Incentive-driven Inattention

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Motivation

- Rational Inattention (RI) (Sims, 2003) is the dominant theoretical framework for endogenizing information frictions
- Central premise is that agents are capacity-constrained and choose attention based on a cost-benefit optimization
- Not tested empirically until now (some experimental results)
  - Hard to observe attention choices and costs and benefits (incentives)

Contribution

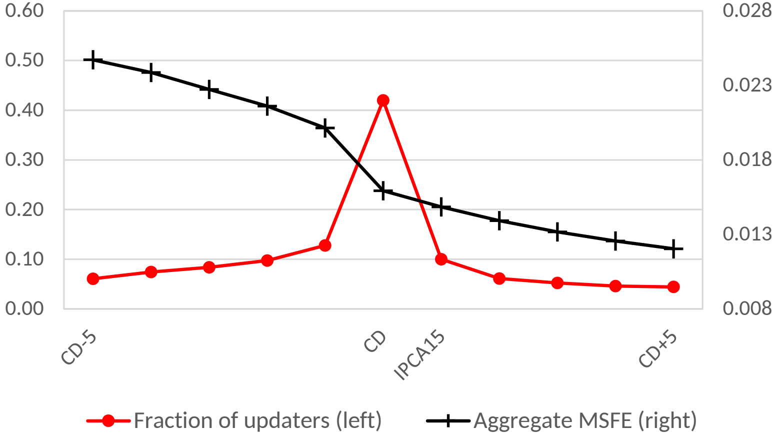
- Fill the gap in the literature by exploiting a little-studied survey of professional forecasters
- The data has unique features that allow us to link observables to attention choices and underlying incentive parameters
- We build and structurally estimate a model with endogenous attention that fits the data and gives realistic predictions
- Contributions:
  - structural estimation is new to RI literature
  - results give empirical credence to modelling attention as an incentive-driven optimal decision
  - counterfactuals show how to design surveys to maximize accuracy

The Brazilian Central Bank's *Focus Survey*

- Observe daily decisions of ($\sim$ 85) professional forecasters to update nowcasts of IPCA inflation during the month, for 132 months
- Unique features:
  1. Observe how many forecasters update (extensive margin) and the magnitude of update (intensive margin) as endogenous decisions
  2. Observe the objective of the optimization (forecast accuracy)
  3. "Shifters" in incentives: a monthly contest (benefit shift) and the release of official data (cost shift) the day after the contest
- Allows us to link observables to incentive parameters, via attention choices, and identify shifts in parameters from shifts in observables

Stylized Facts

Contest (CD) versus information release (IPCA15)



Open questions

- Decompose gain in aggregate accuracy on the contest into contributions of changes in extensive and intensive margins?
- Optimal timing of contest?
- Does the contest "crowd out" updates that would have occurred on the day of information release?
    - The structural model will allow us to answer these questions

Drivers of individual forecast updates and accuracy gains

- Panel regressions:

$$\textbf{(Updating prob.)}\ \Pr\left(z_{it} = 1 \,|X_t\right) = G\left(\alpha_i + \beta' X_t\right)$$

$$\textbf{(Accuracy gains for updaters)}\quad ln(e^2_{it-1}) - ln(e^2_{it}) = \alpha_i + \beta' X_t + u_{it}$$

- $z_{it} = \begin{cases} 1 & \text{if forecaster i updates on day t} \\ 0 & \text{otherwise} \end{cases}$
- e_{it} = forecast error for *updater* i at time t
- X_t includes: day dummies (days of week, contest (CD), IPCA15 release day, monetary policy committee meeting (MPC) day), uncertainty index ($EMBI$) and other controls

Drivers of decision to update

Regressors	Logit Fixed Effect Coefficients	
	(1)	(2)
d_t^{CD-1}	0.911***	0.888***
	(0.031)	(0.031)
	[0.203]	[0.188]
d_t^{CD}	2.609***	2.714***
	(0.023)	(0.024)
	[0.417]	[0.389]
d_t^{IPCA15}	0.539***	0.546***
	(0.034)	(0.035)
	[0.125]	[0.121]
d_t^{MPC}	0.103**	0.261***
	(0.042)	(0.043)
	[0.024]	[0.059]
$EMBI_{t-1}$	-	0.024**
		(0.01)
		[0.006]
d_t^{MON}	-	0.383***
		(0.021)
		[0.087]
d_t^{FRI}	-	0.494***
		(0.022)
		[0.112]

