# Medical Research and Health Care Financing: Evidence from Academic Medical Centers

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# Motivation

- Central assumption in post-war science policy: basic research ultimately generates practical insights
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  - Formal: universities and research institutions; open-access databases; biomaterial libraries; patents [e.g., Furman and Stern 2011; Williams 2010]
  - Informal: collaboration, disclosure and authorship norms; materials sharing; priority and credit allocation [e.g., Gans et al. 2017; Walsh et al. 2005; Hill and Stein 2020]

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- We focus on one particular set of institutions: **Academic Medical Centers (AMCs)**

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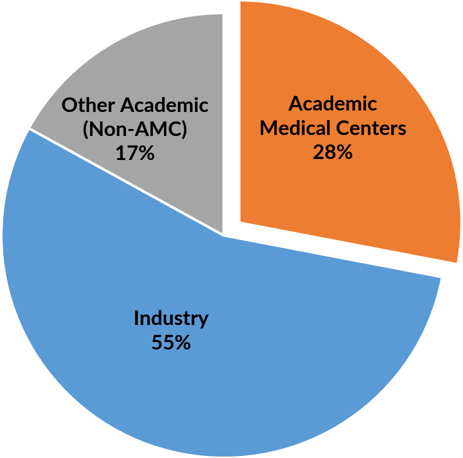
- Bridges the "ideas sector" (i.e., biomedical research) and the "production sector" (i.e., clinical care) of the health care economy
- **This paper:** How do health care reimbursement shocks impact the **rate**, **quality**, and **direction** of subsequent innovation?

# Why do AMCs matter?

## Biomedical research funding

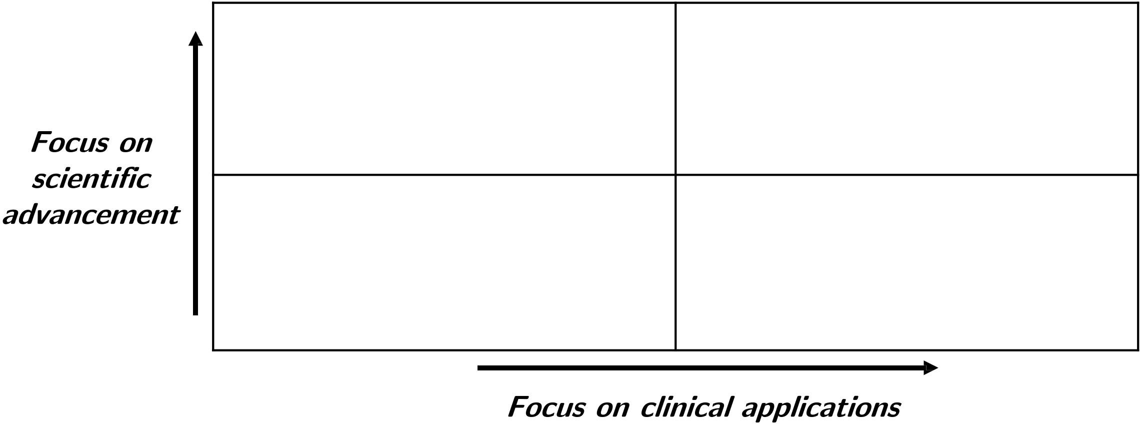



- In 1997, the US spent $42 billion on biomedical R&D
- 76% of NIH's extramural research budget went to AMCs
- Clinical care in AMCs is more expensive. Ongoing debate about whether this premium is justified [Burke et al. 2017; Mechanic, Coleman, and Dobson 1998; Newhouse 2003]

Source: Commonwealth Fund Task Force of Academic Health Centers, 1999

# Why do AMCs matter?

## Biomedical research: a taxonomy



# Why do AMCs matter?

## Biomedical research: a taxonomy

***Focus on scientific advancement***

### Bench Research

- Typically curiosity-driven: *"A new role for the* PAX9 *protein in ribosome biogenesis"*
- Universities, research institutes, AMCs, industry

