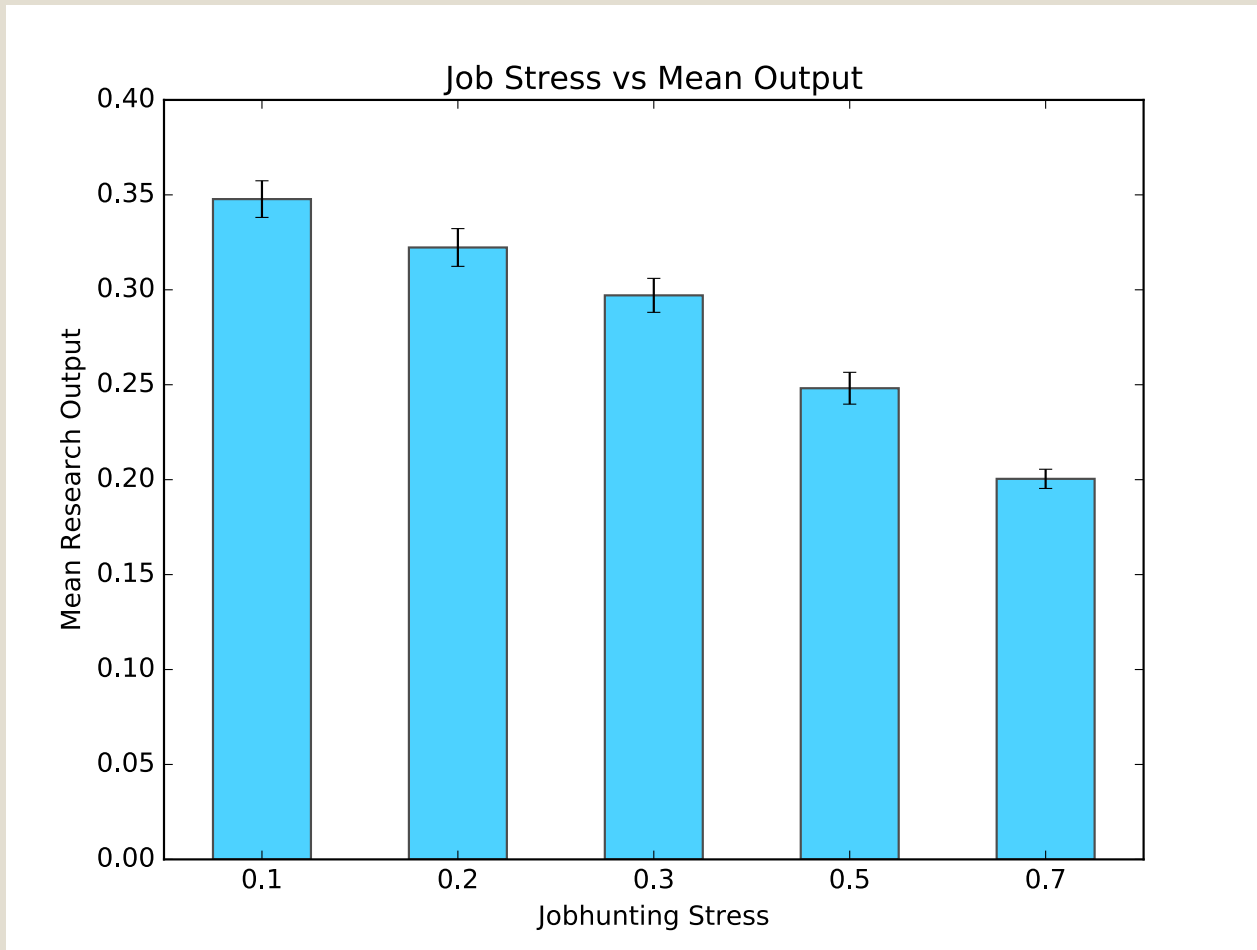
Parameter sweep for *promotion chance* for postdocs – mean research output per agent (50 runs each)

