“Once Highly Productive, Always Highly Productive”? Research Productivity from a Life-Cycle Perspective

The Centre for Global Higher Education (CGHE)
University of Oxford, June 02, 2022

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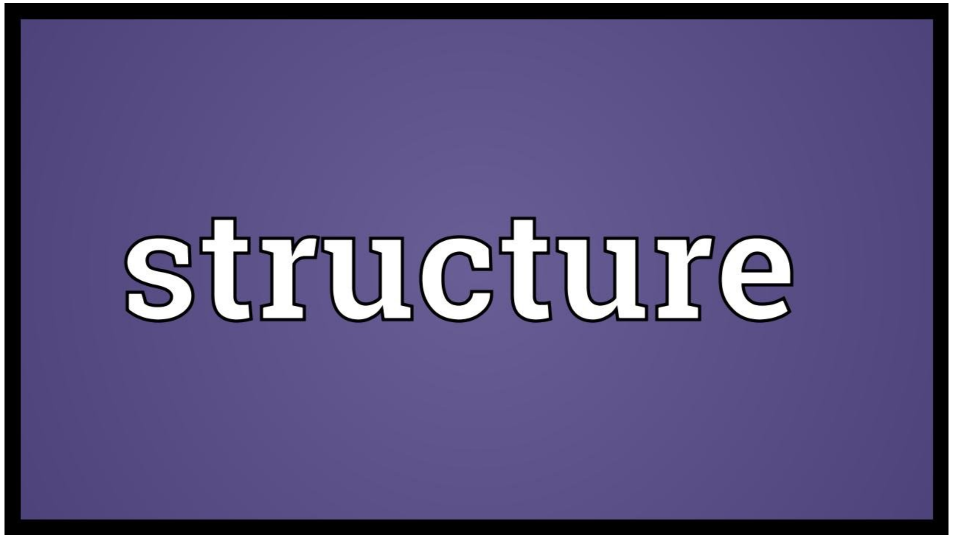
2. Structure

- **Introduction**: productivity & long careers in science
- **Research questions** & hypotheses
- **Data, methods, sample**
- **Methodology**:
  - Constructing individual **lifetime biographical histories** & lifetime publication histories
  - Constructing journal **prestige-normalized productivity**
  - Constructing three **academic career classes**
- **Results: mobility between productivity classes from a life-course perspective**
  - Disciplinary differences
  - Direct lifetime mobility (start to end)
  - Logistic regression models (odds ratios of being in top and bottom classes)



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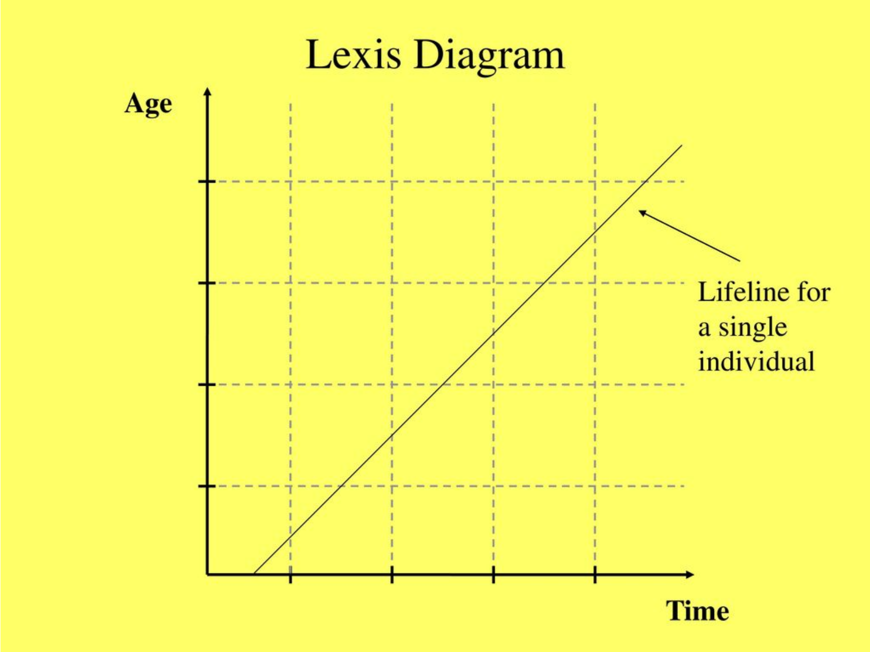
4. Introductory Remarks: Productivity and Long Careers in Science

- **Only several countries** with studies linking **productivity** (and citation impact, collaboration), biological **age** and academic **positions**. E.g.:
  - **Norway:** Kyvik & Olsen 2008; Aksnes et al. 2011; Rørstad and Aksnes 2015; Rørstad et al. 2021;
  - **the USA:** Sugimoto et al. 2016; Savage & Olejniczak (2021)
  - **Canada:** Gingras et al. 2008; Larivière et al. 2011;
  - **Italy:** Abramo et al. 2011; Abramo et al. 2016;
  - **Poland:** Kwiek, 2015b; Kwiek 2020b; and
  - **Spain:** Costas & Bordons 2007; Costas et al. 2010.
- **A major obstacle? Access to reliable data: age & academic positions.**
- **Long careers in science**: **long training period & a long professional career ladder**.
- **Some scientists stay on** in the science sector for decades: (Polish) full professors studied – 30-40 years!
- Ongoing research with **Dr. Wojciech Roszka** (CPPS Team).