Drivers of accuracy gains (relative to previous update)

Regressors	Panel Fixed Effect Coefficients	
	(1)	(2)
d_t^{CD}	7.132**	6.334**
	(3.017)	(3.219)
d_t^{IPCA15}	33.656***	35.299***
	(4.839)	(5.002)
$d_t^{IPCA15+1}$	35.272***	33.549***
	(5.647)	(5.766)
d_t^{MPC}	20.660***	22.847***
	(5.585)	(5.536)
$duration_t$	2.423***	2.381***
	(0.197)	(0.198)
$horizon_t$	−0.490***	−0.490***
	(0.169)	(0.171))
d_t^{MON}	-	4.797*
		(2.693)
d_t^{FRI}	-	3.968
		(2.679)
constant	26.015***	24.150***
	(2.375)	(2.613)

Summary of empirical findings

- Contest primary driver of extensive margin of updating
- Both information releases and contest affect intensive margin
- Possible crowding out of the contest for IPCA15 day (updates on both days occur only 0.65% of the time)
- Other findings that motivate our model specification:
  - no strategic interaction $\rightarrow$ decision-theoretic model
  - heterogeneity in observables not driven by fixed effects $\rightarrow$ assume it is driven by heterogeneous incentives

The Model

Agents' decision problem

- At the beginning of each month all agents give initial forecast
- On each subsequent day $t = 1, ..., T$, agent i makes two decisions:
  - whether or not to update
  - how much attention, k_{it}, to devote to collecting/processing information in order to update
- **Assumption 1:** The two decisions are sequential (so not the result of a joint optimization).
  - makes problem tractable
  - both decisions are still endogenous, since driven by same incentive parameters

1. Decision whether to update

- Agent i updates on day t if the marginal benefit of updating, w_{it}, is greater than the marginal benefit of time devoted to other activities, w_{it}^{o}
- $\rightarrow$ shift in benefits shifts the opportunity cost of updating

2. Decision of how much attention to allocate

- Each day t agent i chooses attention k_{it} in order to minimize the sum of future *MSFEs* in the month, conditional on updating

$$\min_{k_{i\tau}} \sum_{\tau=t}^{T} \left(\frac{w_{i\tau}}{2\ln 2} MSFE_{i\tau}(k_i^{\tau}) + c_{i\tau} k_{i\tau} \right) 1_{w_{i\tau} > w_{i\tau}^{o}}$$

  - k_i^{τ} = history of past attention choices
  - $c_{i\tau}$ = marginal cost of attention
  - $w_{i\tau}$ = marginal disutility of MSFE (same as benefit of updating)

Solving the optimization

- We proceed in five steps:
  1. Specify agents' statistical model
  2. Specify agents' information set
  3. Derive $MSFE_{i\tau}$ based on steps 1 and 2
  4. Use RI framework to express $MSFE_{i\tau}$ as a function of attention
  5. Solve for optimal attention

Step 1. Statistical model

- Monthly inflation y_m can be written as the sum of daily inflation x_t:

$$y_m = \sum_{t=1}^{T} x_t$$

- Agents use an ARMA(1,1) model to forecast y_m, which corresponds (using temporal aggregation results) to AR(1) for x_t:

$$x_t = b + \phi x_{t-1} + \varepsilon_t, \varepsilon_t \sim i.i.d.\mathcal{N}(0, \sigma_\varepsilon^2),$$

Step 2. Information set

- **Assumption 2:** On day t, agents don't observe current daily inflation, but past inflation (= public signal) is observable
- Implies that agents only pay attention in order to collect a signal s_{it} about current day inflation. Information set is thus:

$$s_i^t \equiv (s_{it}, s_p^t) = \{s_{it}, x_{t-1}, x_{t-2}, ...\}$$

  - makes the problem tractable, by turning dynamic problem into sequence of static RI decisions
  - arguably more plausible than agents relying only on past, inaccurate private signals (also supported by data)