***Focus on clinical applications***

# Why do AMCs matter?

## Biomedical research: a taxonomy

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|---|---|---|
| ***Focus on scientific advancement*** ↑ | **Bench Research**<br>• Typically curiosity-driven: *"A new role for the* `PAX9` *protein in ribosome biogenesis"*<br>• Universities, research institutes, AMCs, industry | |
| | | **Bedside Research**<br>• Clinical trials: *"Targeting HPV consequences in a cervical cancer CT"*<br>• "Other": *"Longitudinal measurement of the changing sleep need in adolescence"*<br>• AMCs, SMOs, community hospitals, physician group practices |

→ ***Focus on clinical applications***

# Why do AMCs matter?

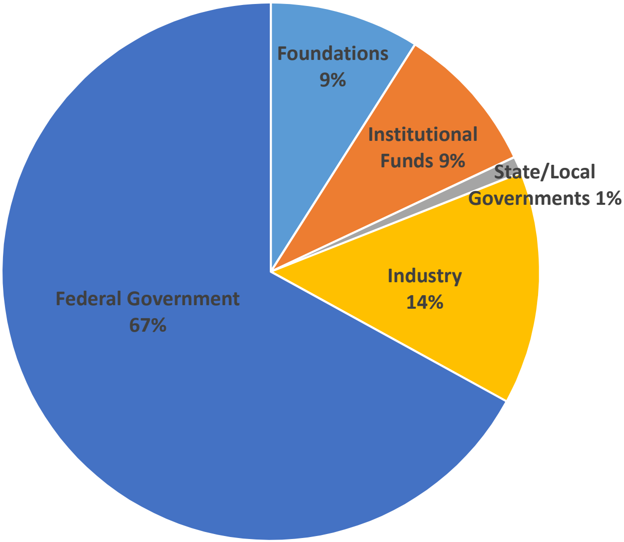
## Biomedical research: a taxonomy

**Focus on scientific advancement** ↑

| | |
|---|---|
| **Bench Research**<br>‣ Typically curiosity-driven: *"A new role for the* `PAX9` *protein in ribosome biogenesis"*<br>‣ Universities, research institutes, AMCs, industry | **Translational Research**<br>‣ Use-inspired research: *"Role of* `notch1` *signaling in abdominal aortic aneurysm"*<br>‣ Needs access to lab space and patients<br>‣ Only AMCs |
| | **Bedside Research**<br>‣ Clinical trials: *"Targeting HPV consequences in a cervical cancer CT"*<br>‣ "Other": *"Longitudinal measurement of the changing sleep need in adolescence"*<br>‣ AMCs, SMOs, community hospitals, physician group practices |

**Focus on clinical applications** →

# Source of research funding in AMCs, 1997

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# Shock: Medicare reimbursement cuts

- Medicare reimburses hospitals prospectively on a per-admission basis, as a function of:
    1. Teaching subsidies
    2. Disproportionate share subsidies
    3. Outlier payments

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  - Planned Medicare spending reductions of $117 billion to $127 billion over 5 years
  - Concerns about severity $\rightarrow$ $20B restored by the Balanced Budget Refinement Act in 1999 and the Benefits and Improvement Protection Act in 2000.

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- Impact of BBA on subsequent research is ambiguous (in sign and magnitude)

# Story #1: Medicare cuts spell the doom of AMC research

- This is the narrative preferred by academic medical leaders and their lobbyists

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April 27, 2016

The Washington Post

Grade Point | Opinion

## Harvard medical professor: The nation's teaching hospitals are under threat


**Amitabh Chandra** @amitabhchandra2 · May 1

If they are it would be an excellent thing because right now they are mostly ATMs hooked up to the **Treasury**

# Story #1: Medicare cuts spell the doom of AMC research

- This is the narrative preferred by academic medical leaders and their lobbyists
- Economists typically skeptical: if this research does not happen in AMCs, it will happen elsewhere
  - “Hobby doctors” would be better off tending to patients
- But self-serving narratives can sometimes be correct
  - Translational research is often very hard to perform outside of the AMC setting
  - Cross-subsidies from clinical care are often argued to be a key source of funding that allow clinical investigators to step on the NIH grant funding treadmill [Jones and Sanderson 1996]

# Story #2: “Induced Research”

- If clinical revenues (and rents) are suddenly decreased, AMCs can “crank up” the research dial
  - Current researchers may be encouraged to apply for more grants or to run more clinical trials
  - They could hire more researchers