Results – Promotion Chance



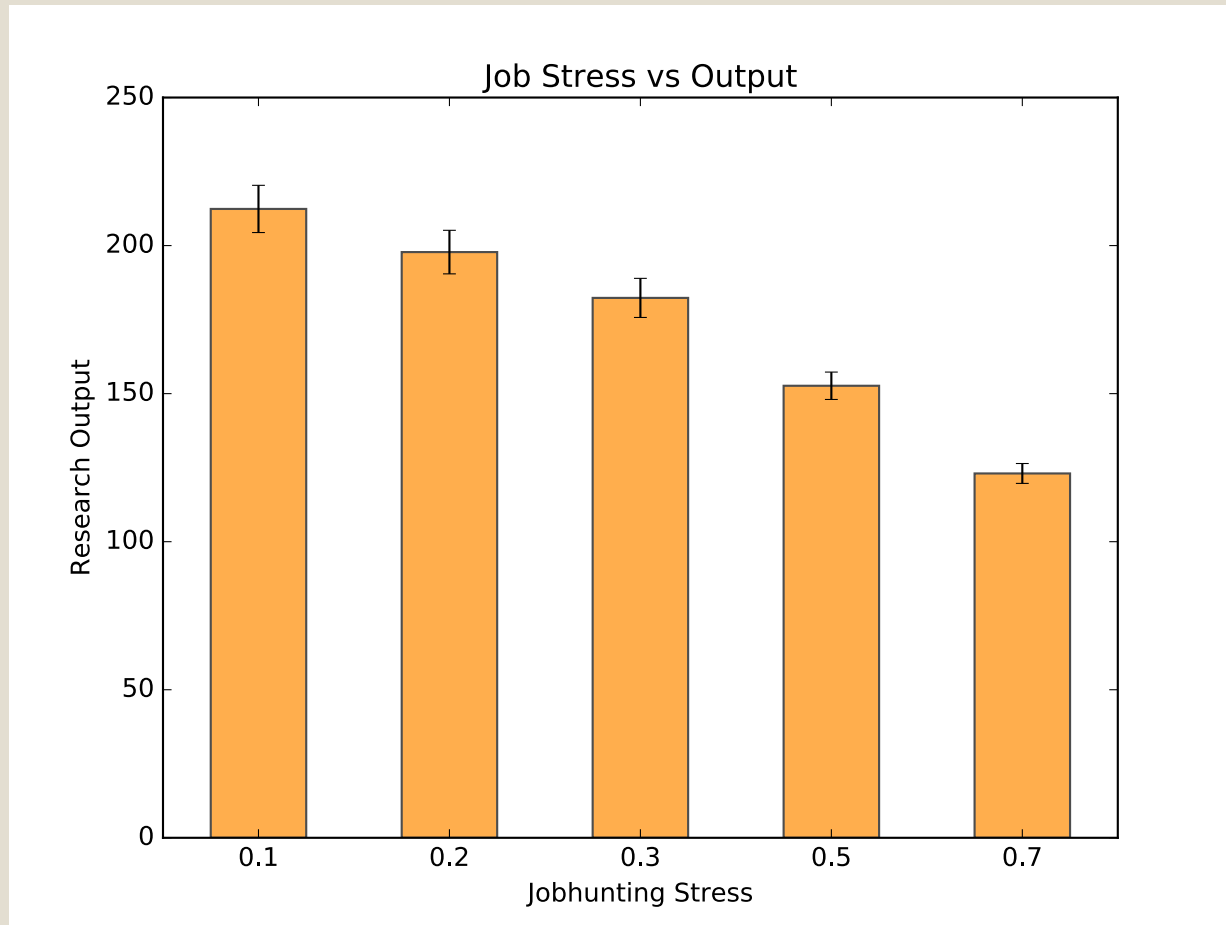
Parameter sweep of *promotion chance* for postdocs – results for total research output of the agent population (50 runs each)