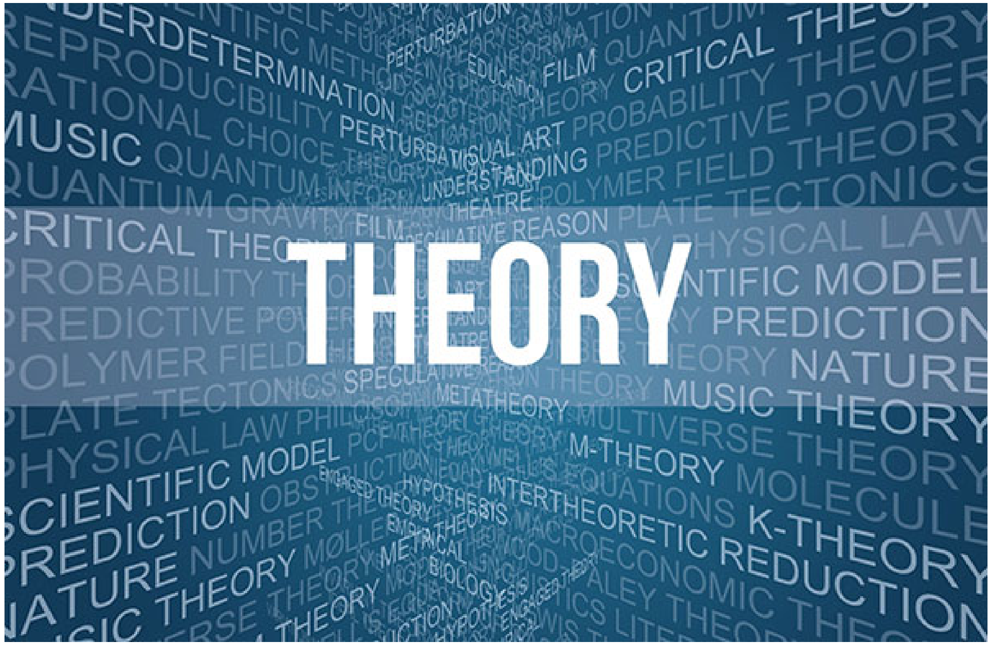
5. Cohorts & Academic Career Research

- **Some cohorts may be more research productive** than others due to **different competition levels in hiring** in their early years (“**cohort matters**”, Stephan 2012).
- **Scientists, hired under different conditions,** may **stay on in academia for decades**.
- **Academic cohorts may be more (or less) productive from the moment they have entered the academic profession.**
- Some cohorts may have always been characterized by low (or high) productivity (Kyvik 1990).
- **Lexis Diagram**: **our full professors** are **aging** (verticallly) and moving in time **across periods** (horizontally). (Age: 30, 40, 50, 60 etc. Time (or period): 1990, 2000, 2010, 2015 etc).
- We **compare professors** of the same position, similar age, working in similar periods, in the same disciplines.
- **Age effects, period effects, and cohort effects** distinguished.



6. Major Theories of Research Productivity

- Traditionally **three theories**: '**sacred spark**', '**cumulative advantage**', and '**utility maximizing**'.
  - **The 'sacred spark' theory:** highly productive scholars are "**motivated by an inner drive to do science and by a sheer love of the work**" (Cole and Cole 1973: 62);
  - **The 'cumulative advantage' theory:** Robert K. Merton (1968) - **productive scientists are likely to be even more productive, and low productive scientists are likely to be even less productive**.
    - Related to the **reinforcement theory** (Cole and Cole 1973: 114):"**scientists who are rewarded are productive**, and scientists who are not rewarded become less productive".
  - **The 'utility maximizing theory':** scientists choose to **reduce their research efforts over time** (other tasks more advantageous). Stephan & Levin (1992: 35): **scientists later in their careers "are less financially motivated to do research**".
- **Complementary rather than competing** theories (Kwiek 2019: 27-32).



7. ‘Full Professors Literature’ & ‘All Ranks Literature’

- Research on full professors can be **classified:**
  - **By their academic position focus** (‘**full professors literature’** and ‘**all ranks literature’** which includes full professors) and
  - By their **methodology** (driven by **survey-data**; **bibliometric, admin & biographical data**; **interview data**; and **mixed-methods** approaches).
- **‘All ranks literature’** clearly **outnumber ‘full professors literature’.**
- **Several papers focus on gender discrimination in promotions to full professorships:**
  - Marini and Meschitti 2018 on **Italian** full professors;
  - Madison and Fahlman 2020 on **Swedish** full professors;
  - Mayer and Rathmann 2018 on all full professors in psychology in **Germany**,
  - Lutter and Schröder 2016 on all full professors in sociology in **Germany**, and
  - Lutter, Habicht and Schröder 2022 on all full professors in psychology in **Germany**).

8. Research Questions and Hypotheses

- The hypotheses pertain to **persistence of *high* productivity** over time (H1), **persistence of *low* productivity** over time (H2) and **persistence of high productivity at the beginning and towards the end** of academic careers (H4).
- We are also examining **disciplinary differentiation** (H3) and **gender differentiation** (H5), as well as **individual features and**

Research Question	Hypothesis	Support
RQ1. What is the relationship between current high productivity and high productivity at the two earlier stages of academic career?	**H1: Persistence of high productivity over time.** We expect that today's highly productive full professors were in a significant proportion highly productive associate professors, and that highly productive associate professors were in a significant proportion highly productive assistant professors.	Supported
RQ2. What is the relationship between current low productivity and low productivity at the two earlier stages of academic career?	**H2: Persistence of low productivity over time.** We expect that today's low-productive full professors were in a significant proportion low-productive associate professors, and low-productive associate professors were in a significant proportion low-productive assistant professors.	Supported
RQ3. What is the relationship between productivity trajectories over a life-cycl and academic disciplines?	**H3: Disciplinary differentiation.** We expect that the level of mobility between productivity classes varies by discipline.	Supported
RQ4. What is the relationship between current productivity and productivity at the beginning of academic career?	**H4: Persistence of productivity at the beginning and at the end of an academic career.** We expect that, from the perspective of their entire academic career, most of today's full professors belonged to the same productivity class at the beginning and at the end of their academic career.	Supported
RQ5. What is the relationship between productivity trajectories over a life-cycl and gender?	**H5: Gender differentiation.** We expect that the level of mobility between productivity classes varies by gender.	Supported
RQ6. What is the relationship between individual and organizational attributes and belonging to top and bottom productivity classes?	**H6: Individual characteristics versus productivity classes.** We expect that individual characteristics determine better a scientist's odds ratios of belonging to the highest and lowest productivity classes than organizational characteristics (in logistic regression models).	Supported

9. Data, Methods and Sample (1/2)

- The integrated “**Polish Science Observatory**” database.
- **Two large databases were merged**: a national administrative and biographical register of all Polish scientists (N=100,000 individuals) and Scopus bibliometric database (2009-2018, N=380,000 publications).
- Articles: 158,743, unique authors: 25,463.
- **The “Observatory” database was then enriched with Scopus publication metadata for 50 years: ca. 1,000,000 publications** (ICSR Lab, International Center for the Study of Research, a cloud-computing platform, Elsevier. Thanks to Kristy James!
- **Gender** for **all scientists** (binary variable).
- **Various individual attributes: for the whole sample** and **for every full professor in 14 STEMM disciplines in our final sample** (N=2,326).

10. Data, Methods and Sample (2/2)

- The **dominant discipline for each full professor:** determined on the basis of all publications (type: article). **All cited references in all publications combined**, lifetime; **the modal value (mode) defined** for each professor. Most often appearing value of discipline (ASJC) for each professor.
- **The academic age: based on the year of the first publication** using the Scopus data provided by the ICSR Lab.
  - Kwiek and Roszka, ”Academic vs. biological age in research on academic careers: a large-scale study with implications for scientifically developing systems, *Scientometrics,* April 2022, a **whole national system**, 24 disciplines, N=21,000.
- Our ”Observatory”data set provides **the date of birth** and the **dates of receiving the three scientific degrees** (doctoral degree, habilitation degree, and professorship title).
- Degrees used as **proxies** of assistant, associate and full professors, respectively.
- We used **both biological and academic age in logistic regression models.**

11. Full Professors: Disciplinary and Age Distribution

Three fourth are men; one third work in research-intensive institutions; **two third are aged more than 60** and a half are aged 65-70.