- In other words, the NIH (and industry) might be considered “just another payer”

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  - They could hire more researchers
- In other words, the NIH (and industry) might be considered “just another payer”
- Of course, no guarantee that such “induced research” is particularly valuable
- Nor is there any guarantee that such increase would target research that occurs primarily within AMCs

# What We Do

- Study research inputs, outputs, and composition in AMCs following a major shock to hospital finance: the BBA of 1997

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- Study research inputs, outputs, and composition in AMCs following a major shock to hospital finance: the BBA of 1997
- Two sample of hospitals: teaching hospitals and AMCs, 1992-2007
- Diff-in-diff design exploiting variation in exposure to the reform

# Preview of Results

**Following cuts to health care reimbursements:**

1. More research (applications, funding, publications) in relatively more exposed hospitals after the reform (relative to before)

2. The financing shock does not seem to change the distribution of research "impact"

3. But it does not cut evenly across research types: only translational and clinical research appear to increase

4. No effect on the quality of care that we can measure

# Measuring research outcomes

1. **NIH grants**
    - Source: NIH IMPAC II
2. **Publications**
    - Source: PubMed and Web of Science
    - Impact measured using
        - Publication-to-publication citations (e.g., top 5 percent of articles, by citations)
        - Patent-to-publication citations from Marx and Fuegi (2020)
        - "Disruptive" index from Funk and Owen-Smith (2017)
    - Direction measured using MeSH terms (e.g., *drosophila melanogaster*)

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     - Prior literature has used this to identify impact of Medicare payment changes [Acemoglu and Finkelstein 2008; Kaestner and Guardado 2008; Wu and Shen 2014]

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        - Prior literature has used this to identify impact of Medicare payment changes [Acemoglu and Finkelstein 2008; Kaestner and Guardado 2008; Wu and Shen 2014]
- We use both sources of variation: simulated change in PPS price per discharge weighted by the share of Medicare patients [Cutler 1998; Dafny 2005; Shen 2003]

# Measuring exposure to the reform (cont.)

- Simulated change in PPS revenue per discharge:

$$sim\Delta rev_{h,1995} = rev_{h,1995} - \text{sim rev}_{h,1995}$$

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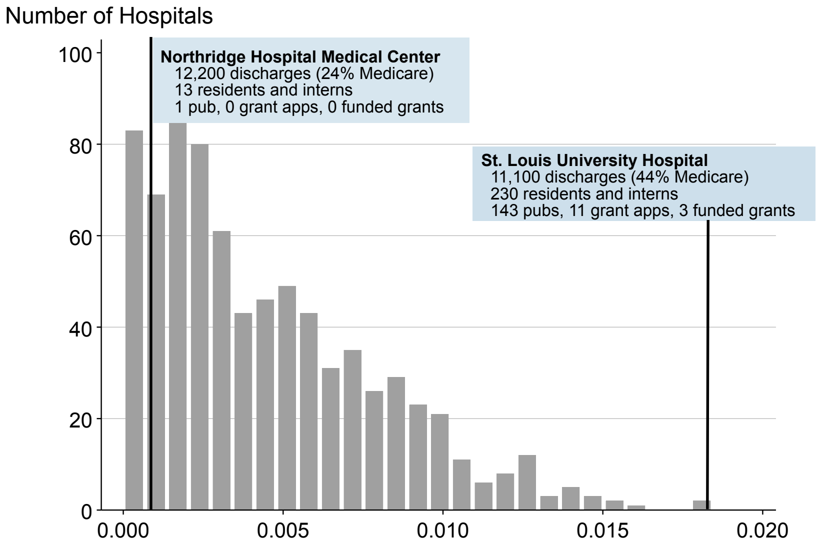
- Simulated change in PPS revenue per discharge:

$$sim\Delta rev_{h,1995} = rev_{h,1995} - \text{sim rev}_{h,1995}$$

- Average revenue loss per discharge:

$$BBA\_Bite_h = sim\Delta rev_{h,1995} \times \left[\frac{MedicareDischarges}{TotalDischarges}\right]_{h,1995}$$

