On-the-job Leisure and Work from Home: Measuring Productive Hours

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Introduction
Motivation

- Changing work environment
  - Computers: How we work
  - Pandemic: Where we work

Goal

- Measure total *productive hours worked*
- Typically, reported usual hours worked:
  - include time spent in leisure on the job (OJL)
  - do not include work from home (WFH)
What we find

- WFH
  - Has increased
  - Increase started just after Great Recession
  - Is now more productive than work at the office
- OJL has declined slightly
Data
How are we going to measure all of this?

American Time Use Survey 2003 - 2019

- Interviews CPS respondents 2-5 months after final interview
  - interviewed on one diary day
- Asks people about their activities
  - what
  - when
  - how long
  - where
  - who with
- Coded into one of 400 categories
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sample Mean</th>
<th>Characteristic</th>
<th>Sample Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.48</td>
<td>White</td>
<td>0.82</td>
</tr>
<tr>
<td>Married</td>
<td>0.55</td>
<td>Black</td>
<td>0.11</td>
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<tr>
<td>Age</td>
<td>40.41</td>
<td>Other</td>
<td>0.07</td>
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<tr>
<td>Child</td>
<td>0.43</td>
<td>Government</td>
<td>0.17</td>
</tr>
<tr>
<td>High School</td>
<td>0.28</td>
<td>Full Time</td>
<td>0.80</td>
</tr>
<tr>
<td>Some College</td>
<td>0.27</td>
<td>Paid Hourly</td>
<td>0.59</td>
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<tr>
<td>Advanced Degree</td>
<td>0.12</td>
<td>One Job</td>
<td>0.87</td>
</tr>
<tr>
<td>College</td>
<td>0.22</td>
<td>At Work</td>
<td>0.62</td>
</tr>
<tr>
<td>Less than HS</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total number of Observations 110,717
Number of people at work on interview day 55,152

Note: ATUS weights used in all calculations.
Key Measures from the ATUS

- If respondent was at work on the diary day
  - *Total time at work*: Sum time at office: work and OJL
  - *OJL*: Sum duration of non-work at work
  - *WFH*: Sum duration of work at home (remote)
Table 2: Work and Leisure at Work Summary Statistics: ATUS 2003-2019

<table>
<thead>
<tr>
<th></th>
<th>Sample Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time at Work ($h^w$)</td>
<td>312.71</td>
</tr>
<tr>
<td>On-the-job Leisure ($h^l$)</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>0.43</td>
</tr>
<tr>
<td>Unconditional Min.</td>
<td>19.87</td>
</tr>
<tr>
<td>Conditional Min.</td>
<td>46.74</td>
</tr>
<tr>
<td>Work from Home ($h^h$)</td>
<td></td>
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<tr>
<td>Participation</td>
<td>0.16</td>
</tr>
<tr>
<td>Unconditional Min.</td>
<td>30.92</td>
</tr>
<tr>
<td>Conditional Min.</td>
<td>190.84</td>
</tr>
<tr>
<td>Productive Work ($h^p$)</td>
<td>323.76</td>
</tr>
</tbody>
</table>

Note: ATUS weights used in all calculations.
Definitions

- Hours at the workplace: $h_{it}^w$
- Hours of OJL at the workplace: $h_{it}^l$
- Hours of work at home: $h_{it}^h$

- Productive hours:

$$h_{it}^p = h_{it}^w - h_{it}^l + h_{it}^h$$ (1)
Hours at work and Productive hours worked: Full sample

(a) Hours at Work
(b) Productive Hours Worked

Note: ATUS weights used in all calculations.
Variation by Occupation

- Large differences in OJL and WFH by occupation
  - eg. office work vs. production
  - computer intensity, etc.
- Participation
- Minutes
Percent Participating

- Production
- Food preparation and serving related
- Building and grounds cleaning and maintenance
- Construction and extraction
- Transportation and material moving
- Office and administrative support
- Installation, maintenance, and repair
- Office and administrative support
- Transportation and material moving
- Construction and extraction
- Building and grounds cleaning and maintenance
- Food preparation and serving related
- Production
- Education, training, and library
- Management
- Arts, design, entertainment, sports, and media
- Community and social service
- Computer and mathematical science
- Legal
- Life, physical, and social science
- Business and financial operations
- Sales and related
- Architecture and engineering
- Healthcare practitioner and technical
- Personal care and service
- Protective service
- Farming, fishing, and forestry
- Healthcare support
- Installation, maintenance, and repair
- Office and administrative support
- Transportation and material moving
- Construction and extraction
- Building and grounds cleaning and maintenance
- Food preparation and serving related
- Production