There are also **relatively young full professors** in the sample: 2% aged 40-44 (like MK, non-STEMM), 4.8% aged 45-49, and 9.2% aged 50-54.

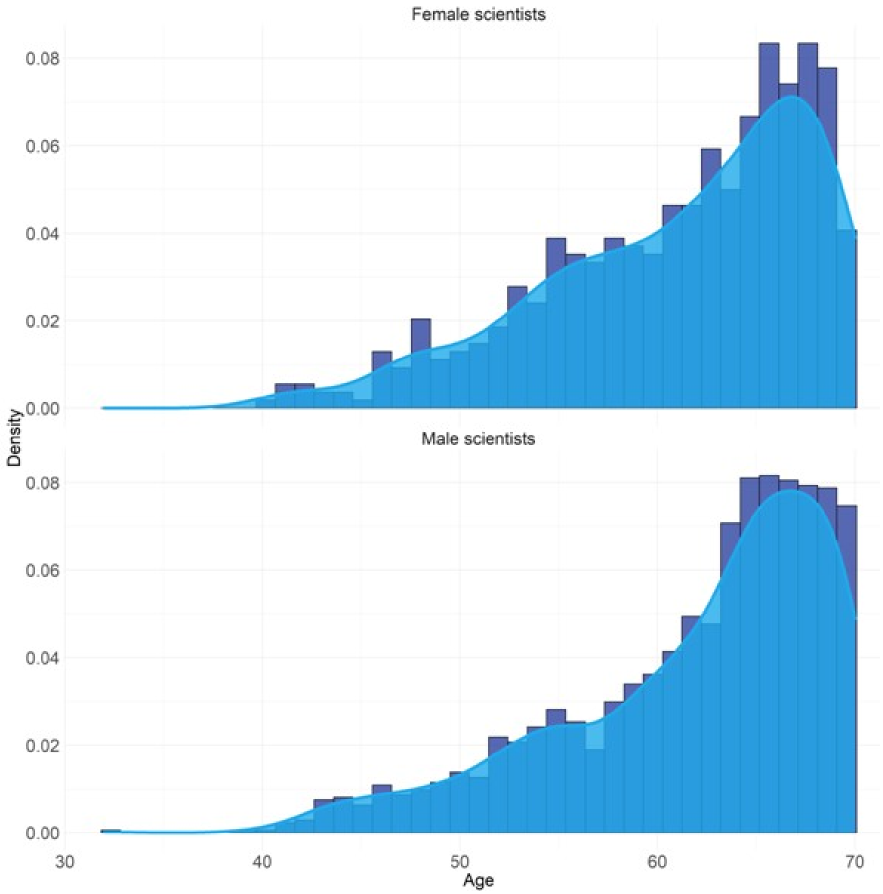


Table 1. Structure of the sample, all Polish internationally visible university full professors, by gender, age groups (under 50, 51-60, 61-65, 65-70), and STEMM discipline.

		Female scientists			Male scientists			Total		
		n	row %	col %	n	row %	col %	n	row %	col %
Age groups	Total	551	23.7	100.0	1775	76.3	100.0	2326	100.0	100.0
	up to 50	48	24.9	8.7	145	75.1	8.2	193	100.0	8.3
	51 - 60	164	27.2	29.8	438	72.8	24.7	602	100.0	25.9
	61 - 65	145	22.3	26.3	505	77.7	28.5	650	100.0	27.9
	65-70	194	22.0	35.2	687	78.0	38.7	881	100.0	37.9
IDUB	IDUB	130	16.7	23.6	650	83.3	36.6	780	100.0	33.5
	Rest	421	27.2	76.4	1125	72.8	63.4	1546	100.0	66.5
Academic discipline*	AGRI	119	33.9	21.6	232	66.1	13.1	351	100.0	15.1
	BIO	66	37.9	12.0	108	62.1	6.1	174	100.0	7.5
	CHEM	41	25.2	7.4	122	74.8	6.9	163	100.0	7.0
	CHEMENG	9	21.4	1.6	33	78.6	1.9	42	100.0	1.8
	COMP	14	14.4	2.5	83	85.6	4.7	97	100.0	4.2
	EARTH	13	11.3	2.4	102	88.7	5.7	115	100.0	4.9
	ENER	6	19.4	1.1	25	80.6	1.4	31	100.0	1.3
	ENG	18	5.8	3.3	292	94.2	16.5	310	100.0	13.3
	ENVIR	57	35.6	10.3	103	64.4	5.8	160	100.0	6.9
	MATER	37	23.1	6.7	123	76.9	6.9	160	100.0	6.9
	MATH	9	6.3	1.6	133	93.7	7.5	142	100.0	6.1
	MED	138	36.4	25.0	241	63.6	13.6	379	100.0	16.3
	PHARM	14	66.7	2.5	7	33.3	0.4	21	100.0	0.9
	PHYS	10	5.5	1.8	171	94.5	9.6	181	100.0	7.8

* STEMM disciplines included are as follows: AGRI, agricultural and biological sciences; BIO, biochemistry, genetics, and molecular biology; CHEMENG, chemical engineering; CHEM, chemistry; COMP, computer science; EARTH, earth and planetary sciences; ENER, energy; ENG, engineering; ENVIR, environmental science; MATER, materials science; MATH, mathematics; MED, medical sciences; PHARM, pharmacology, toxicology, and pharmaceutics; and PHYS, physics and astronomy.

12. Methodology 1. Constructing Individual Lifetime Biographical and Individual Publication Histories (1/2)

- We hold metadata on **all publications** by each scientist **within each of the three stages** of their scientific career development (assistant, associate, full professor).
- **Individual scientific biographies (dates) & individual publication histories (metadata) at earlier stages of development - allow us a retrospective analysis of productivity class changes over time.**
- Only full professors can be compared to each other across the three stages of their scientific career.
- **A long period of scientific activity, spanning several decades!**
- **Full professorship as the crowning of the academic career**: we look retrospectively at professors 20-30-40 years earlier!

13. Methodology 1. Constructing Individual Lifetime Biographical and Publication Histories (2/2)

- **Longitudinal approach**: each (publishing) full professor is characterized by **transitions between productivity classes** (compared to their peers in the discipline &at the same career stage).
- We compare the **productivity of current full professors** - with their **productivity in the past**.
- **We analyze the productivity of scientists as they get older - and as they move up their academic ladders.**
- Transitions between classes at an **individual level**, then **aggregated to the discipline levels & gender levels**.
- **In a cross-sectional approach**, in contrast, a **focus on current productivity only (e.g. a snapshot view of 2014-2017).** Comparison of their **current** productivity with that of lower ranks.

