

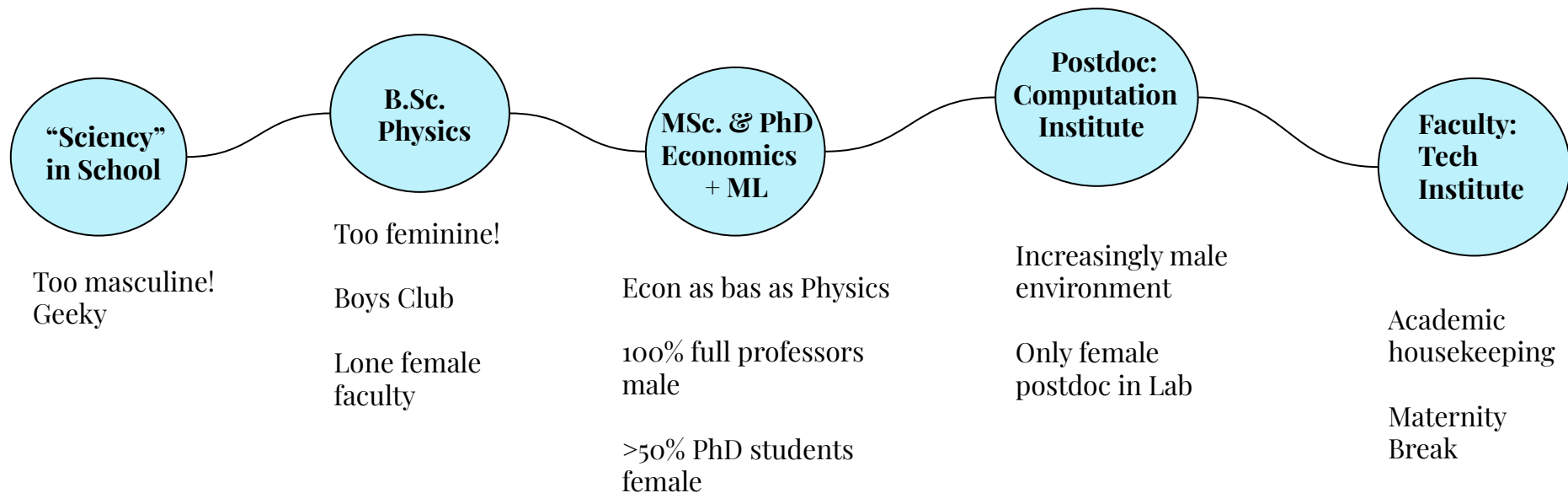
Women in STEM (in India)

**Dr Nandana Sengupta,
Assistant Professor, School of Public Policy, IIT Delhi**

Talk Roadmap

- **Prologue: My STEM Journey**
- **Women in STEM (in India)**
 - Motivation and Literature Review
 - Fixing the leaky pipeline (IITD x Co-Impact)
 - Deep Dive: Supernumerary Seats Scheme
- **Epilogue: A broad overview of other efforts**

Prologue: My STEM Journey



Casual Sexism

Imposter Syndrome

Lack of Role Models

Inadequate Physical Infrastructure

Women in STEM (in India): Motivation

- **Context**

- India 135 (out of 146 countries) in Gender Parity Index [WEF 2022]
- Base rate of STEM faculty 14%, older IITs 11%
- 14% scientists & engineers in research institutes
 - 29% worldwide average
 - 43% female STEM graduates
- No female head of IIT, IIIT, ISER, IISc. Decision making bodies: AICTE, JEE, GATE

- **Literature Review**

- Literature primarily from Global North
- Burgeoning area of research within India
- “Securing the leak, shattering the glass ceiling?” (Kaur and Kapoor 2022)
- I will categorize selected paper based on “STEM Lifecycle”
 - Entry
 - Experience
 - Retention
 - Leadership

Women in STEM (in India): Motivation

Entry

- Parental aspirations and investments [Thakkar et al 2018; Kaur & Kapoor 2019]
- Masculine disciplines [Pierra et al 2013; Chanana 2006; Gautam 2015]
- Institute location [Gupta, 2012; Kalra, 2019; Mukhopadhyay, 2021]
- Nature of exam [Funk & Perrone 2016; Reiner & Wagner 2017; Coffman & Klinowski 2020]

Experience

- Lack of role models [Dasgupta 2011]
- Infrastructure [Mahtani 2004; Espinosa 2011; Kurup & Maithreyi 2011;]
- Norms around socializing [Gupta 2007, 2010;]
- Confidence vs competence [Iriberry, Rey-Biel 2012; Dasgupta & Sharma 2019; Dasgupta et al 2022]

