Lone Stars or Constellations? The Impact of Performance Related Pay on Matching Assortativeness in Academia

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Motivation

- Performance pay is widespread and increasingly more prevalent (Lemieux ’09)
- Effects of performance pay on effort and sorting studied extensively (e.g. Dohmen and Falk ’11, Bandiera et al. ’05, Lazear ’00)
  - BUT effects on workforce composition and matching assortativeness much less understood
- Performance pay is expected to affect matching assortativeness if there are complementarities in worker skill:
  - Complementarities in worker skill cause matching to be positive assortative -> large effects on output and growth (Kremer ’93)
  - Positive assortativeness by worker productivity increases total output if production function is supermodular (Legros and Newman ’02)
- Complementarities may be particularly pronounced in knowledge creation/academia (Borjas and Doran ’15, Agrawal et al. ’14, Oettl ’12, Waldinger ’10, Azoulay et al. ’10)
  - Performance pay may thus have particularly strong effect on matching assortativeness in academia, and academic output
Overview of Paper

- Study of the effect of performance pay on matching assortativeness in academia (clustering of similarly productive academics)
- Use introduction of performance pay in German academia as natural experiment + data of universe of academics in Germany
- Hypothesis:
  - Performance pay should increase positive assortative matching if there are complementarities in worker skill
  - Increase in positive assortativeness should be larger if complementarities are stronger
- Two-step analysis:
  - Estimate strength of complementarities using plausibly exogenous variation in hiring budget to instrument for productivity of new hires
  - Test hypothesis in diff-in-diff framework, using strength of complementarities as continuous treatment variable
  - Focus on 2 channels that affect departmental composition: hiring and “firing” (leavers)
Main findings:

- **There are sizeable positive complementarities in research productivity among co-located faculty**
  - but only in fields with ample collaboration

- **Performance pay increases positive assortative matching**
  - higher quality departments in high complementarity fields hire more productive academics
  - biggest change in matching assortativeness of newly tenured academics (“junior” hires)

- **Evidence of submodularity of production function**
  - suggesting increased assortativeness decreases total research output
Before reform: age-related pay ("C-Pay")

Reform introduced performance-related pay scheme ("W-Pay")

Performance pay scheme pays basic wage plus bonuses
  - Bonuses awarded for performance in research, education, training & promotion of young scientists
    - Research performance: number and quality of papers, funding awards, prizes etc.
  - Bonuses potentially more than double monthly pay
  - Only tenured professors can earn bonuses

Reform announced in 2002, implemented in 2005

As of 2005, any new contract falls under performance pay scheme
Estimation of Spillover Effects

Instrument for productivity of new hire with hiring budget $B_{j,t-1}$: number of professors that retire (turn 66) between $t-1$ and $t$ from university to which department $j$ belongs

- Plausibly exogenous variation in slack in hiring budget, because:
  - departmental age composition historically determined
  - mandatory retirement age
  - constant personnel budget and number of chairs

$$\bar{y}_{j,f,t}^{affil} = \beta_1 \bar{y}_{j,f,t}^{old} + \beta_2 \bar{y}_{j,t-1}^{nh,IV} + \gamma_t + c_f + u_{jt}, \text{ 2SLS}$$

$$\bar{y}_{j,f,t}^{new} = c + \beta_1 B_{j,t-1} + \beta_3 \bar{y}_{j,f,t}^{old} + \gamma_t + c_f + u_{jt}, \text{  first stage}$$

- $\bar{y}_{j,f,t}^{new}$: average productivity of new hires in faculty $j$ in field $f$ in year $t$
- $\bar{y}_{j,f,t}^{old}$: average productivity of existing affiliates of faculty $j$ in field $f$ in pre-sample years 1999/2000 (departmental quality)
- $\bar{y}_{j,f,t}^{affil}$: $n$-year future average productivity of affiliates in faculty $j$ in field $f$ in year $t$
- $\bar{y}_{j,t}^{nh,IV}$: instrumented average productivity of new hires of faculty $j$ in field $f$, hired in year $t$
### Spillover Effects

(Depr. Var.: 2-year Avg Productivity) | First Stage 1a | 2SLS | First Stage 1b | 2SLS | Low Complementarity | First Stage | 2SLS | High Complementarity | First Stage | 2SLS
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
Avg Prod of New Hires | 0.319** (0.137) | 0.325** (0.140) | -0.443 (0.976) | 0.341*** (0.131)
Avg Prod of New Hires * Dept Quality | -0.017*** (0.005) | -0.017*** (0.005) | -0.017*** (0.005) | -0.017*** (0.005)
Department Quality | 0.095*** (0.021) | 0.751*** (0.221) | 1.223*** (0.230) | 0.070* (0.037) | 0.539*** (0.187) | 0.859*** (0.149) | 0.192*** (0.236)
Hiring Budget (lagged) | 0.830*** (0.139) | 0.007** (0.003) | 0.007** (0.003) | 0.007** (0.003)
N | 1896 | 3359 | 3359 | 1031 | 1771 | 865 | 1588
N_g | 705 | 851 | 851 | 389 | 449 | 316 | 402

- **High/Low Complementarity**: academic fields with above/below median average number of authors on a paper
  - **Rationale**: larger coauthor teams > more collaboration > greater opportunity for spillovers
- **Negative interaction** $\bar{y}_{j,t-1}^{old} \cdot \bar{y}_{j,t-1}^{nh,IV}$ in column 1b suggests production function is **submodular**
  - Would imply that an increase in positive matching assortativeness decreases total research output
Increase in Positive Assortativeness?

Study change in departmental composition:

- **Hiring**: “junior” hires (first time tenured professors) and “senior hires” (professors moving)
- **“Firing”**: tenured professors leaving department
- If matching assortativeness increases in response to performance pay, higher quality departments:
  - can attract more productive new hires
  - less productive academics leave
  - Response should be stronger if complementarities are larger

\[
\bar{y}_{j,f,t}^{\{k\}} = \beta_1 \bar{y}_{j,f}^{old} + \beta_2 \text{Compl}_f + \beta_3 \text{Compl}_f \cdot \bar{y}_{j,f}^{old} + \beta_4 \text{post} \cdot \bar{y}_{j,f}^{old} + \beta_5 \text{post} \cdot \text{Compl}_f + \beta_6 \text{post} \cdot \text{Compl}_f \cdot \bar{y}_{j,f}^{old} + c_f + \gamma_t + u_{jt} \tag{1}
\]

- **Compl**$_f$: average number of authors on a paper in a field - a proxy for complementarity strength
- **post** is zero before the reform ($t<2005$) and one thereafter
- sample restricted to 2001-2006 to avoid simultaneity bias and abstract from other events
Positive Assortative Matching - Triple Interactions