14. Methodology 2. Constructing Journal Prestige-Normalized Individual Research Productivity (1/2)

- **The productivity of a scientist at a given stage** calculated in terms of four-year periods.
- For all full professors, we constructed their **lifetime productivity profiles** & **three productivity profiles for every career stage** (with distinct opening & closing dates from our dataset).
- **Full-counting approach** (instead of fractional counting).
- Prestige-normalized individual research productivity **better reflects the workload and its effect** (in the global circulation of science).
- It is **closely related to the Polish system of evaluating scientists** & scientific units.
- The **journal prestige in Scopus measured annually** by placing the journal in the CiteScore system (prepared for all journals indexed in Scopus, 40,079 in 2022).
- **Most intuitive** within the CiteScore metrics: **journal percentile ranks (0-99)**.

Scopus®

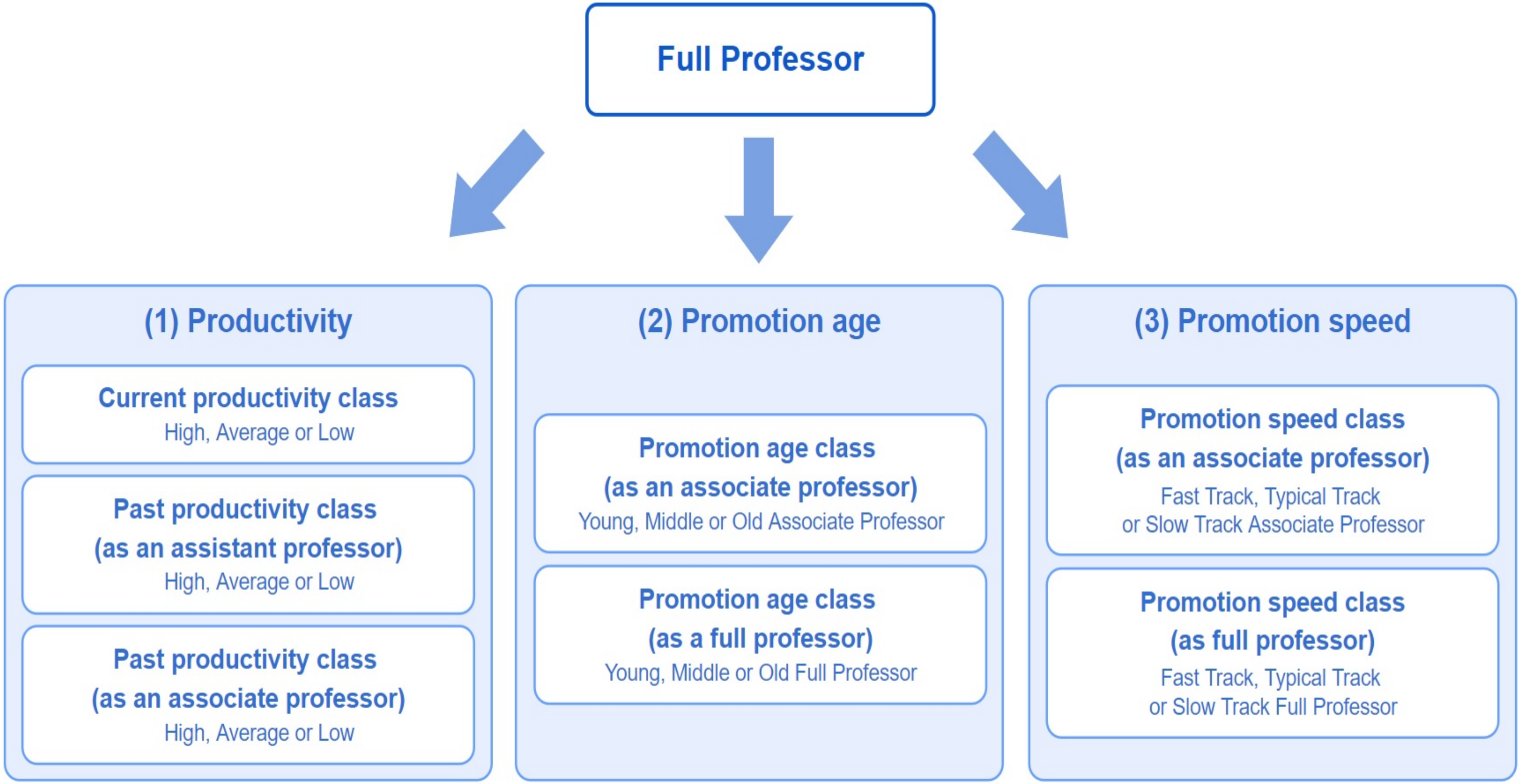
15. Methodology 2. Constructing Journal Prestige-Normalized Individual Research Productivity (2/3)

- The most prestigious journals in each field are usually in the 90-99th percentile of journals. Also in higher education!
  - **See M. Kwiek (2021). The Prestige Economy of Higher Education Journals: A Quantitative Approach. Higher Education. 81. 493-519. CGHE seminar, March 2021: YouTube.**
- Major point: publications **in more prestigious journals count more in productivity calculations** than publications in less prestigious journals.
- In **non-normalized productivity** (raw publication numbers), an an article located in any journal = 1.
- Here: article in a journal with **a percentile rank of 95** will receive a value of **0.95** (and in 30 – 0.3).
- **Fair** approach in STEMM disciplines: a vertical journal stratification is **a fact of life**.
- *Higher Education* (95%) and *Higher Education Forum* (29%): considering **scholarly efforts invested**, 90% rejection rates, 2-3 rounds of tough reviews, etc.

16. Methodology 3. Constructing the Classificatory Scheme: Productivity, Promotion Age, and Promotion Speed Classes

- The idea of **climbing the academic ladder**: today's full professors had to be **earlier** assistant and associate professors.
- They **remained at each stage of their career for a certain number of years** (with a certain productivity). Full data available!
- We **assign all full professors to three productivity classes**: high, average and low productive (20%, 60% and 20%, separately within each of the 14 STEMM disciplines).
- **Three different 'academic career classes'** used in logistic regression models:
  - productivity classes,
  - promotion age classes, and
  - promotion speed classes.

