Productivity Effects of Remote Work

Emma Harrington
University of Virginia
Puzzle

Remote work was rare in seemingly remotal jobs like call-center work & programming before Covid-19

Even though...  

• **Strong demand** for WFH from workers (Mas & Pallais, 2017; He et al., 2021; Maestas et al., 2023; Lewandowski et al., 2024)

• **Positive immediate productivity effects** in an RCT in a Chinese travel agency (Bloom et al., 2015)

So were firms making mistakes? Or were other pieces to the puzzling rarity of remote work?
Working Remotely?
Selection, treatment, and the market for remote work

Natalia Emanuel
New York Federal Reserve Bank

Emma Harrington
University of Virginia

R&R at AEJ: Applied
Key features of context

Data on call-centers at a Fortune 500 firm

- Firm hired both remote & on-site workers before Covid-19.
- Randomly routed calls between them
Remote Work and Calls Per Hour

Calls per Hour

Dec 2019
Apr 2020
Aug 2020

Initial Job
On-Site
Remote

Productivity Effects of Remote Work
Remote Work and Calls Per Hour

Initial Job
- On-Site
- Remote

Calls per Hour
- Dec 2019
- Apr 2020 Week
- Aug 2020
Difference-in-Differences Design

$$\text{Calls/Hour}_{i,t} = \beta \text{ Initially On-Site}_{i} \times \text{Post}_{t} + \mu_{i} + \mu_{t} + X'_{i,t} \kappa + \epsilon_{i,t}$$

![Graph showing calls per hour before and after COVID-19]

**Calls per Hour**

- Dec 2019
- Apr 2020
- Aug 2020

**Initial Job**
- On-Site
- Remote

**Gap in Calls per Hour**

- Dec 2019
- Apr 2020
- Aug 2020

-0.15**

(0.06)
Effects on Call Quality & Worker Development

Deterioration in call quality especially for less experienced workers

Remote work slows career progression

• Less one-on-one time with managers & in training sessions
• Half the promotion rates as on-site workers
• Gaps narrow when offices shut down
Selection into Remote Jobs

Fade-out in Selection → Table →

Initial Job
- On-Site
- Remote

Conditional Gap = -0.30***
(0.08)
[-7.8%]

Calls per Hour

Dec 2019
Apr 2020
Aug 2020

Density

0.0
0.1
0.2
0.3

0.0
2.5
5.0
7.5
10.0
12.5

Calls per Hour

Productivity Effects of Remote Work
<table>
<thead>
<tr>
<th>Pros of WFH</th>
<th>Cons of WFH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Reduces productivity by 4%</td>
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<tr>
<td></td>
<td>• Attracts workers who are 8% less productive</td>
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<tr>
<td></td>
<td>⇒ Total reduction of 12%</td>
</tr>
</tbody>
</table>
## The Firm’s Pro/Con List

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<thead>
<tr>
<th>Pros of WFH</th>
<th>Cons of WFH</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduces office rents, worth 6% of labor costs</td>
<td>• Reduces productivity by 4%</td>
</tr>
<tr>
<td>• Reduces attrition, worth 0.8% of labor costs</td>
<td>• Attracts workers who are 8% less productive</td>
</tr>
<tr>
<td></td>
<td>→ Total reduction of 12%</td>
</tr>
</tbody>
</table>

**Productivity Effects of Remote Work**
Market Provision of Remote Work

![Graph showing the price of remote work against the quantity of remote work.]

**Demand**
Lewandowski et al.

**Firm Cost =**
- Treatment
- Selection
- Rent - Turnover

Productivity Effects of Remote Work
Market Provision of Remote Work

![Graph showing the relationship between the price of remote work and the quantity of remote work provided. The graph illustrates the demand and firm cost curves, with the social cost adjusted for treatment and selection effects, and rent and turnover costs.]

Demand
Lewandowski et al.

Firm Cost =
+ Treatment
+ Selection
- Rent - Turnover

Social Cost =
+ Treatment
- Rent - Turnover

Productivity Effects of Remote Work
Market Provision of Remote Work

\[ 100 \cdot \left( W_{\text{On-Site}} - W_{\text{Remote}} \right) / W \]

- **Demand**: Lewandowski et al.
- **Firm Cost**: + Treatment + Selection - Rent - Turnover
- **Social Cost**: + Treatment - Rent - Turnover

\[ Q = 34 \quad Q^* = 70 \]

Quantity of Remote Work (% Remote)
Summary: Remote work’s rarity was more due to adverse selection than a negative productivity effect.
The Power of Proximity to Coworkers
Training for Tomorrow or Productivity Today?

