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)

Takeaways

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 **sub**modularity of production function
  - suggesting increased assortativeness decreases total research output

Institutional Detail - Pay Reform

- 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

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

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

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

Spillover Effects

(Dep.Var.: 2-year Avg Productivity)	First Stage	2SLS		Low Complementarity First Stage	Low Complementarity 2SLS	High Complementarity First Stage	High Complementarity 2SLS
		1a	1b				
Avg Prod of New Hires		0.319**	0.325**		-0.443		0.341***
		(0.137)	(0.140)		(0.976)		(0.131)
Avg Prod of New Hires * Dept Quality			-0.017***				
			(0.005)				
Department Quality	0.830***	0.751***	1.223***	0.070*	0.539***	0.859***	0.744***
	(0.139)	(0.221)	(0.230)	(0.037)	(0.187)	(0.149)	(0.236)
Hiring Budget (lagged)	0.095***			0.007**		0.192***	
	(0.021)			(0.003)		(0.049)	
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 $\bar{y}^{old}_{j} \cdot \bar{y}^{nh,IV}_{j,t-1}$ in column 1b suggests production function is **sub**modular
  - 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

$$\bar{y}^{\{k\}}_{j,f,t} = \beta_1 \bar{y}^{old}_{j,f} + \beta_2 Compl_f + \beta_3 Compl_f \cdot \bar{y}^{old}_{j,f}$$

$$+\beta_4 post \cdot \bar{y}^{old}_{j,f} + \beta_5 post \cdot Compl_f + \beta_6 post \cdot Compl_f \cdot \bar{y}^{old}_{j,f} + c_f + \gamma_t + u_{jt} \quad (1)$$

- $Compl_f$: 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