17. Methodology 3. Constructing the Classificatory Scheme: Productivity, Promotion Age, and Promotion Speed Classes



18. Limitations

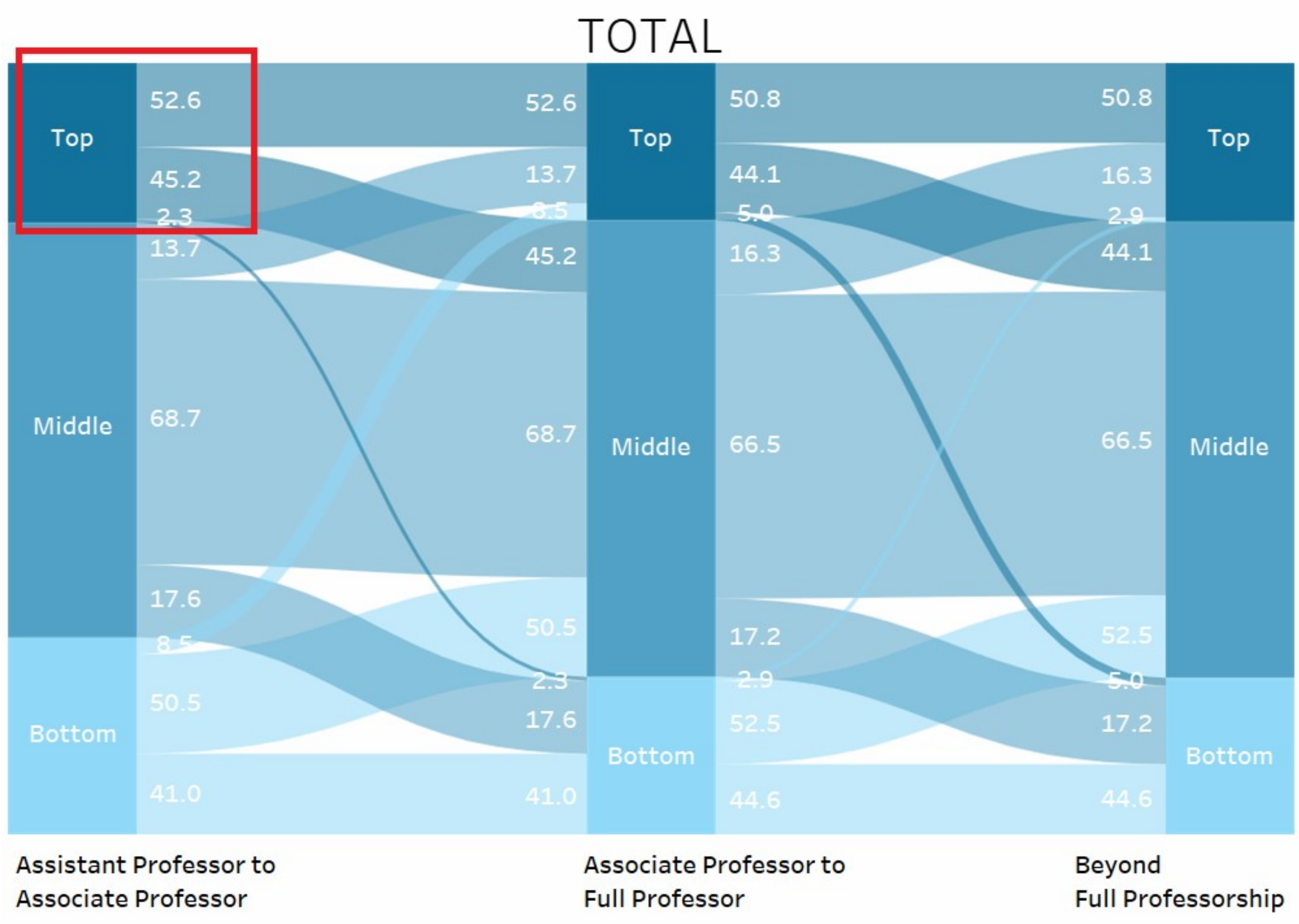
- **Non-publishing scientists not included.**
- Combination of **(near perfect) admin & biographical data** from a national registry of scientists with (**much less perfect) bibliometric data** at an individual level.
  - Data on **real individuals** (with individual IDs) - & the metadata on publications by **individual Scopus IDs** (rather than real scientists).
  - Scopus data: their **own linguistic, geographical, & disciplinary biases**.
  - However, no other source of publication metadata is **available for Polish scientists for the past 40 years**.
- **Scopus disciplinary classification** (ASJC) used.


RESULTS

20. Mobility Between Productivity Classes – All Disciplines Combined (Figure Explained)

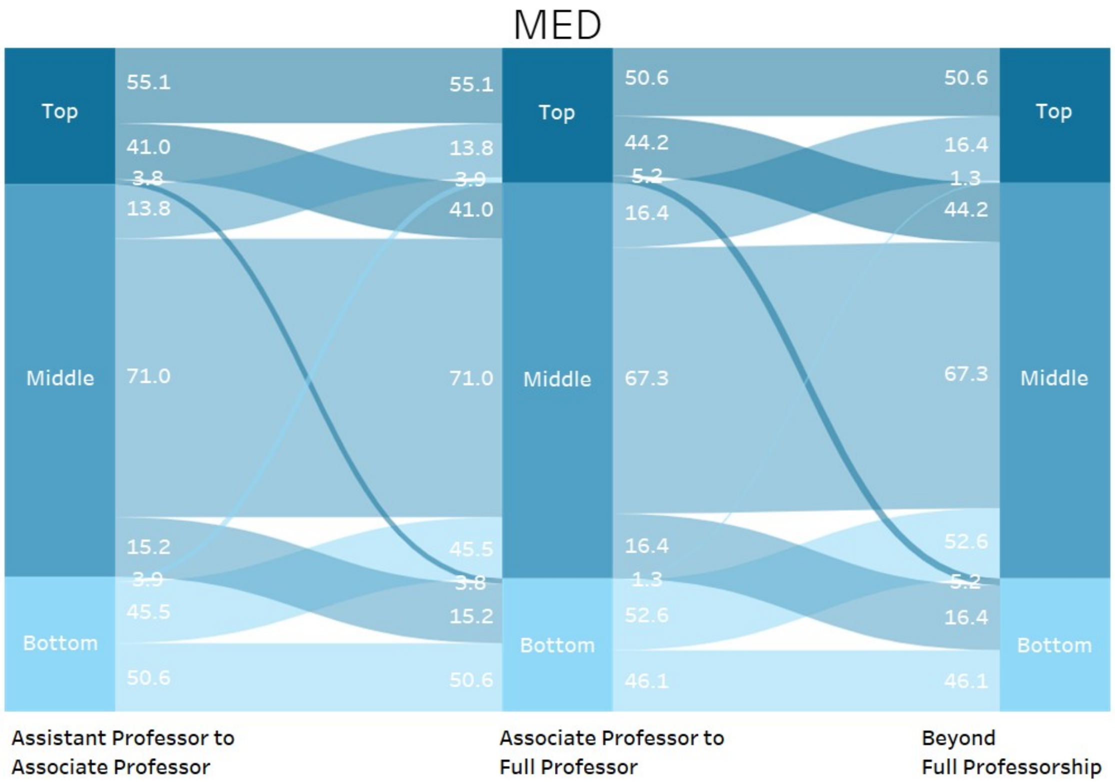
- The Figure on next slide: **lifetime career trajectories** of 2,326 full professors, 14 STEMM disciplines combined (**TOTAL**).
- Their productivity (top, middle or bottom) in 3 periods (exact dates available):
  - **between becoming an assistant professor - and becoming an associate professor** (left column);
  - **between becoming an associate professor - and becoming a full professor** (middle column); and
  - **after becoming a full professor** (right column).
- Special interest: **mobility between top productivity classes**.
- **The majority of highly productive scientists stayed on as highly productive** (compared with their peers in the same discipline and within the same academic position):
  - See thick horizontal flows: more than a half of highly productive scientists **moved from top to top class in both the first (52.6%) and the second stage of academic career (50.8%).**
  - **Exceptional cases of top-to-bottom mobility** (35 out of over 2,300) in productivity classes are shown as **thin descending flows**.
  - **Bottom-to-top mobility also limited** (65 out of over 2,300): upward mobility is shown by **thin ascending flows**.