Retention

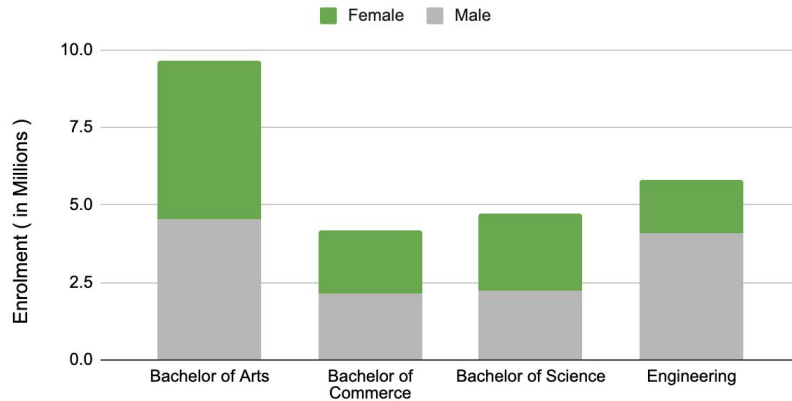
- Male imaginary of scientist [Acker 1990]
- Organizational culture [Seron et al 2018;]
- Dual burden of managing home and work [Afridi et al 2019; Kaur 2021]
- Maternity break [Mavriplis et al 2010]

Leadership

- Organizational periphery [Parikh & Sukhatme, 2004]
- Academic housekeeping and non-promotable tasks [Babcock et al 2022]
- Networking and mentorship [Su et al 2015;]
- Female representation in leadership [Teague 2015; Marschke et al 2007; Hurtado & DeAngelo 2009]

Women in STEM (in India): Motivation

Figure 1: Enrolments in STEM and Non STEM undergraduate courses in 2019



- Focus within STEM needs to be on engineering.
- Gender balance in engineering relevant because:
 - Engineering fields are essential for future job market (Noonan, 2017)
 - Engineering graduates increasingly occupying administrative service spaces (TCPD-IAS 1951-2020)
 - Exclusion would lead to an impact on equity (Fayer et al, 2017)

Fixing the leaky pipeline (IITD x ColImpact)

● Background

- **Co-Impact Gender Fund:** 5 year project, USD 500,000
- **Approach:**
 - Life-cycle: Entry > Experience > Retention > Leadership
 - Interdisciplinary: Economics / Sociology/ Geography
 - Participatory: Stakeholder inputs, Dissemination in-built
- **Research Gaps:**
 - Landscaping
 - Bridging the knowledge gap
 - Design (and implement) evidence based “Gender Inclusion Framework”
- **Team:**
 - PI: Ravinder Kaur, Co-PIs: Sangeeta Kohli, Narayanan Kurur, Nandana Sengupta
 - Researchers: Swati Sharma, Rohit Munshi, Gayatri Balu, Ananya Redkar, Khushdeep Malhotra

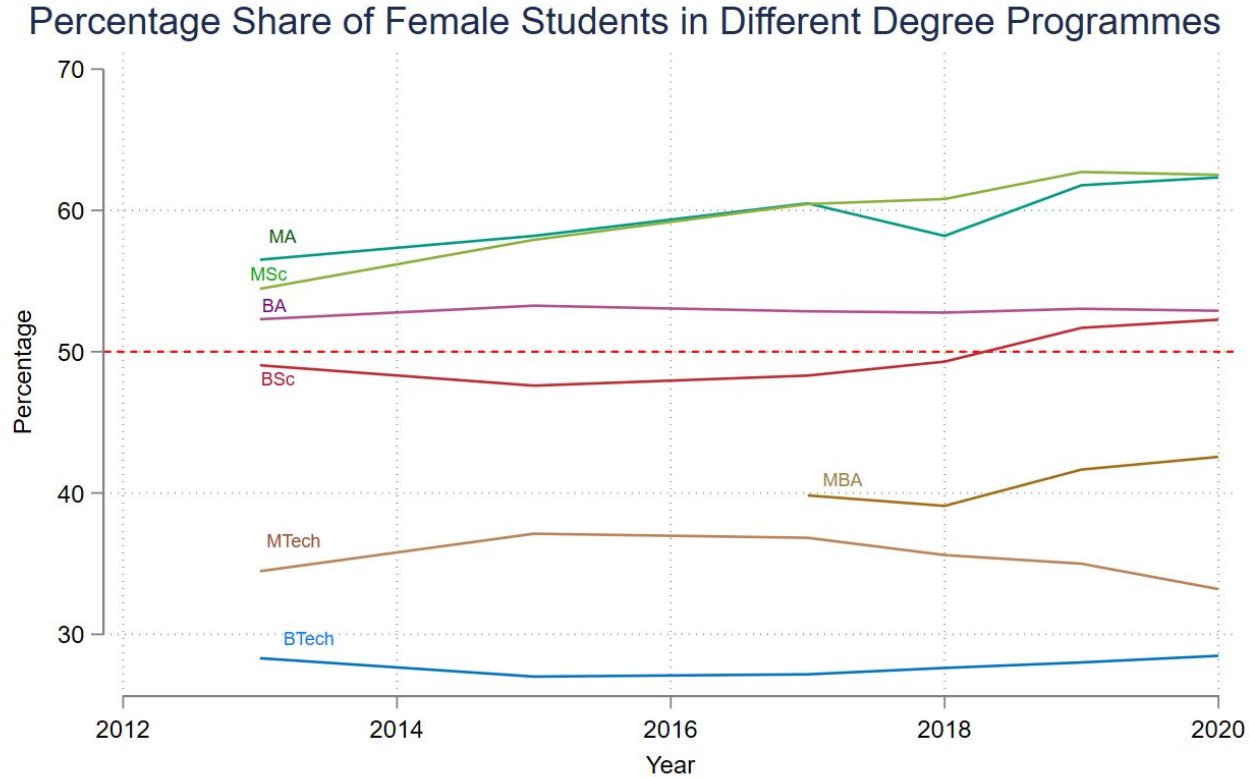
Fixing the leaky pipeline (IITD x ColImpact)