Step 3. Derive *MSFE*

- Assumptions in steps 1 and 2 imply:

$$MSFE_{it} = \left[1 + (1+\phi)^2 + ... + \left(1 + \phi + ... + \phi^{T-1-t}\right)^2\right]\sigma_\varepsilon^2 + \left(\sum_{j=t}^{T} \phi^{j-t}\right)^2 E\left[\sigma^2_{x_t|s_i^t}\right]$$

where $\sigma^2_{x_t|s_i^t}$ = conditional variance of x_t

Step 4. RI: *MSFE* as a function of attention

- RI assumes that the *additional* information content of the signal s_{it} is captured by the relative entropy based on the information sets with and without the signal
- Under normality assumptions, this implies

$$E\left[\sigma^2_{x_t|s_i^t}\right] = \sigma^2_{x_t|s_i^t} = \sigma^2_{x_t|s_p^t}(2^{2k_{it}})^{-1}$$

Step 5. Solving for optimal attention

The optimization problem simplifies to sequence of static problems:

$$\min_{k_{it}} \left(\frac{w_{it}}{2\ln 2} \left(\sum_{j=t}^{T} \phi^{j-t} \right)^2 \sigma_\varepsilon^2 \left(2^{2k_{it}} \right)^{-1} + c_{it} k_{it} \right) 1_{w_{it} > w_{it}^o} \quad \text{s.t. } k_{it} \geq 0,$$

so optimal attention is:

$$k_{it}^* = \begin{cases} \frac{1}{2} \log_2 \left(\frac{w_{it}}{c_{it}} \left(\sum_{j=t}^{T} \phi^{j-t} \right)^2 \sigma_\varepsilon^2 \right) & \text{if } \frac{w_{it}}{c_{it}} \left(\sum_{j=t}^{T} \phi^{j-t} \right)^2 \sigma_\varepsilon^2 > 1 \\ & \text{and } w_{it} > w_{it}^o \\ 0 & \text{otherwise} \end{cases}$$

Bringing the model to the data

- The two decisions depend on ratios (respectively, $\frac{w_{it}}{w_{it}^{o}}$ and $\frac{w_{it}}{c_{it}}$) $\rightarrow$ impose normalizations
- E.g., eliminate w_{it}^{o} as a free parameter by assuming

$$w_{it}^{o} = \frac{c}{\sigma_{\varepsilon}^{2}}$$

  - Motivated by assumption that the cost of updating is small relative to the cost of attention
- Conclusions robust to other normalizations

Bringing the model to the data

- We model heterogeneity by assuming that the cross-sectional distribution for w_{it} is a truncated normal $TN(\mu_t, \sigma_w^2)$
- Restrict μ_t and c_{it} by assuming they are step functions[1]:

$$\mu_t = \begin{cases} \mu_B & \text{if } t < CD - 1 \\ \mu_{CD-1} & \text{if } t = CD - 1 \\ \mu_{CD} & \text{if } t = CD \\ \mu_A & \text{if } t > CD \end{cases}$$

$$c_t = \begin{cases} c_{IPCA15} & \text{if } t = IPCA15 \\ c & \text{otherwise.} \end{cases}$$

[1] Additional restrictions $\mu_B = \mu_A$, $\mu_{CD-1} = \mu_{CD}$, $c_{IPCA15} = c$ are rejected

Model-implied moments

Fraction of updaters on day t:

$$\lambda_t = P\left(w_{it} > \frac{c}{\sigma_\varepsilon^2}\right)$$

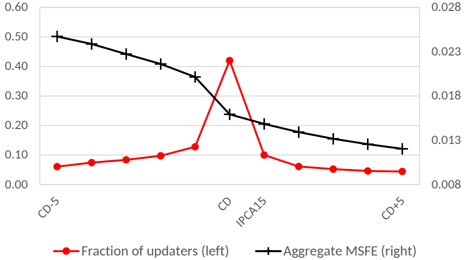
Optimal $MSFE_{it}^* =$

$$\begin{cases} \left[1 + (1+\phi)^2 + ... + \left(1 + \phi + ... + \phi^{T-1-t}\right)^2\right]\sigma_\varepsilon^2 + \frac{c}{w_{it}} & \text{if } w_{it} > \frac{c}{\sigma_\varepsilon^2} \\ MSFE_{it-1}^* \text{ otherwise} \end{cases}$$