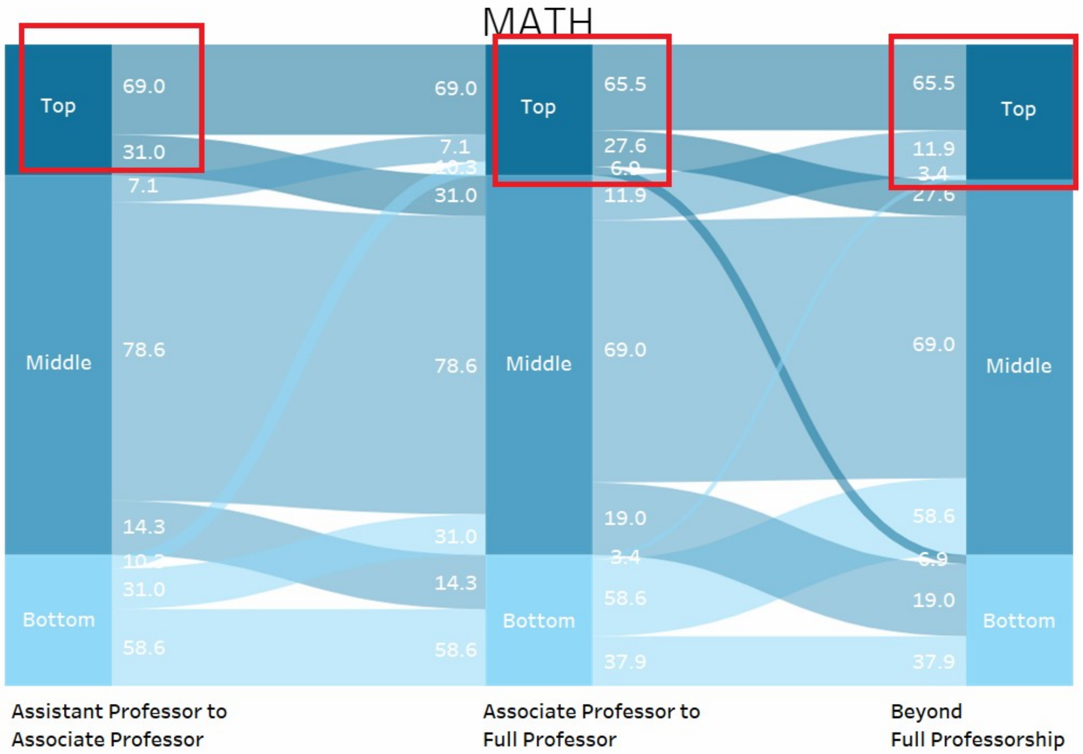
21. Retrospectively constructed mobility between productivity classes in the three stages of academic careers, all STEMM disciplines combined, current full professors only. Top (upper 20%), middle (middle 60%), and bottom productivity class (lower 20%), in percentages; 100% in each of the three classes.
N=2326. The data behind the figure in the table.



Transition from: source academic position	Transition from: productvity class	Transition to: target academic position	Transition to: productvity class	Number of scientists in transition	Number of scientists in a given productivity class	%
Assistant Professor	Bottom	Associate Professor	Bottom	245	598	41.0
Assistant Professor	Bottom	Associate Professor	Middle	302	598	50.5
Assistant Professor	Bottom	Associate Professor	Top	51	598	8.5
Assistant Professor	Middle	Associate Professor	Bottom	222	1260	17.6
Assistant Professor	Middle	Associate Professor	Middle	866	1260	68.7
Assistant Professor	Middle	Associate Professor	Top	172	1260	13.7
Assistant Professor	Top	Associate Professor	Bottom	11	485	2.3
Assistant Professor	Top	Associate Professor	Middle	219	485	45.2
Assistant Professor	Top	Associate Professor	Top	255	485	52.6
Associate Professor	Bottom	Full Professor	Bottom	213	478	44.6
Associate Professor	Bottom	Full Professor	Middle	251	478	52.5
Associate Professor	Bottom	Full Professor	Top	14	478	2.9
Associate Professor	Middle	Full Professor	Bottom	238	1387	17.2
Associate Professor	Middle	Full Professor	Middle	923	1387	66.5
Associate Professor	Middle	Full Professor	Top	226	1387	16.3
Associate Professor	Top	Full Professor	Bottom	24	478	5.0
Associate Professor	Top	Full Professor	Middle	211	478	44.1
Associate Professor	Top	Full Professor	Top	243	478	50.8
Full Professor	Bottom			475	475	100
Full Professor	Middle			1385	1385	100
Full Professor	Top			483	483	100

22. Disciplinary differentiation: MED (the largest discipline); MATH (the extreme case – highest stability over time).






AGRI
BIO
CHEM
CHEMENG
COMP
EARTH
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MATER
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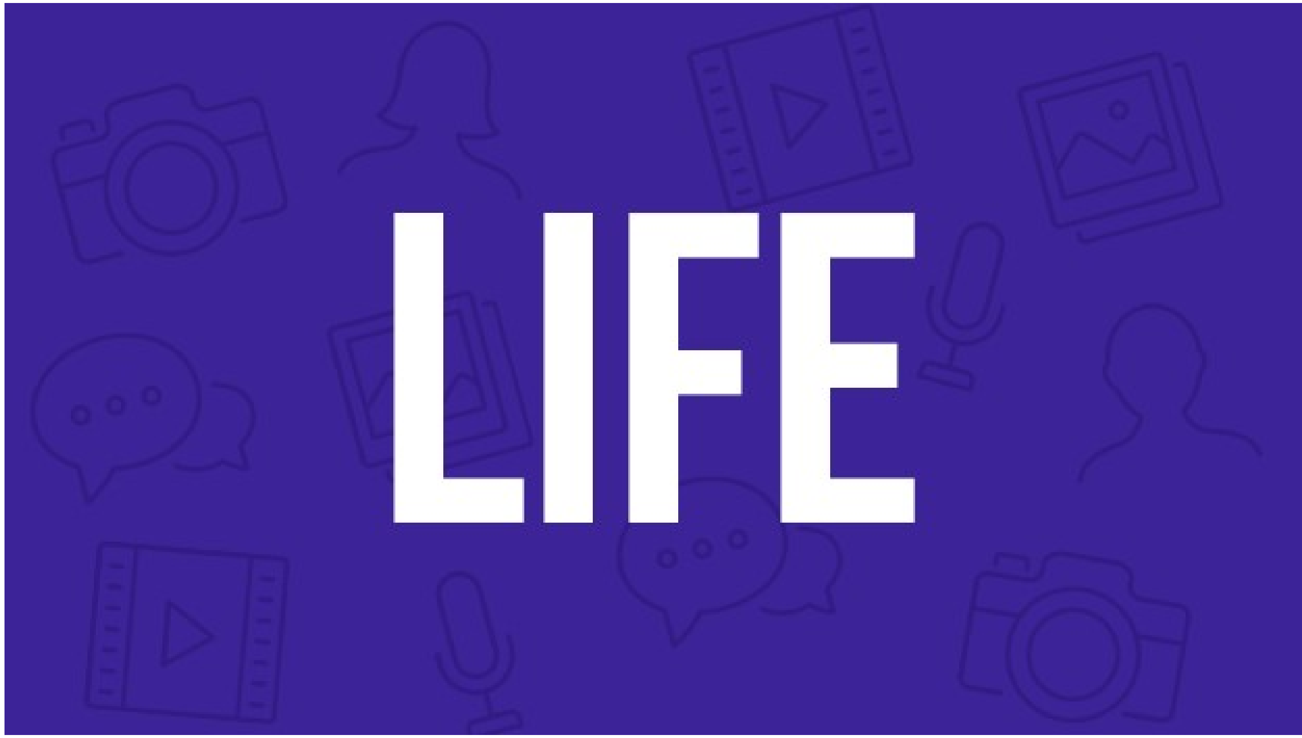
TOTAL