Stage of Lifecycle	Quantitative Approach	Qualitative Approach
Entry	JEE data: impact of schemes, question paper design	Parents, incoming students, coaching centers
Experience	Experiments: Aspirations, Imposter Syndrome, Role Models, Team dynamics	Campus mapping, Lab and classroom observation studies, Student clubs
Retention	Alumni Data, Meta data of IITs, Time use surveys	Faculty and alumni interviews, Time use surveys
Leadership	Citation Data, Meta data of IITs	Case studies of alumni and faculty in leadership roles

Deep Dive: Supernumerary Seats

- **Context:**
 - Skewed gender balance at IITs:
 - Registered (~ 18- 20%)
 - Qualified (~ 12-15%)
 - Allotted (~ 7-9%)
 - Median CGPA of girls in IIT Delhi was nearly 1 point higher than the median for boys, as of 2012
- **Supernumerary Scheme:**
 - Increase female representation in IIT classrooms to at least 20% by 2020
 - Without substantially affecting seats for male students
 - Phased out implementation (2018 - 2020)
- **Research Objectives:**
 - Setting the context
 - Unpacking the algorithm
 - Evaluating scheme's overall performance
 - Studying variations by location and discipline
- **Methodology:**
 - Data: JEE reports
 - Trends analysis
 - Cross-sectional analysis

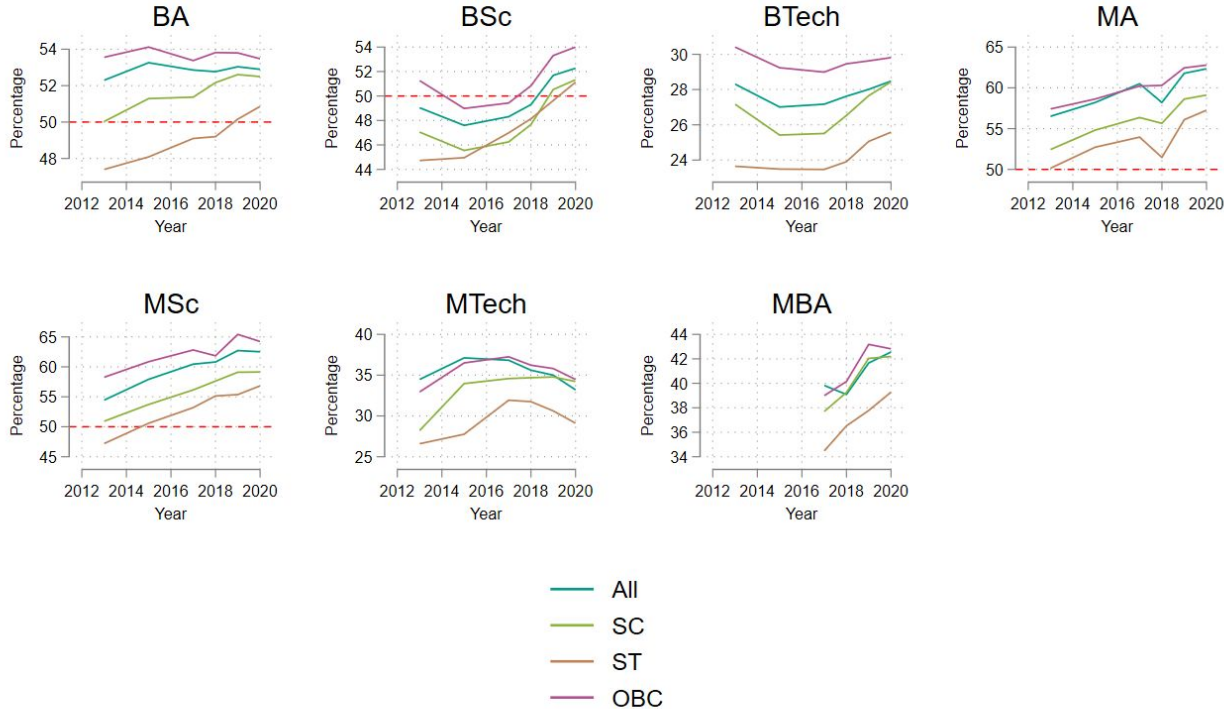
Supernumerary Seats: Setting the Context