# Distribution of BBA Bite



# Annual Hospital Characteristics: N = 780 Teaching Hospitals

| | mean | median | sd | min | max |
|---|---|---|---|---|---|
| ***Hospital Characteristics*** | | | | | |
| BBA Bite (x100) | 0.45 | 0.35 | 0.35 | 0.00 | 1.84 |
| Medicare share of discharges | 0.34 | 0.34 | 0.13 | 0.02 | 0.71 |
| Medicare price per discharge ($1,000s) | 8.30 | 7.48 | 2.85 | 3.67 | 27.48 |
| Discharges (1000s) | 16.82 | 14.91 | 10.39 | 0.34 | 62.79 |
| Medicare teaching payment ($ Mill.) | 5.45 | 2.26 | 7.91 | 0.00 | 59.81 |
| Medicare DSH payment ($ Mill.) | 3.97 | 2.38 | 4.54 | 0.00 | 36.21 |
| Residents and interns | 101.92 | 41.82 | 139.35 | 0.06 | 1,097.72 |
| ***Number of Grant Applications*** | | | | | |
| Total | 8.82 | 0.00 | 32.97 | 0.00 | 444.00 |
| New | 7.15 | 0.00 | 26.43 | 0.00 | 355.7 |
| Competitive Renewal | 1.67 | 0.00 | 6.60 | 0.00 | 88.25 |
| MD Principle Investigator | 3.08 | 0.00 | 11.87 | 0.00 | 158.62 |
| PhD Principle Investigator | 4.26 | 0.00 | 16.22 | 0.00 | 193.38 |
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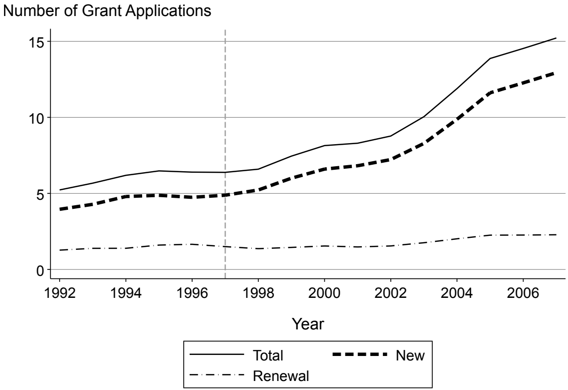
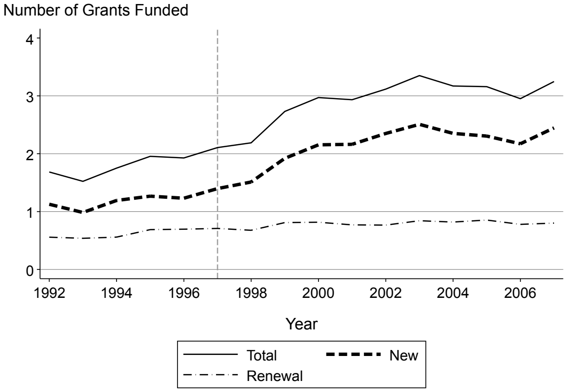
# Trends in NIH-funded research activity, 1992-2007



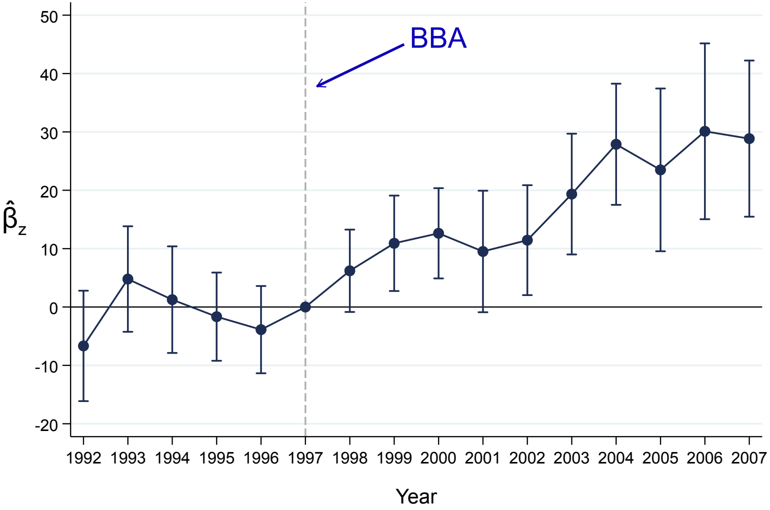
# Difference in differences regression

For hospital *h* in year *t*:

$$ResearchOutcome_{h,t} = \alpha + \sum_z \beta_z \times 1(z) \times BBA\_Bite_h + \delta_h + \tau_t + \varepsilon_{h,t}$$