Structural Estimation

Estimation

- SMM estimation of parameter $\theta = \left(\mu_t, \sigma_w^2, c_t, \phi, \sigma_\epsilon^2\right)$, to jointly match the moments in the figure:



- Assess fit and see if patterns of benefits and costs are plausible
- Compare AR parameters to estimates based on inflation data (which was not used in model estimation)

Estimation results

Parameter	Estimate	S.E.	Parameter	Estimate	S.E.
μ_B	0.476	4.1E-18	c_{IPCA15}	1.34E-05	1.4E-13
μ_{CD-1}	0.488	4.0E-18	c	1.38E-05	1.4E-13
μ_{CD}	0.542	3.6E-18	ϕ	0.925	2.1E-18
μ_A	0.463	4.2E-18	σ_ε	0.005	3.9E-16
σ_w	0.058	3.4E-17			

- AR(1) parameters implied by Brazil's inflation data:

$$\phi = .963 \text{ and } \sigma_\epsilon = 0.003$$

Model fit

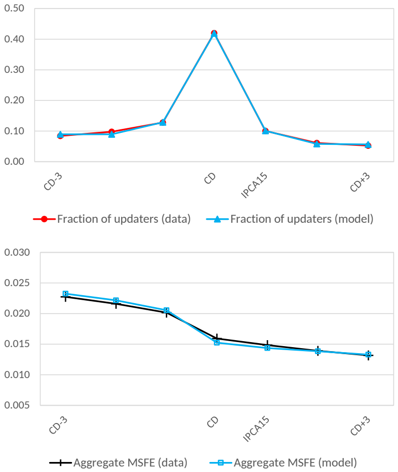


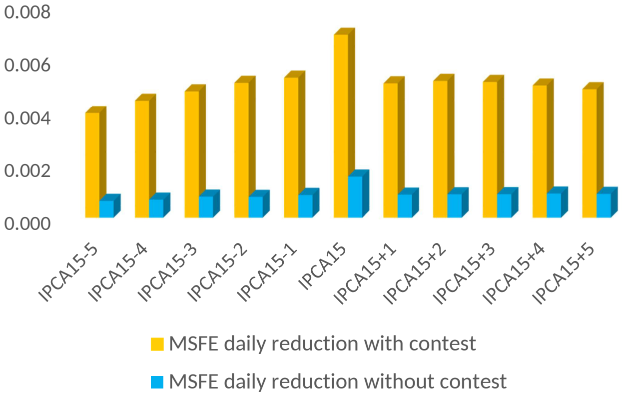
Figure: P-value of J-test = .49

Counterfactuals

- Decompose change in aggregate accuracy on contest into contribution of extensive margin (70%) and intensive margin (30%)

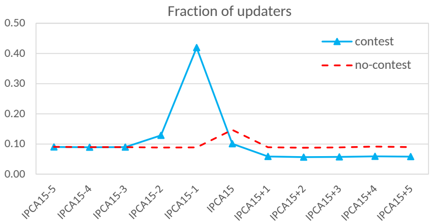
Counterfactuals

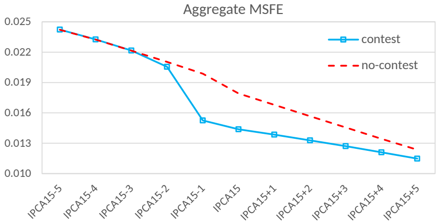
- Optimal time of the contest is IPCA15 day $\rightarrow$ align higher benefits with lower costs of information



Counterfactuals

- "Crowding out" effect of the contest is present but small → contest is key for aggregate accuracy