source: AISHE Reports

Supernumerary Seats: Setting the Context

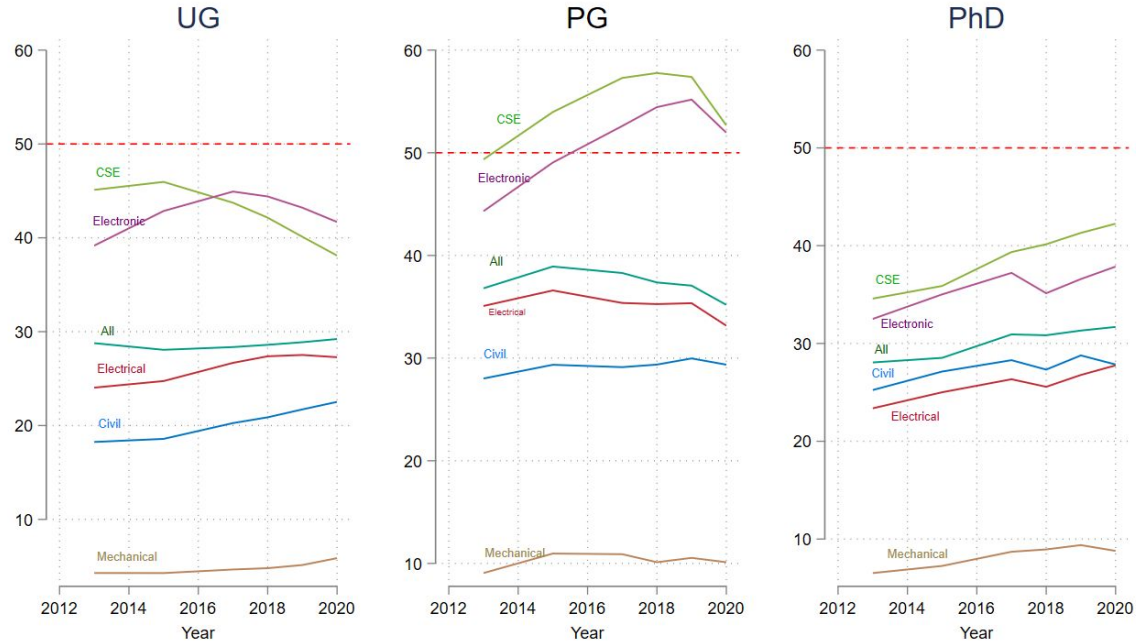
Percentage Share of Female Students by Caste Category in Different Degree Programmes



source: AISHE Reports

Supernumerary Seats: Setting the Context

Percentage of Female Students in Engineering Departments at Different Degree Levels



source: AISHE Reports

Supernumerary Seats: Unpacking the Algorithm

Types of seats and cutoffs:

$$N_{pre} = N_{m,pre} + N_{f,pre} ; \quad cutoff_{pre} = f(N_{pre})$$

$$N_{post} = N_{mf,post} + N_{f,post} ; \quad cutoff_{post} = f(N_{post})$$

$$\text{where } N_{mf,post} = N_{m,pre} ; \quad N_{f,post} = \frac{1}{4} \times N_{m,pre}$$

$N_{mf,post}$ referred to as “gender-neutral” seats

$N_{f,post}$ referred to as “female-only” seats

$[N_{post} - N_{pre}]$ referred to as “supernumerary” seats

$N_{f,cutoff}$ refers to number of females who make the cutoff

Potential Scenarios:

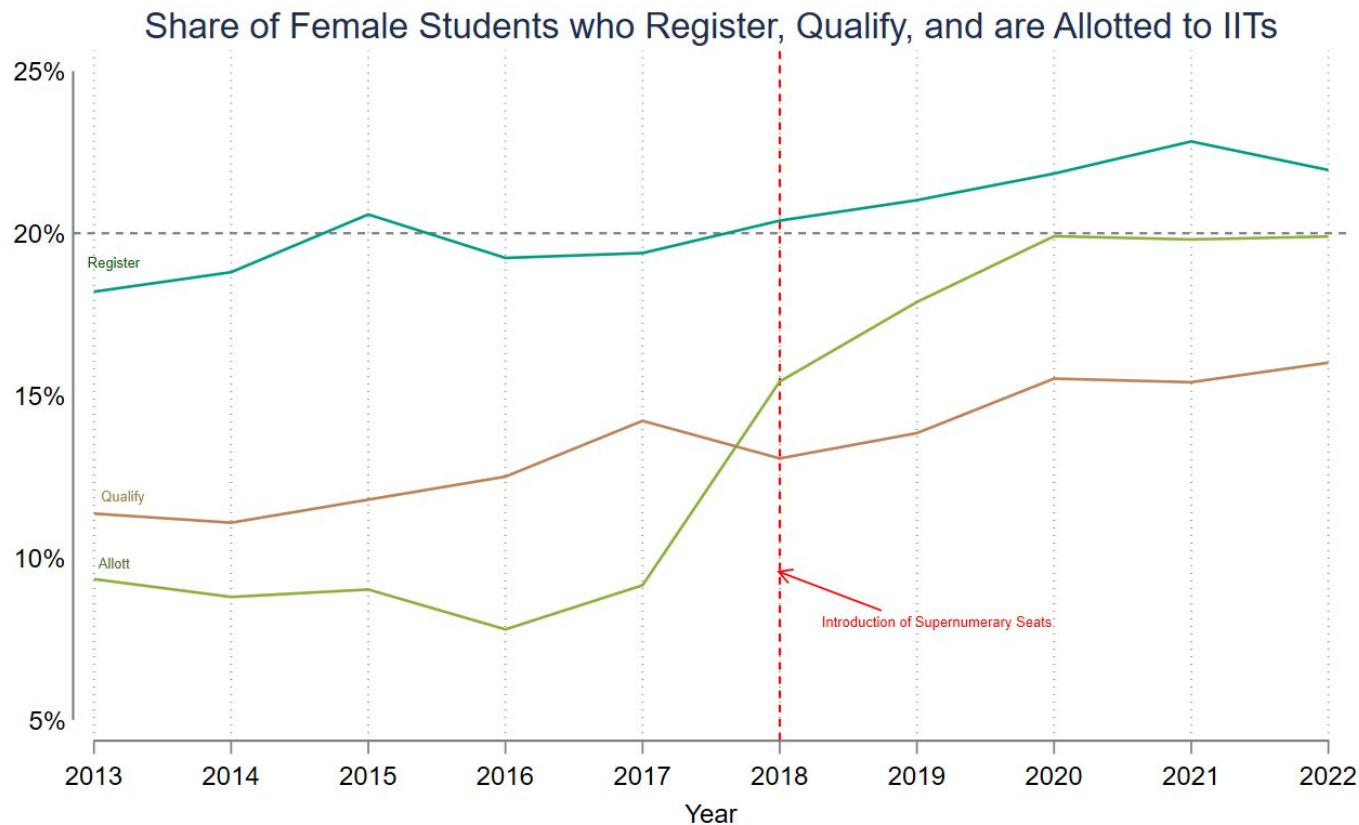
Scenario	$N_{f,cutoff} < N_{f,post}$	$N_{f,cutoff} \geq N_{f,post}$
No. of direct female beneficiaries	$N_{f,post} - N_{f,cutoff}$	none
Effect on standard	reduction (depends on number above)	no change
Effect on male students	none	$N_{m,post} \leq N_{m,pre}$ by $N_{f,cutoff} - N_{f,post}$