Results – Stress



Parameter sweep of *job hunting stress* for postdocs – results for mean research output of individual agents (50 runs each)

Results – Stress



Parameter sweep of *job hunting stress* for postdocs – results for total research output of the agent population (50 runs each)

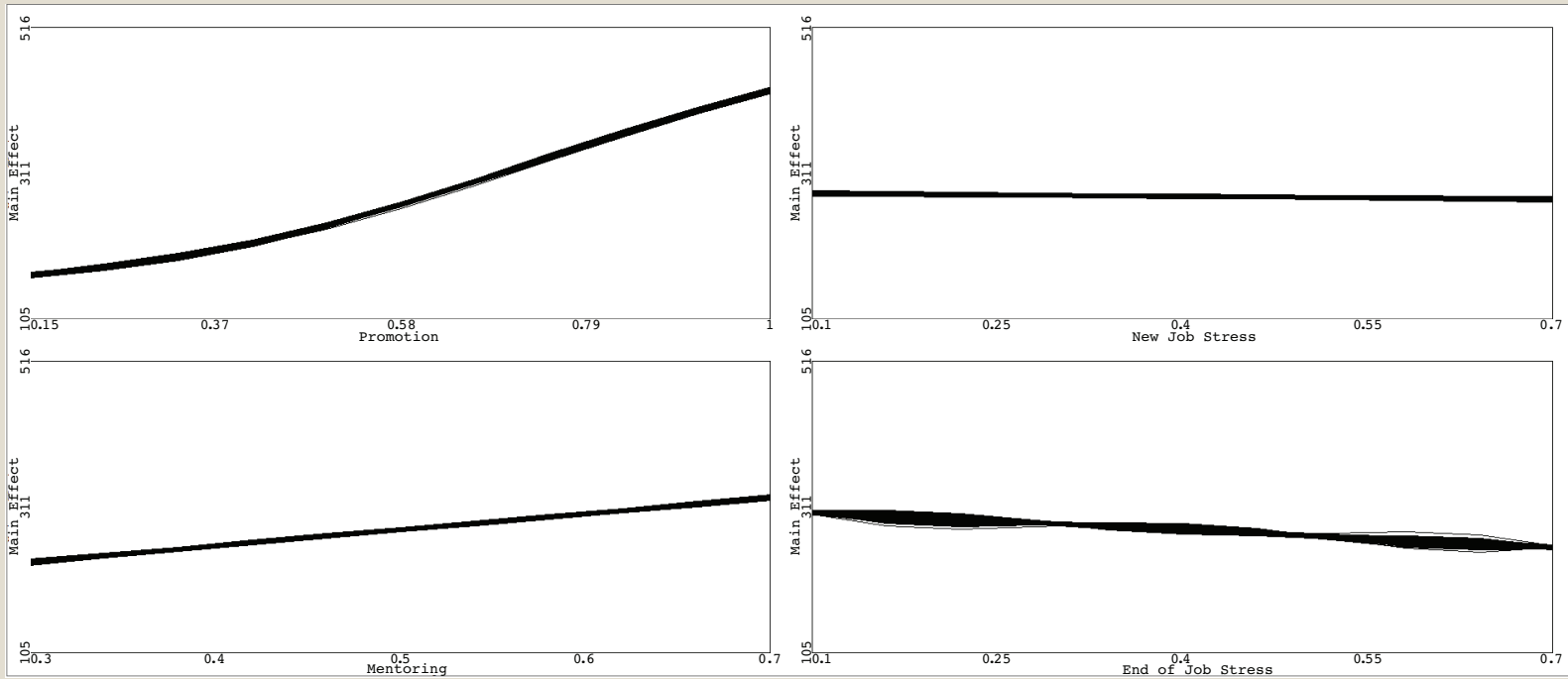
Sensitivity Analysis

In order to determine which parameters have the strongest impact on research output, we used ***Gaussian Process Emulators*** for sensitivity analysis