Natalia Emanuel  Emma Harrington  Mandy Pallais
NY Fed  University of Virginia  Harvard & NBER
How does remote work affect mentorship & output?

- Software engineers at a Fortune 500 firm

1. Data on mentorship in code reviews & programming output
How does remote work affect mentorship & output?

- Software engineers at a Fortune 500 firm

1. Data on mentorship in code reviews & programming output
2. Variation in proximity

- **Offices open**: Difference in proximity
- **Offices closed**: Differential loss in proximity for previously co-located teams (diff-in-diff)
Proximity to Teammates and Online Feedback

Engineer's Team

One-Building

Multi-Building
Proximity to Teammates and Online Feedback

![Graph showing comments per program over time for different team configurations: Engineer's Team, One-Building, and Multi-Building.]
Evidence of Mentorship

Driven by feedback to junior engineers

- Also impacts younger engineers with independent effect
- Disproportionately feedback from senior engineers
Mentorship has an Opportunity Cost
Firm policies seem to reflect tradeoff
Firm policies seem to reflect tradeoff...
Summary of Results

1. **Proximity increases online feedback for junior engineers**
   - Evidence that it’s easier to ask for advice in-person

2. **Mentorship has an opportunity cost**
   - Proximity reduces programming output, especially of senior engineers

3. **The tradeoffs show up in firm policies**
   - Firm required most junior & senior to be on-site pre-COVID and shifted to hiring more experienced workers post-COVID

4. **The tradeoffs from proximity are more acute for women**
   - ↑ junior women’s training; ↓ senior women’s output
Piecing Together the Puzzle

Immediate productivity effects of remote work unlikely to be key deterrent

• Positive immediate effects for the programmers
• Slightly negative effects in the call-center context
  • But outweighed by other savings

Evidence of longer-term productivity costs in both settings

• Reduced investments in workers’ skills & reduced promotion rates

These longer-term consequences in turn impact selection into remote work, further compounding costs to the firm and potentially leading to an underprovision of remote work
Thank you!

Feedback welcome in-person or online
emma.k.harrington4@gmail.com
Difference-in-Differences Design

\[ \text{Calls/Hour}_{i,t} = \beta \text{Initially On-Site}_i \times \text{Post}_t + \]
\[ \phi \text{Initially On-Site}_i + \rho \text{Post}_t + X'_{i,t} \kappa + \epsilon_{i,t} \]

**Observation:** worker-day level and clustering by worker
Difference-in-Differences Design

\[ \text{Calls/Hour}_{i,t} = \beta \text{Initially On-Site}_i \times \text{Post}_t + \phi \text{Initially On-Site}_i + \rho \text{Post}_t + X'_{i,t} \kappa + \epsilon_{i,t} \]

**Observation:** worker-day level and clustering by worker

**Identifying assumption:** remote and on-site workers face similar pandemic shocks
Difference-in-Differences Design

\[
\text{Calls/Hour}_{i,t} = \beta \text{Initially On-Site}_i \times \text{Post}_t + \\
\phi \text{Initially On-Site}_i + \rho \text{Post}_t + X'_{i,t} \kappa + \epsilon_{i,t}
\]

**Observation:** worker-day level and clustering by worker

**Identifying assumption:** remote and on-site workers face similar pandemic shocks

Relax identifying assumptions with controls in \(X_{i,t}\)

- **Preferred:** call-level x date x time-zone FE, gender x age x post FE, worker FE
- **Additional:** local Covid-19 cases & mother/father x post FE
Remote Work and Calls Per Hour

\[
\text{Calls/Hour}_{i,t} = \beta \text{Initially On-Site}_i \times \text{Post}_t + X'_i, t \kappa + \epsilon_{i,t}
\]