- $BBA\_Bite_h = (rev_{h,1995} - simrev_{h,1995}) \times \left[\frac{MedicareDischarges}{TotalDischarges}\right]_{h,1995}$
- $\beta_z$: impact of BBA on research outcomes
- $\delta_h$: hospital FE
- $\tau_t$: calendar year FE
- Outcomes are transformed with the inverse hyperbolic sine function

# Total grant applications increase



# Total grant applications increase: magnitudes

| | Total (1) |
|---|---|
| A. BBA Bite × Post | 19.07*** |
| | (4.284) |
| Elasticity | 0.053 |
| Adjusted $R^2$ | 0.023 |
| Diff. Wald test p-value | |
| | |
| B. High BBA Bite × Post | 0.105*** |
| | (0.0247) |
| Elasticity | 0.110 |
| Adjusted $R^2$ | 0.019 |
| Diff. Wald test p-value | |
| Mean of Outcome | 0.751 |
| Nb. Observations | 12,480 |
| Nb. Hospitals | 780 |
| Year FEs | Yes |
| Hospital FEs | Yes |

- A 1 % increase in BBA Bite $\Longrightarrow$ 5% increase in grant applications

# Total grant applications increase: magnitudes

| | | Grant Cycle | |
|---|---|---|---|
| | Total | New | Renewal |
| | (1) | (2) | (3) |
| A. BBA Bite × Post | 19.07*** | 24.53*** | 3.314 |
| | (4.284) | (4.421) | (2.754) |
| Elasticity | 0.053 | 0.069 | 0.011 |
| Adjusted $R^2$ | 0.023 | 0.034 | 0.005 |
| Diff. Wald test p-value | | 0.000 | |
| B. High BBA Bite × Post | 0.105*** | 0.136*** | 0.00913 |
| | (0.0247) | (0.0249) | (0.0152) |
| Elasticity | 0.110 | 0.146 | 0.009 |
| Adjusted $R^2$ | 0.019 | 0.028 | 0.005 |
| Diff. Wald test p-value | | 0.000 | |
| Mean of Outcome | 0.751 | 0.705 | 0.372 |
| Nb. Observations | 12,480 | 12,480 | 12,480 |
| Nb. Hospitals | 780 | 780 | 780 |
| Year FEs | Yes | Yes | Yes |
| Hospital FEs | Yes | Yes | Yes |

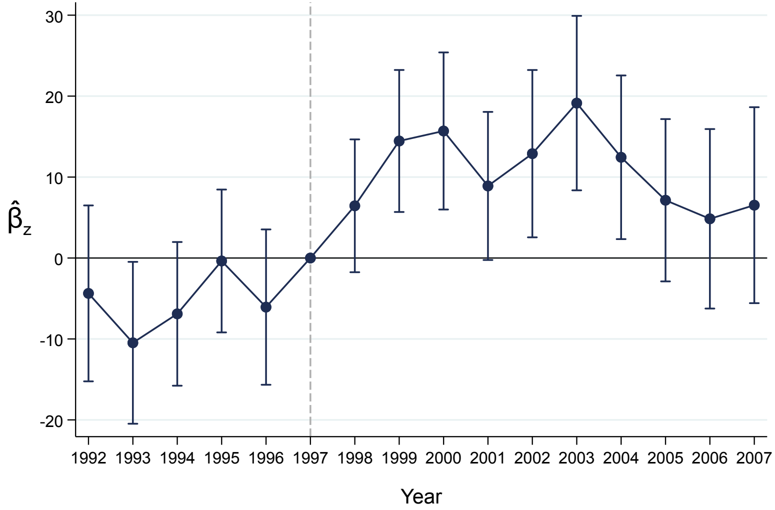
- A 1 % increase in BBA Bite $\Longrightarrow$ 5% increase in grant applications
- Effects driven by new grant applications (vs. competitive renewals)