Percent Participation

OJL WFH
Aggregate Hours
From Individual to Aggregate Hours

- Aggregate our measure for comparison
  - Current Employment Statistics (CES)
  - Current Population Survey (CPS)
  - Composite BLS series (BLS)
- ATUS sample weights aggregate to quarterly total hours
  \[ H^p_t = \sum_i h^p_{it} \times wgt_{it}. \]  
  (2)
- Convert to average weekly hours
  \[ \bar{H}^p_t = \frac{H^p_t}{13 \times E_t}. \]  
  (3)
- \( E \) is total employed in our sample
  \[ E_t = \sum_i \frac{wgt_{it}}{91.5}. \]  
  (4)
From Individual to Aggregate Hours

- Same for $\bar{H}^h$, $\bar{H}^l$ and $\bar{H}^w$.

$$
\bar{H}^h_t = \frac{\sum_i h^h_{it} \times \text{wgt}_{it}}{13 \times E_t} \quad (5)
$$

$$
\bar{H}^l_t = \frac{\sum_i h^l_{it} \times \text{wgt}_{it}}{13 \times E_t} \quad (6)
$$

$$
\bar{H}^w_t = \frac{\sum_i h^w_{it} \times \text{wgt}_{it}}{13 \times E_t} \quad (7)
$$

- Smooth with a 12-quarter moving average.
Comparison to Other Measures

- Well-known large level differences
  - Different sample populations
  - Different hours concept (paid vs. all hours)
  - Frazis and Stewart [2004]
- Sample differences cannot explain trends
- Frazis and Stewart [2010]
Hours Comparison: Levels

- CES Production
- CES Private
- BLS Composite
- CPS ORG
- Productive Hours
- ATUS Usual Hours
Hours Comparison: Trends

- CES Production
- CES Private
- BLS Composite
- CPS
- Productive Hours
- ATUS Usual Hours
So Far...

- Increase in work from home
- Small decrease in on-the-job leisure
- Reporting issue in usual hours?
Trends
Accounting for Trend Changes I

- Changing occupational distribution

- Across occupations
  - Fix occupational distribution at 2003 distribution
  - Construct 1,000 bootstrapped samples of OJL and WFH
  - Take means and apply 12 quarter moving average
WFH: Weekly Hours

2003Q1, 2004Q1, 2005Q1, 2006Q1, 2007Q1, 2008Q1, 2009Q1, 2010Q1, 2011Q1, 2012Q1, 2013Q1, 2014Q1, 2015Q1, 2016Q1, 2017Q1, 2018Q1, 2019Q1

Fixed Occupation Data

Data
OJL: Weekly Hours

[Graph showing data for weekly hours with two lines representing Fixed Occupation and Data, spanning from 2003Q1 to 2019Q1.]
Accounting for Trend Changes II

- Within occupations
  - Combine ATUS data with O*NET 2004-2019 (5.0 - 25.0)
  - Worker attributes and job characteristics
  - 1,000 occupations
  - Focus on working with computers
  - How important is working with computers?
    - 1-5, 5 most important
- How do computers affect OJL? WFH?
Ambiguous effect of computers

- OJL and an increase in computer usage
  - More efficient → more OJL
  - More distractions → more OJL
  - More monitoring → less OJL
- WFH and an increase in computer usage
  - Less work to take home → less WFH
  - Zoom → more WFH
- How important are computers at work?
Importance of Computers at Work

- Computer and mathematical science
- Architecture and engineering
- Business and financial operations
- Life, physical, and social science
- Management
- Office and administrative support
- Legal
- Arts, design, entertainment, sports, and media
- Sales and related
- Education, training, and library
- Healthcare support
- Healthcare practitioner and technical
- Community and social service
- Protective service
- Installation, maintenance, and repair
- Production
- Food preparation and serving related
- Farming, fishing, and forestry
- Personal care and service
- Building and grounds cleaning and maintenance
- Transportation and material moving
- Construction and extraction

ONet Edition

5 10 15 20 25
Computers, OJL and WFH

- Extensive margin
  - Logit on indicator of participation in OJL
  - Control for worker and job characteristics
  - Estimate the probability of participation in OJL