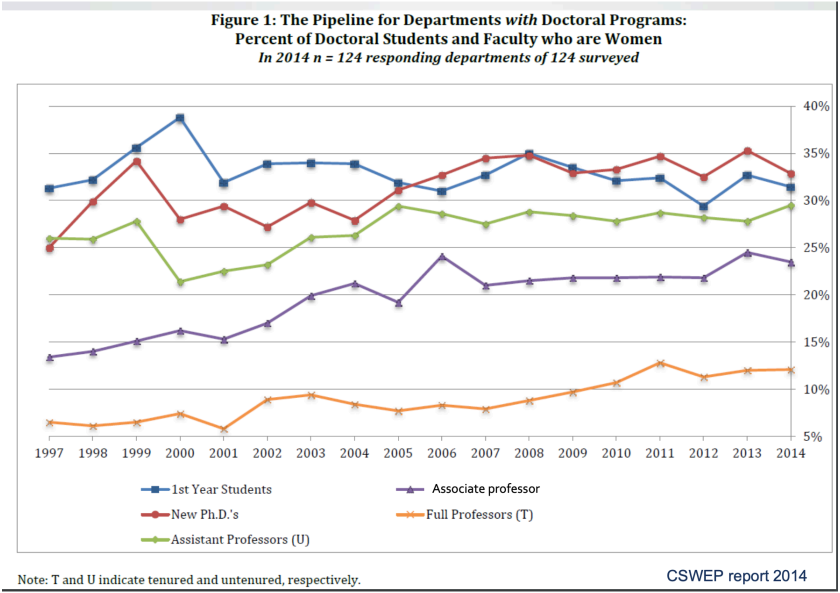
Conclusion

- We connect two central ideas in economics: attention is limited and incentives matter
- Results show that formal incentives have a large effect on accuracy, particularly when aligned with information releases
- People devote more attention when they compete. Relevant for:
  - Expert opinions, survey design
  - Employees' savings/retirement plans choices

Part 2: Reflections on the status of women in Economics

The status quo

The leaky pipeline

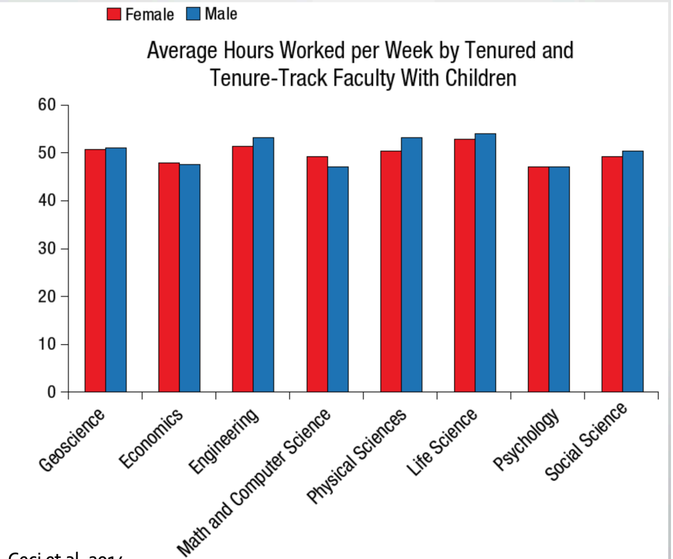


Economics is an outlier

- Ginther and Kahn (2004): Women economists are 21% less likely to get tenure 10 years after PhD
- In social sciences the gap is 8.1% and in engineering -3.9%