<table>
<thead>
<tr>
<th>Calls per Hour</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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</thead>
<tbody>
<tr>
<td>Initially On-Site × Post</td>
<td>−0.19***</td>
<td>−0.14**</td>
<td>−0.16*</td>
<td>−0.15**</td>
<td>−0.15**</td>
<td>−0.21***</td>
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<tr>
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<td>(0.07)</td>
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<td>(0.08)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.08)</td>
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<tr>
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<td>0.45***</td>
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<td>−0.04</td>
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<td>−0.04</td>
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<tr>
<td>Father × Post</td>
<td>−0.14</td>
<td>−0.14</td>
<td>−0.14</td>
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<tr>
<td>Pre Dependent Mean On-Site</td>
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</tr>
<tr>
<td>Initially On-Site × Post in %</td>
<td>−5.1%</td>
<td>−3.6%</td>
<td>−4.1%</td>
<td>−3.9%</td>
<td>−3.9%</td>
<td>−5.5%</td>
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<td></td>
<td>(1.80)</td>
<td>(1.80)</td>
<td>(2.20)</td>
<td>(1.60)</td>
<td>(1.60)</td>
<td>(2.00)</td>
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</table>
Relative Calls Per Hour

-20
-10
0
10
20

Weeks to Switch to Remote Work

-0.3 -0.2 -0.1 -0.0
## Remote Work and Call Quality

<table>
<thead>
<tr>
<th></th>
<th>Decomposition</th>
<th>Call Quality</th>
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<tbody>
<tr>
<td></td>
<td>% On Phone</td>
<td>Min. Call</td>
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<tr>
<td>Initially On-Site x Post</td>
<td>$-1.99^{***}$</td>
<td>0.37*</td>
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<tr>
<td></td>
<td>(0.54)</td>
<td>(0.22)</td>
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<tr>
<td>$R^2$</td>
<td>0.63</td>
<td>0.38</td>
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<tr>
<td>Pre Mean On-Site</td>
<td>74.3</td>
<td>13.2</td>
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<tr>
<td>Initially On-Site x Post in %</td>
<td>$-2.7%$</td>
<td>2.8%</td>
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<tr>
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<td>(0.7)</td>
<td>(1.7)</td>
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</table>
Career Consequences

New Skill Training
Min. Per Month

Manager One-on-One
Min. Per Month

% Promoted
Each Month

On-Site vs. Remote Gap

On-Site vs. Remote Gap

On-Site vs. Remote Gap

Pre Closure | Post Closure | Diff-in-Diff
-19.12**
(8.37)

Pre Closure | Post Closure | Diff-in-Diff
-10.23***
(1.93)

Pre Closure | Post Closure | Diff-in-Diff
-3.60**
(1.49)

Productivity Effects of Remote Work
Fade-out in Selection

![Graph showing the gap between remote and on-site hires over time.](image)
$$\text{Calls/Hour}_{i,t} = \alpha \text{ Initially On-Site}_i + X'_{i,t} \kappa + u_{i,t}$$

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<tbody>
<tr>
<td>Initially Remote</td>
<td>$-0.20^{***}$</td>
<td>$-0.31^{***}$</td>
<td>$-0.30^{***}$</td>
<td>$-0.30^{***}$</td>
<td>$-0.24^{***}$</td>
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<td>Base Pay</td>
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<td>Local Outside Option Pay in MSA</td>
<td>0.03</td>
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<td>Unemployment Rate in MSA</td>
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<td>Father</td>
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</thead>
<tbody>
<tr>
<td>Initially Remote in %</td>
<td>$-5.3%$</td>
<td>$-8.2%$</td>
<td>$-7.8%$</td>
<td>$-7.9%$</td>
<td>$-6.4%$</td>
<td>$-7.2%$</td>
<td>$-5.6%$</td>
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<td></td>
<td>$(1.9)$</td>
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<td>Call Queue FE</td>
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</tr>
</tbody>
</table>
By Gender

Female Programmer

-2.83***

(0.81)

Male Programmer

-0.83*

(0.45)

Comments per Program


Engineer's Team

One-Building

Multi-Building
By Gender

---

**Female**

- October 2019 to October 2020
- Programs per Month
- Engineer's Team: One-Building (solid blue line), Multi-Building (dashed red line)

**Male**

- October 2019 to October 2020
- Programs per Month
- Engineer's Team: One-Building (solid blue line), Multi-Building (dashed red line)