- Intensive margin
  - Estimate minutes of OJL given OJL
## OJL Estimates

<table>
<thead>
<tr>
<th></th>
<th>Probability of OJL</th>
<th>Minutes of OJL</th>
<th>Minutes of OJL w/o eating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Across (1)</td>
<td>Within (2)</td>
<td>Across (3)</td>
</tr>
<tr>
<td>Interacting with Computers</td>
<td>0.018</td>
<td>-0.327</td>
<td>-0.827</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.072)</td>
<td>(0.824)</td>
</tr>
<tr>
<td>log(Hours at work)</td>
<td>1.961</td>
<td>2.046</td>
<td>31.256</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.054)</td>
<td>(1.590)</td>
</tr>
<tr>
<td>Female</td>
<td>0.069</td>
<td>0.039</td>
<td>-0.215</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.034)</td>
<td>(0.624)</td>
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<tr>
<td>Child</td>
<td>-0.011</td>
<td>-0.020</td>
<td>-1.062</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.031)</td>
<td>(0.588)</td>
</tr>
<tr>
<td>Occupation FE</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Onet Edition FE</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Month FE</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Diary Day FE</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mean Dependent Variable</td>
<td>0.682</td>
<td>0.682</td>
<td>0.087</td>
</tr>
<tr>
<td>N</td>
<td>48,824</td>
<td>48,824</td>
<td>32,352</td>
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### WFH Estimates

<table>
<thead>
<tr>
<th>Probability of WFH</th>
<th>Minutes of WFH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across Within</td>
<td>Across Within</td>
</tr>
<tr>
<td>Interacting with Computers</td>
<td>-0.054 0.261</td>
</tr>
<tr>
<td></td>
<td>(0.038) (0.066)</td>
</tr>
<tr>
<td>At Work</td>
<td>0.633 0.607</td>
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<tr>
<td></td>
<td>(0.079) (0.078)</td>
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<tr>
<td>At Work × log(Hours at work)</td>
<td>-0.928 -0.925</td>
</tr>
<tr>
<td></td>
<td>(0.037) (0.037)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.156 -0.087</td>
</tr>
<tr>
<td></td>
<td>(0.028) (0.030)</td>
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<tr>
<td>Age</td>
<td>0.011 0.010</td>
</tr>
<tr>
<td></td>
<td>(0.001) (0.001)</td>
</tr>
<tr>
<td>Married</td>
<td>0.085 0.046</td>
</tr>
<tr>
<td></td>
<td>(0.028) (0.029)</td>
</tr>
</tbody>
</table>

| Occupation FE | ✓ | ✓ |
| Onet Edition FE | ✓ | ✓ |
| Month FE | ✓ | ✓ | ✓ |
| Diary Day FE | ✓ | ✓ | ✓ |

| Mean Dependent Variable | 0.163 0.163 | 191.880 191.880 |
| N | 99,403 99,403 | 16,517 16,517 |
Computers and Trends in OJL and WFH

- Using “within” estimates predict OJL and WFH
  - Construct aggregate expected minutes
  - Calculate average weekly hours
  - Use 12 quarter moving average smoother

- Do this for
  - Full data set
  - Counterfactual holding fixed computer importance
WFH: Computer Importance Fixed at 2004 Level

![Graph showing average weekly hours from 2003Q1 to 2019Q4 with trends for predicted data, counterfactual data, and actual data.](image-url)
OJL: Computer Importance Fixed at 2004 Level

Average Weekly Hours

Predicted: Data

Predicted: Counterfactual

Data

2003Q1 2004Q1 2005Q1 2006Q1 2007Q1 2008Q1 2009Q1 2010Q1 2011Q1 2012Q1 2013Q1 2014Q1 2015Q1 2016Q1 2017Q1 2018Q1 2019Q1
Relative Productivity
Productive Time

- Calculate productivity relative to office work

  - Output is generated by

    \[ Y = K^\alpha L^{1-\alpha} \]  \hspace{1cm} (8)

    \[ L = H_o + A_h H_h + A_l H_l \]  \hspace{1cm} (9)

- \( A_h \): productivity of a home relative to office
- \( A_l \): productivity of OJL relative to office
- Assume a competitive firm
Productivity

- Taking wages as given
- Optimality conditions imply

\[
\frac{s_h}{s_o} = A_h \times \frac{H_h}{H_o} \quad \text{(10)}
\]
\[
\frac{s_l}{s_o} = A_l \times \frac{H_l}{H_o} \quad \text{(11)}
\]