GPEs measure the influence of model parameters on output variance – essentially by building a statistical model of the computer model

We ran the simulation 8,000 times across a wide range of combinations of values for four key parameters, then ran the GPE 42,000 times

Main Effects



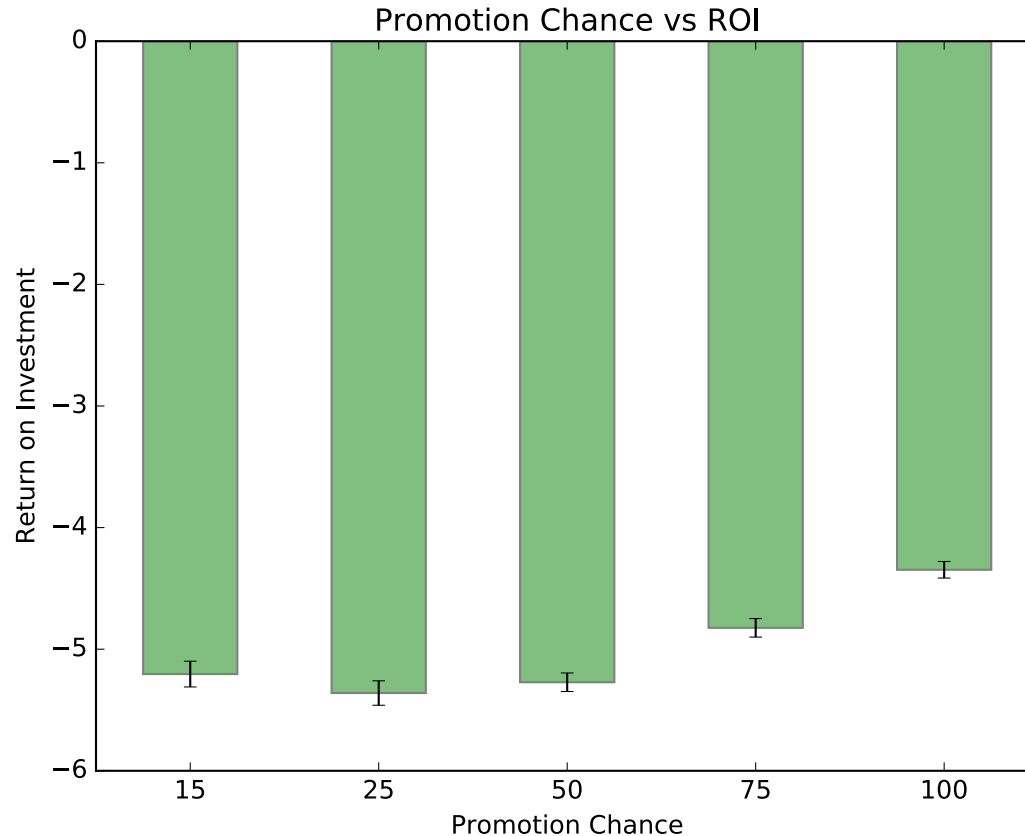
GPE results for four key parameters. Promotion, mentoring, and end of job stress have the strongest impact on final output.

Interaction Effects

<i>Parameter</i>	<i>Variance (%)</i>
Promotion Chance	86.43
Mentoring Bonus	8.87
New Postdoc Stress	0.08
Job-Hunting Stress	2.57
Promotion x Mentoring	1.31
Promotion x New Stress	0.01
Promotion x Job-Hunt Stress	0.69
Other Interactions	0.02