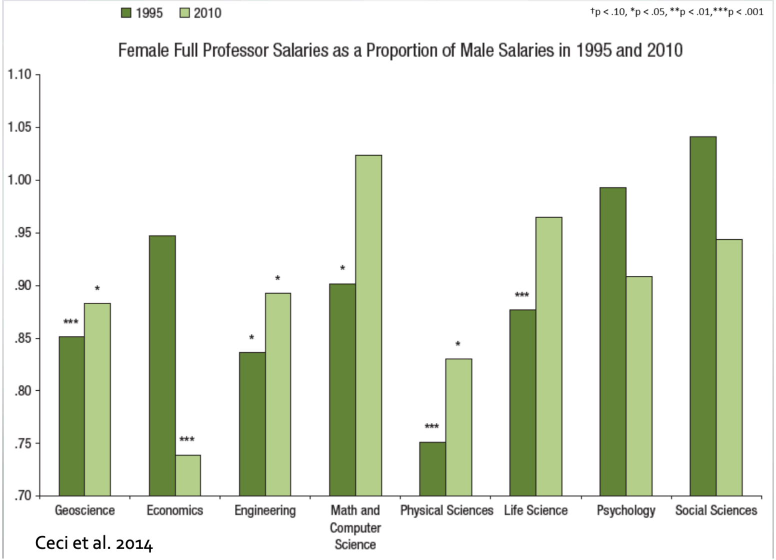
Is it our choice?

We work as hard as men, even if we have children



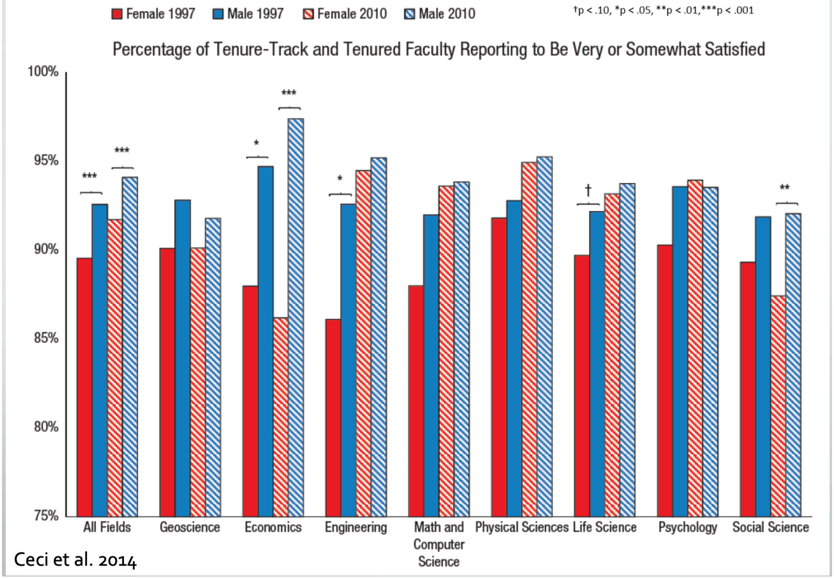
Ceci et al. 2014

But we get paid less...



Ceci et al. 2014

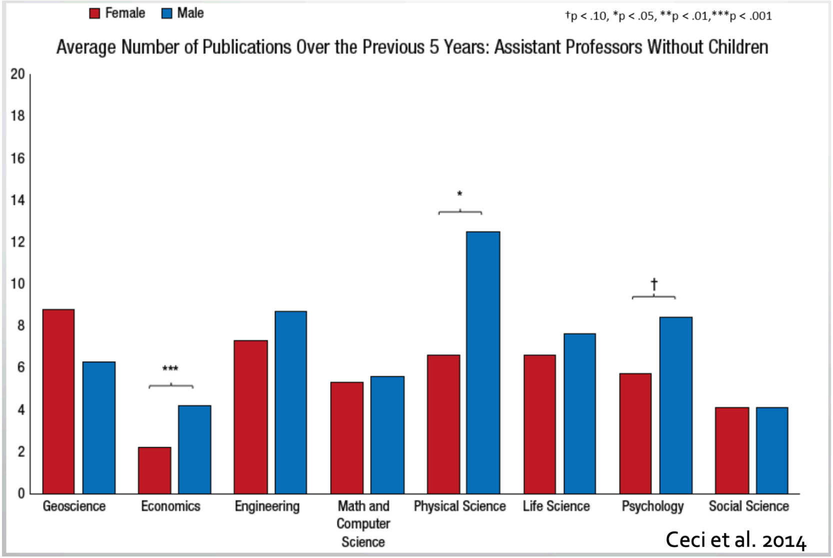
...and we are not happy about it



Ceci et al. 2014

What is it, then?