# Total grant applications increase: magnitudes

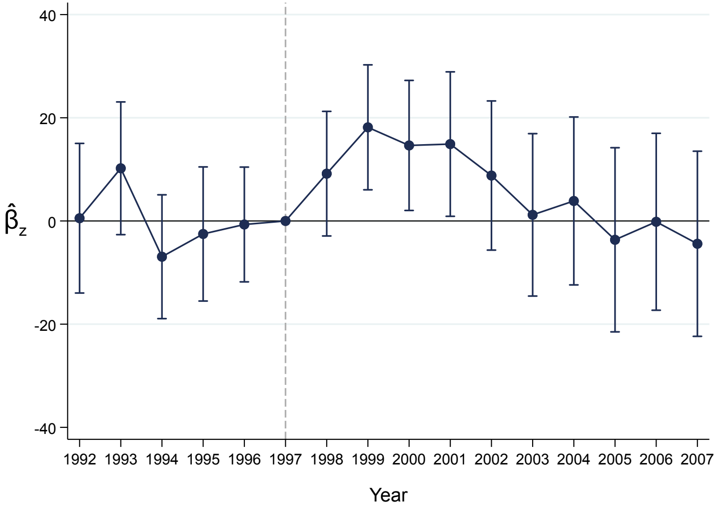
| | Total | Grant Cycle | | Principal Investigator | | |
|---|---|---|---|---|---|---|
| | | New | Renewal | MD | PhD | MD-PhD |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| A. BBA Bite × Post | 19.07*** | 24.53*** | 3.314 | 16.40*** | 22.75*** | 28.53*** |
| | (4.284) | (4.421) | (2.754) | (4.298) | (4.032) | (4.070) |
| Elasticity | 0.053 | 0.069 | 0.011 | 0.048 | 0.065 | 0.099 |
| Adjusted $R^2$ | 0.023 | 0.034 | 0.005 | 0.021 | 0.039 | 0.056 |
| Diff. Wald test p-value | | 0.000 | | | 0.151 | 0.010 |
| B. High BBA Bite × Post | 0.105*** | 0.136*** | 0.00913 | 0.0944*** | 0.122*** | 0.145*** |
| | (0.0247) | (0.0249) | (0.0152) | (0.0216) | (0.0213) | (0.0219) |
| Elasticity | 0.110 | 0.146 | 0.009 | 0.099 | 0.129 | 0.155 |
| Adjusted $R^2$ | 0.019 | 0.028 | 0.005 | 0.018 | 0.032 | 0.043 |
| Diff. Wald test p-value | | 0.000 | | | 0.211 | 0.038 |
| Mean of Outcome | 0.751 | 0.705 | 0.372 | 0.519 | 0.533 | 0.328 |
| Nb. Observations | 12,480 | 12,480 | 12,480 | 12,480 | 12,480 | 12,480 |
| Nb. Hospitals | 780 | 780 | 780 | 780 | 780 | 780 |
| Year FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Hospital FEs | Yes | Yes | Yes | Yes | Yes | Yes |

- A 1 % increase in BBA Bite $\Longrightarrow$ 5% increase in grant applications
- Effects driven by new grant applications (vs. competitive renewals)

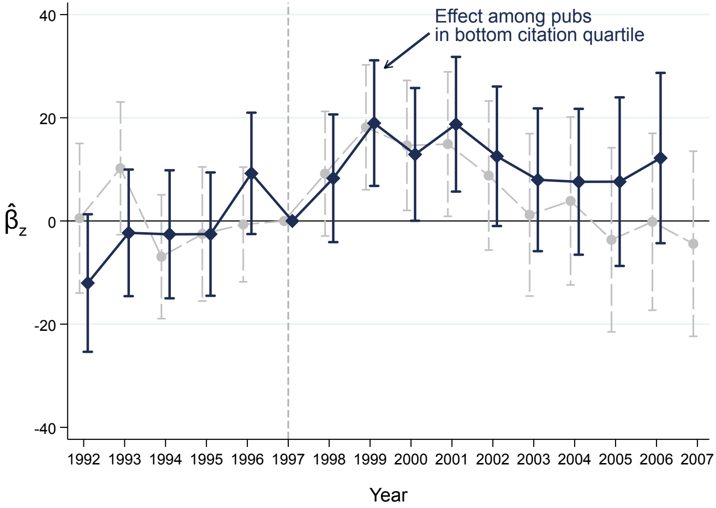
# Total number of grants funded increase by 5-10%