Supernumerary Seats: Unpacking the Algorithm

Some Implications:

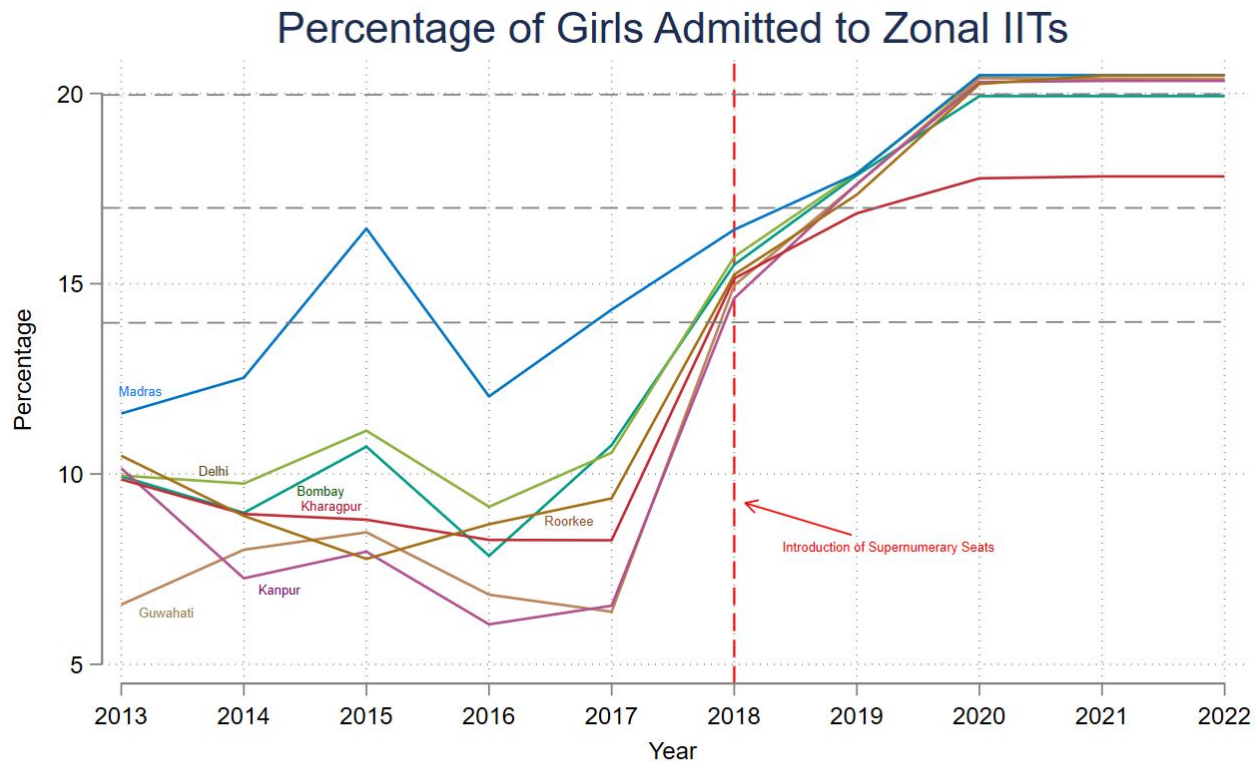
- **Lack of transparency regarding implementation details**
 - Not available for most IITs
 - IITD-IGES document
- **Complicated wording:**
 - Beneficiary/ non-beneficiary
 - Female only/ Supernumerary seats
- **In the design:**
 - Anchored to number of male students in year before implementation (arbitrary)
 - Anchor of total seats prior to scheme would be more robust
- **In the classroom:**
 - Seat-stealer narrative
 - Lowering standards narrative
 - Imposter syndrome