We write fewer papers, and it's not about children



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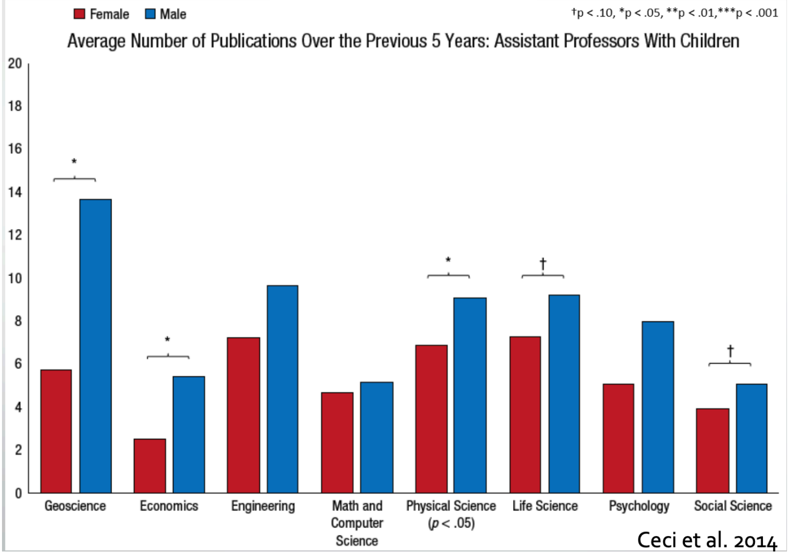

Discrimination?

- Krawczyk and Smyk (2016): female-authored manuscripts are evaluated more critically
- Hengel (2017): female-authored abstracts in top five economics journal better written
- Hengel (2017): higher standards lower women productivity

Toxic environment?

Econ Job Market Rumors

Most "female"		Most "male"	
Word	Marginal Effect	Word	Marginal Effe
hotter	0.336	juicy	-0.218
lesbian	0.301	keys	-0.196
bb	0.276	adviser	-0.181
sexism	0.245	bully	-0.174
tits	0.233	prepare	-0.173
anal	0.223	fought	-0.170
marrying	0.215	wharton	-0.168
feminazi	0.213	austrian	-0.164
slut	0.194	fieckers	-0.163
hot	0.193	homo	-0.153
vagina	0.187	genes	-0.151
boobs	0.176	e7ee	-0.142
pregnant	0.176	mathematician	-0.137
pregnancy	0.174	advisor	-0.134
cute	0.167	burning	-0.132
marry	0.167	pricing	-0.131
levy	0.159	philly	-0.126
gorgeous	0.157	band	-0.124
horny	0.153	kfc	-0.124
crush	0.153	nobel	-0.123

My speculative take on it

- Winner-takes-all environment + difficult to assess real scientific contribution in economics
- $\rightarrow$ more difficult for women to overcome constraints to career progression?
  - Difficult to publish in top journals if you are not established and don't belong to certain networks (constraints to visibility?)
  - Tastes and preferences determine what gets published in some fields (male-dominated networks?)
  - Career progression driven by outside offers (constraints to mobility?)

My experience with the paper you just saw

- Paper rejected by all top-five journals
  - 14 referee reports overall, no two alike criticisms/reasons for rejection
  - my coauthor and I are outsiders in the field
  - the paper now solicited for submission to top field journal (after mentioning it to editor)

What can we do?

Increase visibility

- For ourselves:
  - go to/organize conferences and seminars at key times in your career (first 5-7 years, when you want a promotion)
  - choose coauthors who are visible but not too senior
- For other women:
  - cultivate female networks (this conference!)
  - keep a list of women to suggest for awards, keynote etc.

Support network and mentors

- find supportive partner and make clear to them that it is a requirement of your job to travel and perhaps move a few times
- ask senior women how they have done it
  - you may hear a variety of non-standard personal life arrangements (children alone, traveling with mum, long distance relationships, partners later in life)
  - ...but find that we are all quite happy with our life and job!

Don't give up! More women = more likely to change the rules of the game...