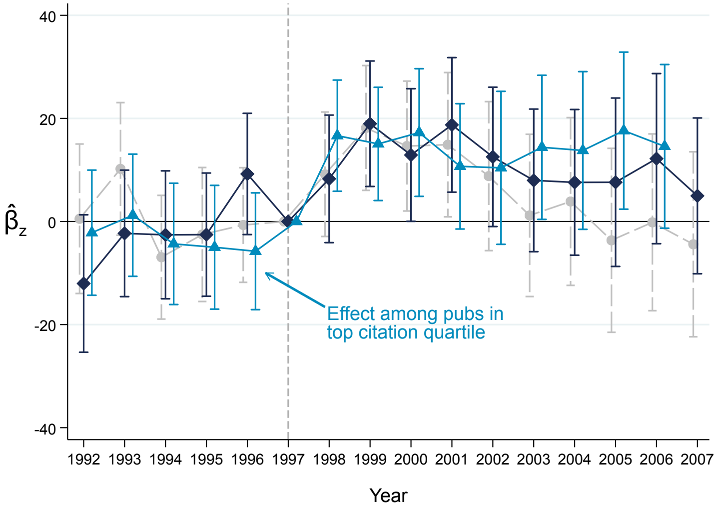
# Total publications increase by 2-8%...



# With similar effects among low impact publications...

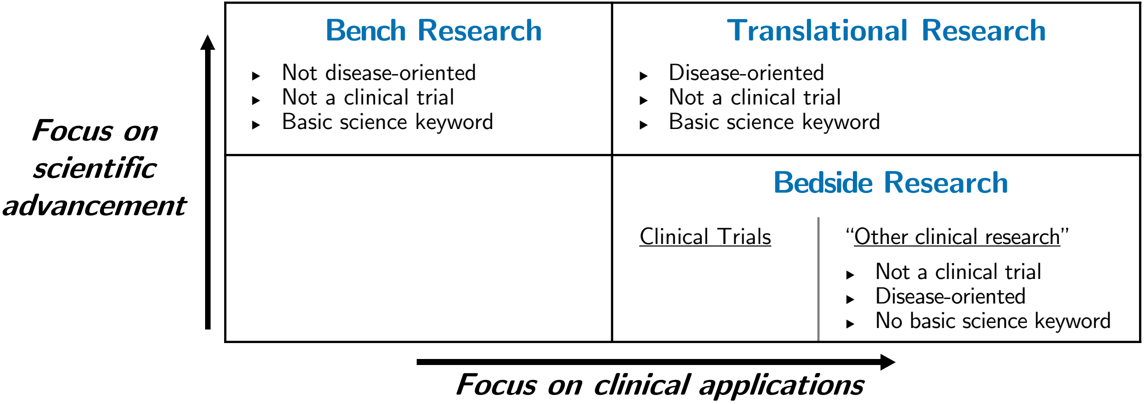


# ...and high impact publications




- Similar for other measures of impact: patent-to-pub citations, "disruptive" vs. "consolidating" pubs

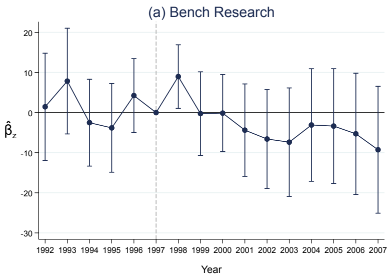
# Measuring the BBA effect on research composition




Basic science keyword:

- Molecular biology technique MeSH term
- Model organism MeSH term
- Cellular structures and macromolecules MeSH term
- Biochemical and cellular processes MeSH term

# Variation across research composition



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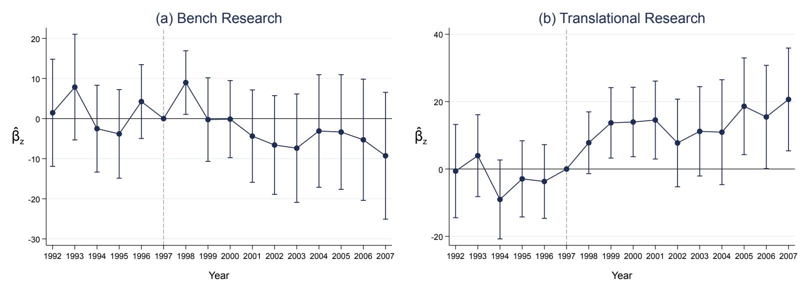