Supernumerary Seats: Evaluating Overall Performance



source: JEE reports

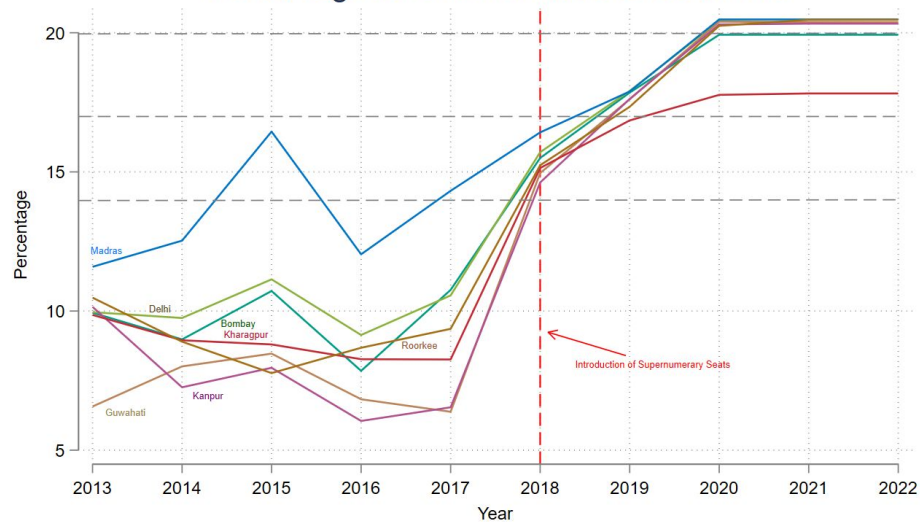
Supernumerary Seats: Evaluating Overall Performance



source: JEE Reports

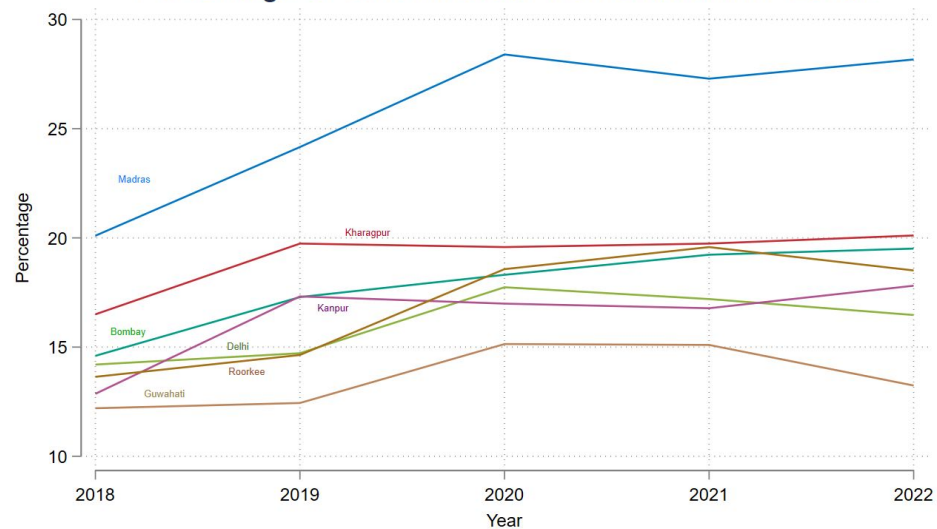
Supernumerary Seats: Evaluating Overall Performance