24. Lifetime Class Mobility: Directly from Assistant Professors to Full Professors

- Comparison of academic careers **at first and last stages**: assistant professor vs. full professor.
- **Almost a half of current highly productive full professors - were already highly productive assistant professors 20-30 years earlier (46.8%).**



Discipline	Mobility: 3 academic career stages (Assistant Professor → Associate Professor → Full Professor)												Mobility: 2 academic career stages (Assistant Professor → Full Professor)					
	Mobility 1 (Bottom to Bottom): from Assistant Professor Bottom class to Associate Professor Bottom class			Mobility 2 (Bottom to Bottom): from Associate Professor Bottom class to Full Professor Bottom class			Mobility 3 (Top to Top): from Assistant Professor Top class to Associate Professor Top class			Mobility 4 (Top to Top): from Associate Professor Top class to Full Professor Top class			Mobility 5 (Bottom to Bottom): from Assistant Professor Bottom class to Full Professor Bottom clas			Mobility 6 (Top to Top): from Assistant Professor Top class to Full Professor Top class		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
AGRI	33.3	41.1	38.5	56.2	42.6	45.7	52.2	52.1	52.1	26.9	61.4	48.6	35.4	31.6	32.9	39.1	50.0	46.5
BIO	46.2	36.4	40.0	40.0	38.1	38.9	46.2	69.6	61.1	37.5	63.2	51.4	30.8	31.8	31.4	23.1	52.2	41.7
CHEM	-	43.8	41.2	75.0	28.6	34.4	50.0	56.5	54.3	27.3	54.5	45.5	50.0	25.0	26.5	41.7	52.2	48.6
CHEMENG	-	42.9	40.0	100.0	55.6	60.0	33.3	50.0	44.4	33.3	33.3	33.3	100.0	21.4	26.7	33.3	16.7	22.2
COMP	50.0	53.3	52.4	16.7	42.9	35.0	-	45.0	45.0	33.3	35.3	35.0	-	13.3	9.5	-	30.0	30.0
EARTH	-	33.3	30.4	33.3	35.0	34.8	66.7	55.0	56.5	33.3	70.0	65.2	50.0	33.3	34.8	-	60.0	52.2
ENER	75.0	22.2	38.5	66.7	40.0	50.0	100.0	50.0	57.1	100	50.0	57.1	50.0	55.6	53.8	100.0	50.0	57.1
ENG	50.0	34.2	35.0	33.3	44.1	43.5	100.0	48.3	50.8	40	49.1	48.4	25.0	30.3	30.0	33.3	45.0	44.4
ENVIR	39.1	42.3	40.8	46.2	63.6	57.1	41.7	58.3	52.8	62.5	65.4	64.7	26.1	50.0	38.8	58.3	50.0	52.8
MATER	-	32.0	25.0	-	40.6	40.6	62.5	25.0	34.4	37.5	43.8	40.6	-	32.0	25.0	62.5	33.3	40.6
MATH	75.0	56.0	58.6	-	42.3	37.9	100.0	67.9	69.0	50	66.7	65.5	-	40.0	34.5	100	46.4	48.3
MED	54.5	47.7	50.6	55.2	40.4	46.1	56.7	54.2	55.1	37.5	60.0	50.6	51.5	40.9	45.5	46.7	62.5	56.4
PHARM	75.0	-	60.0	33.3	50.0	40.0	50.0	33.3	40.0	25	-	20.0	50.0	-	40.0	-	33.3	20.0
PHYS	-	47.2	45.9	-	62.9	61.1	100.0	44.4	45.9	33.3	54.3	52.6	-	47.2	45.9	100.0	44.4	45.9
Total	**41.2**	**40.9**	**41.0**	**47.0**	**43.9**	**44.6**	**54.9**	**51.9**	**52.6**	**35.8**	**56.7**	**50.8**	**34.0**	**34.2**	**34.1**	**42.5**	**48.1**	**46.8**

Retrospectively constructed selected mobility between productivity classes (top to top, bottom to bottom) in the three stages of academic careers.

The 20/60/20 and 10/80/10 divisions: top, middle, and bottom class, in percentages, N=2326.