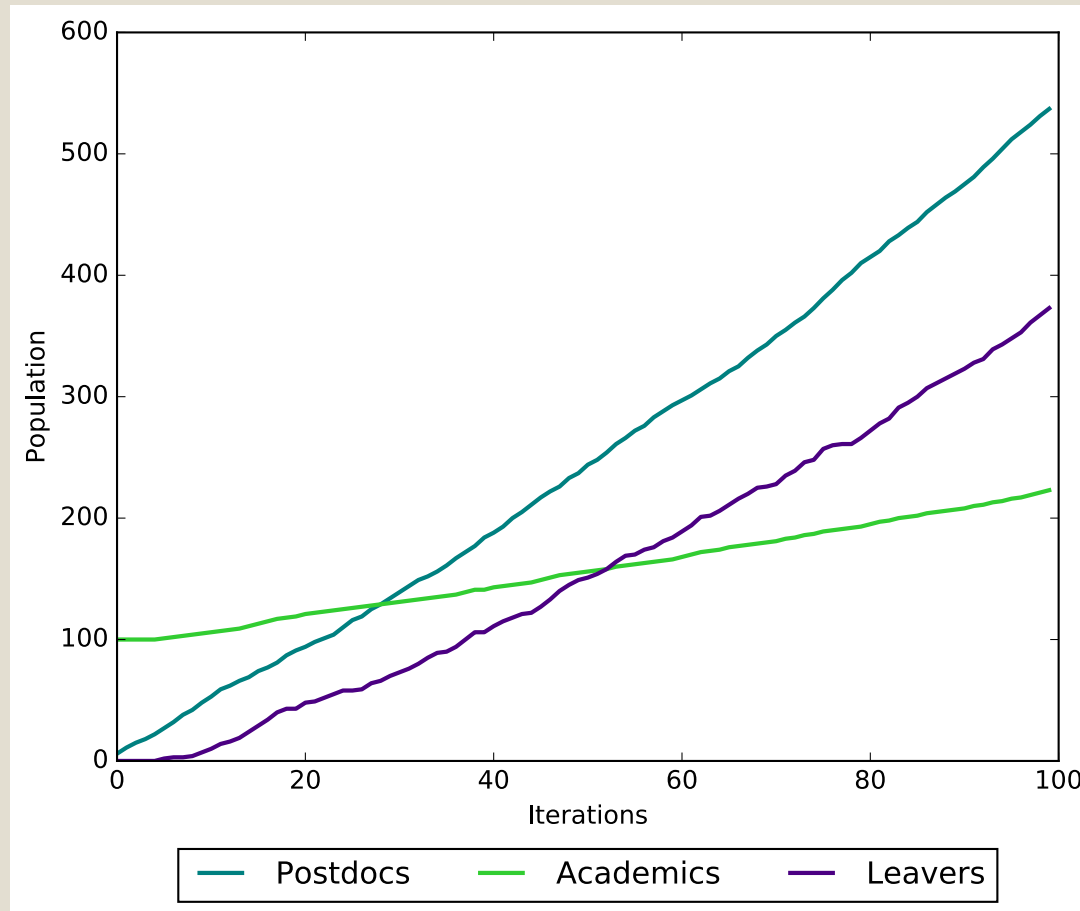
Promotion chance has by far the largest impact on final output, followed by mentoring, then job-hunting stress. Promotion and mentoring also have interaction effects.

Return on Investment



ROI vs Promotion Chance. Baseline is the no-postdocs scenario. Note that *all* results are negative! Promoting everyone is the best of a bad lot. (50 runs each)

The Human Cost



Small growth in permanent posts, huge growth in postdoc positions – and on a typical run ~400+ postdocs leave academia (taking their experience and training with them!)

Conclusions

- Adding postdocs to the system generally decreases research output across the system
- Changing postdoc-related policies has strong effects, despite their small numbers
- Promoting more postdocs, *irrespective of their quality*, produces better results
- Postdocs are too stressed and too transient to take up the research slack from busy academics
- Return on investment is poor – and this model does not include additional costs for training, hiring, redundancy payments, etc.

Future Steps

- Wider range of grant types – different sizes and copes, lengths of funding, etc.
- More realistic postdoc lifecourse:
 - Allow for a succession of fixed-term contracts
 - Collect and incorporate more detailed data on postdoc career paths and decisions
- Test different models of funding disbursement