Percentage of Girls Admitted to Zonal IITs



source: JEE Reports

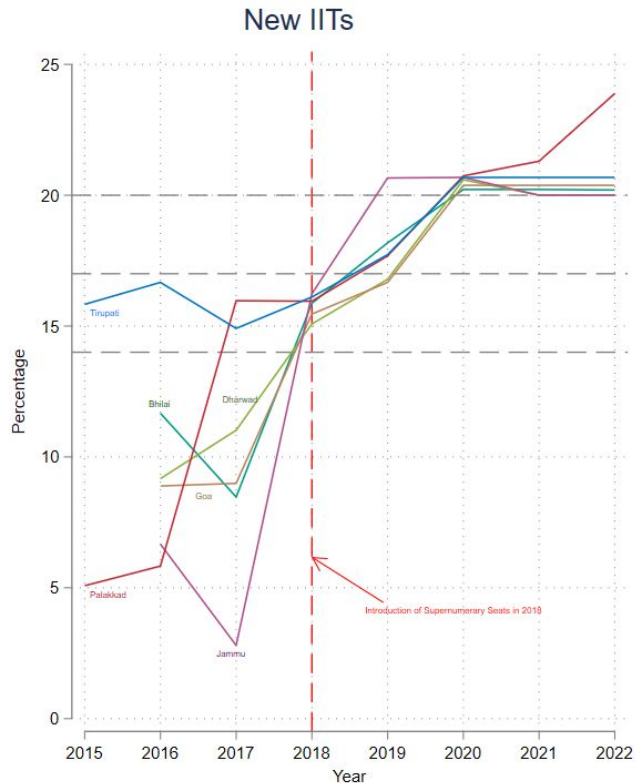
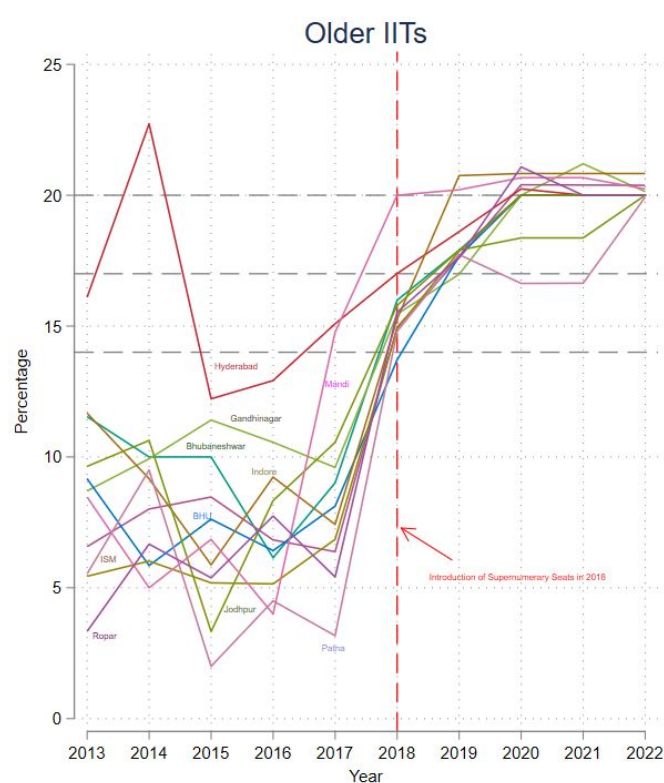
Percentage of Girls Allotted From Different IIT Zones



source: JEE Reports

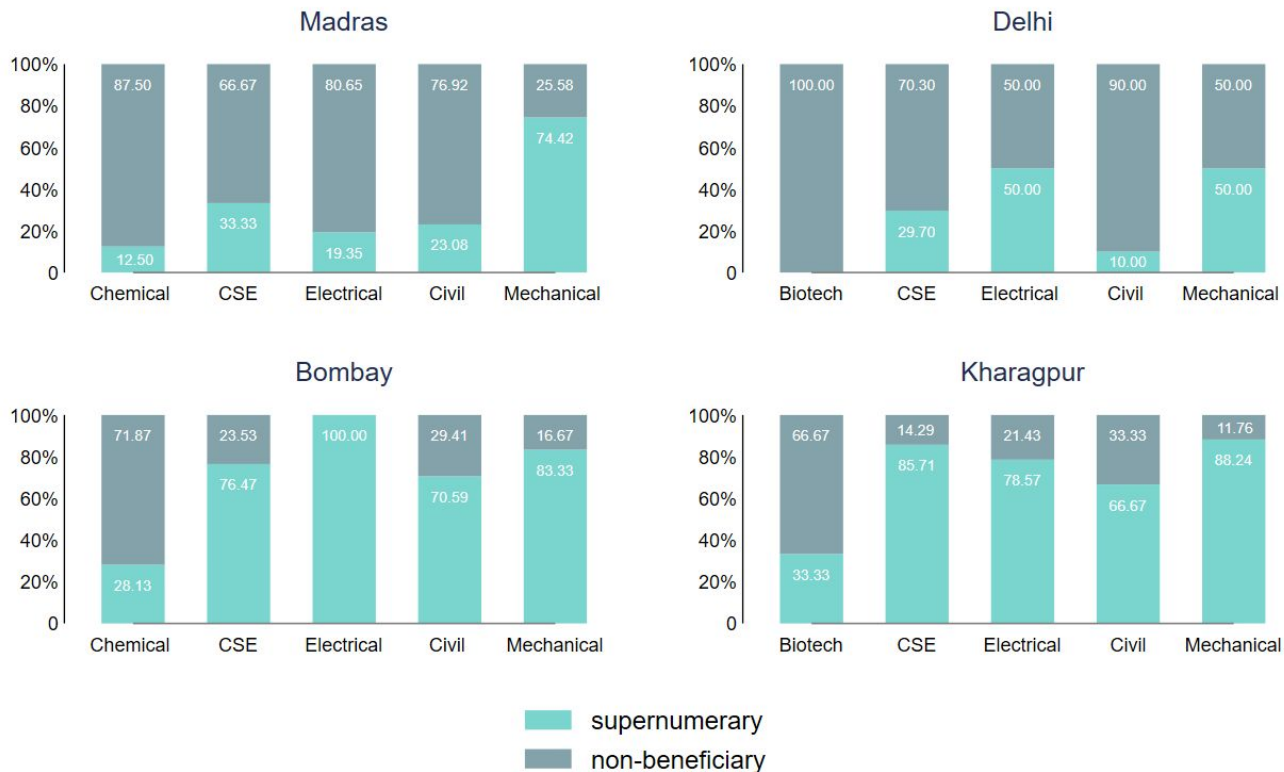
Supernumerary Seats: Evaluating Overall Performance