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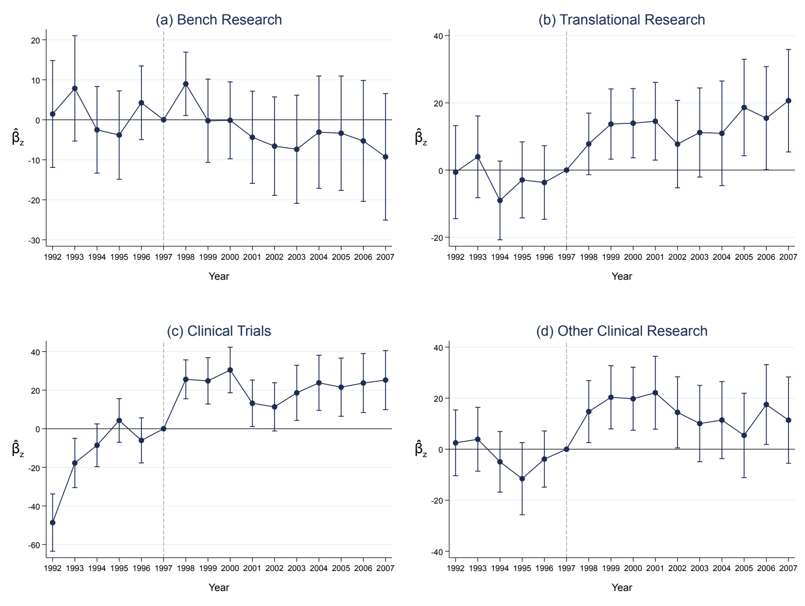

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- Researchers might increase their research effort, potentially substituting away from patient care (in the case of physicians)
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- Researchers might increase their research effort, potentially substituting away from patient care (in the case of physicians)
  - But: from qualitative evidence, NIH-funded research tends to be an "all-or-nothing" commitment
  - Generating preliminary results for a NIH grant application requires substantial resources
- Changes can occur at the institution level
  - Soft money appointments entail that AMCs can issue an unlimited number of "hunting licenses" for NIH grants (which carry substantial overhead)
  - Consistent with the extensive margin channel, our effects are driven by new grant applications and not competitive renewals

# Are there countervailing effects on the quality of care? No

For hospital $h$: $\Delta SurvivalRate_{h,c} = \beta BBA\_Bite_h + Discharges_h + \varepsilon_h$

| | Heart Attack (1) | Heart Failure (2) | Hip/Knee (3) | Pneumonia (4) |
|---|---|---|---|---|
| A. BBA Bite | -0.0835 | -0.0137 | -0.0031 | -0.0117 |
| | (0.0544) | (0.0319) | (0.0311) | (0.0367) |
| Ln(Discharges in 1995) | 0.0017 | 0.0014 | 0.0001 | 0.0046** |
| | (0.0025) | (0.0015) | (0.0014) | (0.0019) |
| B. High BBA Bite | -0.0084** | -0.0015 | 0.0006 | -0.0013 |
| | (0.0031) | (0.0019) | (0.0019) | (0.0022) |
| Ln(Discharges in 1995) | 0.0020 | 0.0015 | 0.0000 | 0.0047** |
| | (0.0024) | (0.0015) | (0.0014) | (0.0019) |
| Mean of Outcome | 0.0270 | 0.0106 | -0.0005 | 0.0147 |
| Nb. Observations | 700 | 700 | 700 | 700 |

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- Undermines a plausible rationale for Medicare GME subsidies
  - Cross-subsidies from patient revenues might be less important for the research enterprise than previously thought
- Substituting clinical care for research activities might be hard to do for individual faculty members; but institutions can adjust.
  - Caveat #1: what if the NIH budget had not expanded in the same time period?
  - Caveat #2: some shocks might be really too big to handle (e.g., COVID-19)

Questions & comments welcome!

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