Discipline	Mobility: 3 academic career stages (Assistant Professor → Associate Professor → Full Professor)												Mobility: 2 academic career stages (Assistant Professor → Full Professor)					
	Mobility 1 (Bottom to Bottom): from Assistant Professor Bottom class to Associate Professor Bottom class			Mobility 2 (Bottom to Bottom): from Associate Professor Bottom class to Full Professor Bottom class			Mobility 3 (Top to Top): from Assistant Professor Top class to Associate Professor Top class			Mobility 4 (Top to Top): from Associate Professor Top class to Full Professor Top class			Mobility 5 (Bottom to Bottom): from Assistant Professor Bottom class to Full Professor Bottom class			Mobility 6 (Top to Top): from Assistant Professor Top class to Full Professor Top class		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
AGRI	31.2	35.8	34.3	57.1	41.4	44.4	33.3	21.3	24.2	33.3	57.7	51.4	25.0	17.9	20.3	28.6	44.8	41.7
BIO	50.0	23.5	33.3	-	41.7	27.8	33.3	33.3	33.3	22.2	55.6	38.9	20.0	17.6	18.5	-	58.3	38.9
CHEM	-	31.2	31.2	20.0	35.7	31.6	100.0	20.0	25.0	20.0	45.5	37.5	-	18.8	18.8	40.0	35.7	36.8
CHEMENG	-	28.6	26.7	50.0	33.3	40.0	-	80.0	80.0	-	66.7	40.0	-	21.4	20.0	50.0	33.3	40.0
COMP	33.3	40.0	38.1	-	40.0	40.0	-	37.5	27.3	-	22.2	20.0	-	13.3	9.5	-	10.0	10.0
EARTH	-	25.0	22.7	-	36.4	33.3	-	30.0	23.1	-	50.0	50.0	50.0	25.0	27.3	-	54.5	50.0
ENER	50.0	22.2	30.8	-	100.0	75.0	-	33.3	20.0	-	50.0	50.0	25.0	33.3	30.8	-	66.7	50.0
ENG	50.0	19.7	21.2	-	43.3	41.9	50.0	36.7	37.5	33.3	35.7	35.5	25.0	18.4	18.8	-	43.3	41.9
ENVIR	30.4	34.6	32.7	75.0	50.0	55.6	12.5	33.3	25.0	60.0	50.0	52.9	4.3	30.8	18.4	50.0	57.1	55.6
MATER	-	13.3	9.1	50.0	33.3	37.5	-	12.5	12.5	44.4	42.9	43.8	-	13.3	9.1	50.0	33.3	37.5
MATH	50.0	45.0	45.5	100.0	42.9	46.7	-	30.8	26.7		76.9	66.7	-	20.0	18.2	-	50.0	46.7
MED	61.1	58.3	59.5	46.2	36.0	39.5	61.1	33.3	46.2	11.1	60.0	36.8	38.9	16.7	26.2	30.8	48.0	42.1
PHARM	66.7	-	66.7	-	-	-	50.0	-	33.3	33.3	-	33.3	33.3	-	33.3	-	-	-
PHYS	-	33.3	33.3	-	50.0	50.0	-	38.9	38.9	-	57.9	55.0	-	27.8	27.8	-	33.3	33.3
Total	**36.7**	**31.5**	**32.9**	**39.1**	**41.6**	**41.2**	**35.4**	**29.8**	**31.1**	**25.4**	**51.4**	**44.2**	**20.3**	**20**	**20.1**	**28.3**	**43.1**	**40.3**

26. Logistic Regression Models

- Estimating **odds ratio estimates of belonging to top productivity classes**.
- **Individual-level independent variables**:
  - **Gender,**
  - **Age:** current biological age & academic age,
  - **Career milestones:** age for doctorate, postdoctoral degree, and for full professorship;
  - **Career classes**: age promotion class, speed promotion class.
- **Major predictors? Just 3!**
  - **Gender, age, university type – statist. insignificant!**
  - **Being earlier** a **highly productive** associate professor (increase the odds four times - by 361%!)
  - **Being earlier** a **highly productive** assistant professor (increase the oods two times - by 179%)
  - Becoming a **full professor early** - belonging to 20% youngest full professors (increase by 100%)

Model	Model 1: Full Professors R^2=0.254				Model 2: Associate Professors R^2=0.582				Model 3: Assistant Professors R^2=0.355			
	Exp(B)	95% C.I.for EXP(B)		Sig.	Exp(B)	95% C.I.for EXP(B)		Sig.	Exp(B)	95% C.I.for EXP(B)		Sig.
		Lower	Upper			Lower	Upper			Lower	Upper	
Male					1.426	1.03	1.974	0.033				
Resarch intensive												
Biological age					0.694	0.665	0.724	<0.001	0.774	0.753	0.796	<0.001
Academic age					1.021	1.002	1.041	0.028	1.122	1.098	1.148	<0.001
Assistant_age					0.942	0.892	0.995	0.032	1.207	1.143	1.273	<0.001
Associate_age					1.475	1.404	1.549	<0.001	-	-	-	-
Full_age					-	-	-	-	-	-	-	-
Top_Assistant	2.793	2.14	3.646	<0.001	6.667	4.72	9.416	<0.001	-	-	-	-
Top_Associate	4.61	3.558	5.974	<0.001	-	-	-	-	-	-	-	-
Young_Assistant									1.739	1.232	2.455	0.002
Young_Associate									-	-	-	-
Young_Full	1.942	1.503	2.509	<0.001	-	-	-	-	-	-	-	-
Fast_Associate									-	-	-	-
Fast_Full					-	-	-	-	-	-	-	-
Constant	0.1			<0.001	46.17			<0.001	128.62			<0.001

„-" – observations structurally not applicable.

27. Further (Ongoing) Research: OECD Economies

- **Do productivity patterns found for Poland, a relative newcomer to the global academic enterprise, hold in a global context?**
- **300,000 older scientists** (publishing for the period of 25-35 years) **across 16 STEMM disciplines:** how they have been **changing their research productivity classes in 38 OECD economies.**
- **Several proxies** where **hard demographic data** cannot be used.
- **A clearly defined full sample** is **4.1 million scientists:** "the **global academic profession**" (Scopus data and Core Collection raw dataset from Clarivate Analytics).
- **Academic age rather than biological age** and **four career stages constructed using academic age** (beginning, early, middle and late career).
- Major issue: ourPolish **"Observatory" dataset is unbeatable in its precision and accuracy** (national registry) – there are no registries available on a global scale.

28. Final Words – Implications (1/2)

- First: only the **combination** of reliable admin & biodemographic data and raw Scopus metadata (50 years) - made it possible to create **current productivity classes and retrospectively past productivity classes**.
- Second: **the power of structured Big Data** (Scopus): for each full professor:
  - To define **discipline** (lifetime: all cited references)
  - To define **prestige-related** productivity (lifetime – 3 stages)
  - To allocate all **publications** (articles only) to 3 career stages (lifetime)
  - To define **academic age** (first publication).
- Third: **every full professor was compared with their exact peers** (with current peer professors when they were at the same stage of careers). **Comparing apples with apples.**
- **Fourth: other options seem to take time:** following scientists over time through periodic surveys (method with its own limitations).

29. Final Words - Implications (2/2)

- The **hiring of low-productivity (and high-productivity researchers)** has long-term consequences: for **institutions** and the **national science system**.
- **A high level of immobility in the system: for many years.** The moment of **accepting a scientist to work after the doctorate matters.**
- Productivity thus emerges as **largely pre-determined** – **support for the 'sacred spark' theory of productivity** (both descriptive statistics & logistic regression models).
- **"Once highly productive, forever highly productive"?**
- **Half of scientists belong to the same productivity class throughout their entire research careers: they remain in the top class for decades (and minimal top-bottom or bottom-top transitions!)**
- **Highly skewed productivity continues (10/50 rule)**: full professors are working within stable productivity classes over lifetime, with **very limited cross-class mobility.**
- **Persistent inequality of science cross-sectionally (in points in time) / coexists with persistent inequality of science across time (longitudinally, over lifetimes).**
- Another contribution to inequality research!

- Thank you! Questions? Comments? kwiekm@amu.edu.pl, Twitter: @Marek_Kwiek