Percentage of Girls Admitted to Non-Zonal IITs



Supernumerary Seats: Evaluating Overall Performance

Percentage of Female-Only Seats Allotted to Beneficiary vs. Non-Beneficiary of the Scheme in 2022



source: JEE Reports

Supernumerary Seats: Overview

- **Ecosystem:**
 - Main laggard: Engineering especially BTech
 - Exacerbated for Scheduled Tribes
 - Exacerbated for certain disciplines like Mechanical engineering
- **Algorithm:**
 - Complicated and non-intuitive
 - Masks beneficiary vs non-beneficiary
- **Scheme performance:**
 - Broad trends – successful
 - Allotment vs qualification percentage
 - **Variations:**
 - Regional: Madras + Southern IITs
 - Regional: Kharagpur puzzle
 - Beneficiaries narrative: discipline and location
- **Recommendations:**
 - Clarification of algorithm
 - Improved Reporting
 - Break the narrative of “lower standards” and “seat-stealing”
 - Support for beneficiary students
 - Intersectional lens important

Epilogue: A broad overview of other efforts

Policy:

- DST efforts: GATI, WISE-KIRAN, INSPIRE

Publications:

- Bias Watch
- Seminar Magazine Dec 2022 issue

Fellowships and Grants;

- Rukhmabai grants: Stories of Women in STEM
- Center for Civil Society: Short film grant on Women in STEM

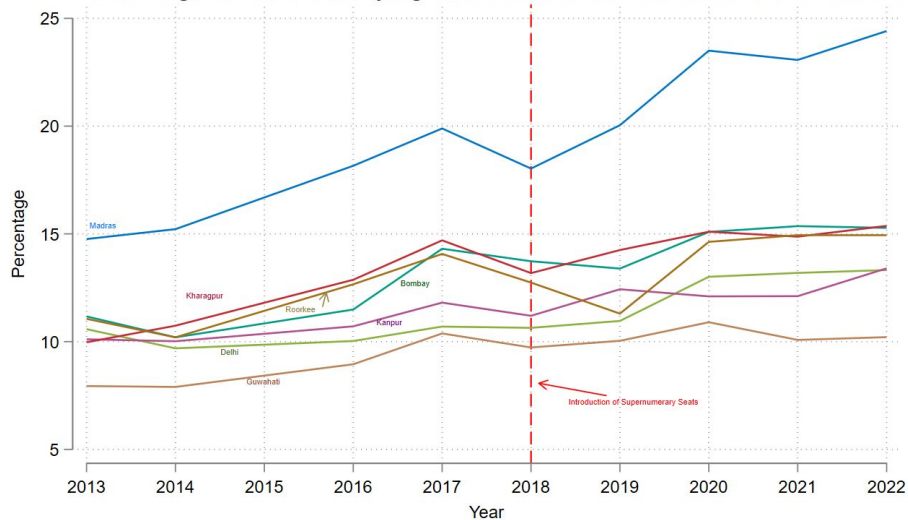
Other related ongoing research projects:

- COVID19 and engineering education (with Kavya Vohra)
- Women & Tech: Algorithmic bias in street safety ratings, FATE framework and gender, Digital Skilling

Thank you!

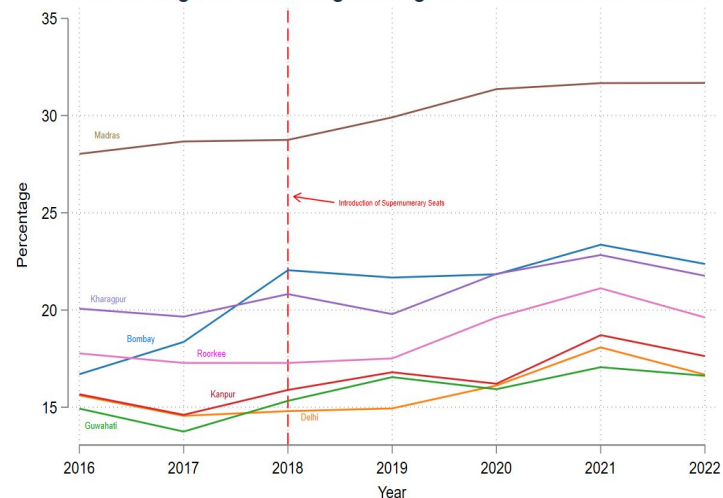
Comments, questions and suggestions welcome :)

Percentage of Girls Qualifying JEE Advanced From Different IIT Zones

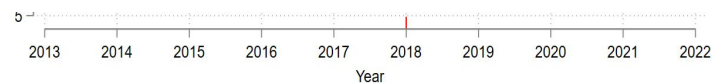


source: JEE Reports

Percentage of Girls Registering From Different IIT Zones



source: JEE Reports



source: JEE Reports