- Where \( s_o, s_h \) and \( s_l \) are income shares
- \( H \)'s from our constructed hours series
Productivity

- Share of working time in WFH and OJL

\[
\theta^h_{it} = \frac{h^h_{it}}{h^o_{it} + h^h_{it} + h^l_{it}} \tag{12}
\]

\[
\theta^l_{it} = \frac{h^l_{it}}{h^o_{it} + h^h_{it} + h^l_{it}} \tag{13}
\]

- Income shares are now given by

\[
s^h_{it} = \sum_i w_{it} \times \theta^h_{it} \times h^h_{it} \times wgt_{it} \tag{14}
\]

\[
s^l_{it} = \sum_i w_{it} \times \theta^l_{it} \times h^l_{it} \times wgt_{it} \tag{15}
\]

\[
s^o_{it} = \sum_i w_{it} \times (1 - \theta^h_{it} - \theta^l_{it}) \times h^o_{it} \times wgt_{it} \tag{16}
\]
<table>
<thead>
<tr>
<th>Year</th>
<th>Relative Supply</th>
<th>Relative Income Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003Q1</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>2004Q1</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>2005Q1</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>2006Q1</td>
<td>0.14</td>
<td>0.14</td>
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<td>2007Q1</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>2008Q1</td>
<td></td>
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</tr>
<tr>
<td>2009Q1</td>
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<td>2010Q1</td>
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<td>2017Q1</td>
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<td>2018Q1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019Q1</td>
<td></td>
<td></td>
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</tbody>
</table>
Relative Productivity: WFH
Relative Supply and Income Share: OJL

![Graph showing Relative Supply and Relative Income Share from 2003Q1 to 2019Q1. The graph compares the two metrics over time, with a linear trend line for each. The Relative Supply line stays relatively constant, while the Relative Income Share shows minor fluctuations.]
Relative Productivity: OJL
So Far....

- Time spent WFH has risen
- WFH productivity now higher than at the office
  - One avenue: time spent with children
  - ATUS has child care as a secondary activity
  - Calculate the fraction of time worked while caring for a child

\[
\frac{\tilde{H}_t^h}{H_t^h} = \frac{\sum_i \tilde{h}_{it}^h \times wgt_{it}}{\sum_i h_{it}^h \times wgt_{it}}. 
\]

- Use the 12 quarter smoother
Percent of Hours WFH while caring for Children
Hours WFH by time of Day

![Chart showing average weekly hours worked between 9am and 5pm and outside of 9am and 5pm from 2003Q1 to 2019Q1. The chart shows an increase in hours worked outside of 9am and 5pm over time, with a sharp rise starting around 2014Q1.](image-url)
## Productivity Estimates

<table>
<thead>
<tr>
<th>Relative Productivity of WFH</th>
<th>OLS (1)</th>
<th>OLS (2)</th>
<th>IV (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFH 9am-5pm</td>
<td>0.892</td>
<td>1.053</td>
<td>1.471</td>
</tr>
<tr>
<td></td>
<td>(0.246)</td>
<td>(0.323)</td>
<td>(0.540)</td>
</tr>
<tr>
<td>WFH providing Childcare</td>
<td>-0.557</td>
<td>-1.011</td>
<td>-1.770</td>
</tr>
<tr>
<td></td>
<td>(0.795)</td>
<td>(1.127)</td>
<td>(0.721)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.657</td>
<td>-0.460</td>
<td>-0.684</td>
</tr>
<tr>
<td></td>
<td>(0.334)</td>
<td>(0.565)</td>
<td>(0.347)</td>
</tr>
<tr>
<td>Occupation Percentage WFH</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>First Stage F-stat</td>
<td></td>
<td></td>
<td>8.751</td>
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<td>N</td>
<td>64</td>
<td>64</td>
<td>63</td>
</tr>
</tbody>
</table>
Implication of Productivity Estimates

- 1pp increase in the share of WFH occurring between 9-5 increases relative productivity by 0.015

- 15pp increase $\Rightarrow$ 0.22 increase in relative productivity

- 1pp decrease in WFH w/ children $\Rightarrow$ 0.05 increase in relative productivity

- Together they account for roughly the whole increase
Conclusion

- OJL has not changed much

- Time spent WFH has risen substantially

- WFH productivity now higher than at the office
  - One avenue: time spent with children