

Research Output Before and During the Pandemic

Anthony M. Diercks ¹

¹D.C. Area Economist

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The analysis and conclusions set forth are those of the author and do not represent the views of my employer.

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 - Positive outcomes are all attributed to hybrid.
- **Big picture: Should the negative productivity findings based on call center and data entry workers be generalized and extended to the entire knowledge workforce?**
- Instead, what are the productivity outcomes of **fully remote work** for individuals that tend to be highly motivated with advanced degrees?

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What is the likely effect of fully remote work on productivity?

- **The number one answer: It depends. It depends on the individual.**

The effect on productivity of fully remote work is heterogeneous.

For some, the effects may be negative, while for others, the effects may be positive.

- Call center, data entry workers: Negative
- Highly motivated w/ advanced degrees: ????

Big Picture

Literature about **fully remote** has documented objective (not self-assessed) positive outcomes for decades.

- Geisler (1978): 26% higher productivity for key coders working at home vs in-office for Blue Cross Blue Shield South Carolina.
- Phelps (1980): 48% higher productivity for course development managers at Mountain Bell in Denver.
- Newman (1989): 20% higher productivity for programmers at Travelers Insurance Company.
- Dubrin (1991): 29.9% higher productivity for data entry workers at NPD Group in New York.
- Loy et al (2003): 150.1% higher productivity for call center workers at Kentucky American Water Company.
- Collins (2005): 23% higher productivity for insurance techs at Lloyd's Insurance in the UK.

Big Picture

Again, goal is to convince you that...

The effects of **fully remote work** on productivity are potentially **heterogeneous**.

Two other studies speak to the potential heterogeneity.

- Dutcher (2012) provides experimental evidence that
 - Remote work for **simple, repetitive** tasks was associated with 10 percent **lower productivity**.
 - Remote work for tasks requiring **critical thinking and creativity** associated with 20 percent **higher productivity**.
- Monteiro, Straume, and Valente (2019) study Portuguese firms (2011-2016)
 - Remote work had **negative productivity** association with firms primarily employing **low-skilled workers**.
 - In contrast, remote work had significantly **positive productivity** effects for firms that undertake **research and development (R&D)** activities.

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 - Largest gains accrued to top 10 schools.
- However, Jiang et. al (2022) look at top 1,000 schools and find an overall **decline** in productivity, with increased inequality.
 - Extra time spent on teaching had an important negative effect.
- **Federal Reserve System economists were explicitly excluded from these studies and did not face these teaching costs.**

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- Was there any effect on inequality among economists?
- Can a general equilibrium model rationalize any of the findings?
- What would be the macroeconomic effects?
 - Important because **increases in productivity tend to reduce inflation.**

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- We examined working paper output from the 12 Federal Reserve System regional banks as well as a richer measure of output for Board authors
- Working papers are a consistent and relatively parsimonious measure which persists across all regional banks.
 - Avoids issues associated with lag times related to publication process.
- We use quarterly output per author as our measure of interest and construct a time series for each author.

Caveats to Using Working Papers

- Working papers are obviously just one dimension of output.
 - For the 12 regional banks, we do not include publications, revisions, book chapters, notes, and other research contributions.
- Output related to policy work is not included yet also important.
- Some economists use SSRN to release new papers, which we are not tracking.

Caveats to Using Pandemic

Pandemic was a unique time period, one perspective on results coming from the Pandemic...

- A land-grab of papers on COVID
- More demand for papers on COVID
- Short-run/long-run trade-off
 - Less time on conferences,
 - Less lunch with colleagues
 - More just pumping out papers

As robustness checks,

- We can exclude Covid papers
- We can exclude 2020.
 - Vaccine was widely available in 2021 i.e. more in-person activities.
- We can check 2008 financial crisis, another land-grab event.

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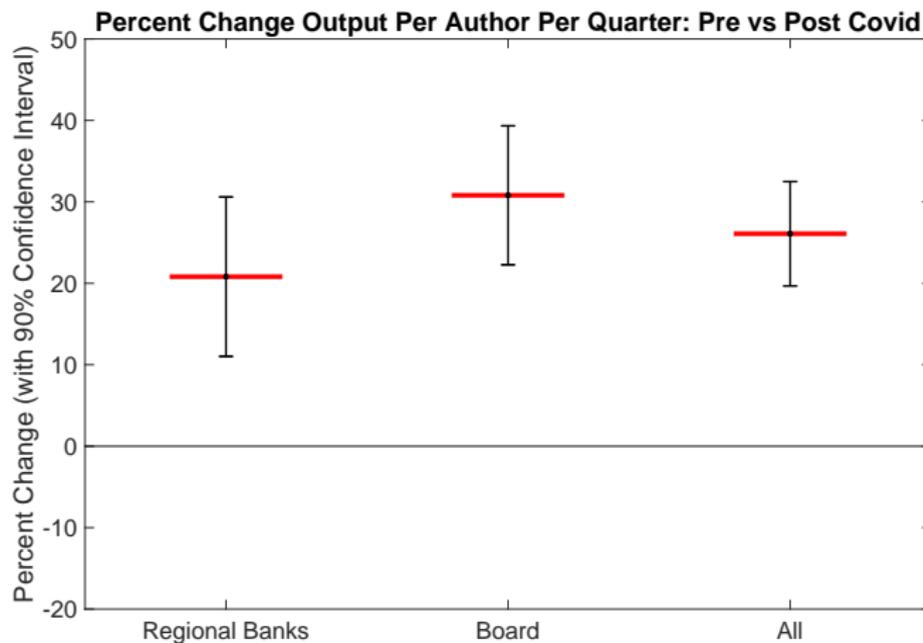
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- 507 Authors, 2,400 research pieces from the Board

Results: Summary Statistics Visualized



Takeaway: Entire system had about 25% increase in output.

Results: Regression Specifications

Previous results were just summary statistics.

- Regressions provide for more formal analysis and controls.

Given that we are using count data, which is zero-bounded and right-skewed, we use Poisson regressions in addition to linear regressions.

- Cohn, Liu, and Wardlaw (2022) show Poisson regressions are more appropriate for this type of data.

Poisson regressions assume dependent variable follows a Poisson distribution and assumes the log of its expected value is linearly related to the independent variables.

We also control for author fixed effects.

Main Regression Results: Quarterly Output per Author

	Linear	Poisson
Panel A: Federal Reserve Regional Banks		
Covid	0.041*** (3.29)	0.170*** (3.33)
Constant	0.223*** (37.83)	
Observations	6369	

	Linear	Poisson
Panel B: Board of Governors		
Covid	0.091*** (6.32)	0.282*** (6.39)
Constant	0.276*** (42.61)	
Observations	7559	

	Linear	Poisson
Panel C: Combined		
Covid	0.068*** (7.03)	0.239*** (7.13)
Constant	0.252*** (56.32)	
Observations	13928	

Constant: 0.252 × 4 ≈ about 1 working paper per year per economist for pre-Covid.

Regional Banks had 17.0%, Board had 28.2%, and Combined 23.9% increases.

Takeaway: Large significant gains across entire system during pandemic

Quarterly Output per Author: Top Half of Distribution

We split the sample up into the top and bottom half based on Pre-Covid production.

	Linear	Poisson
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Covid	0.130*** (12.46)	0.864*** (12.87)
Top Half	0.308*** (26.10)	1.451*** (24.30)
Covid x Top Half	-0.125*** (-6.53)	-0.854*** (-10.94)
Constant	0.094*** (18.69)	-2.361*** (-44.15)

Pre-Covid

Constant: 0.094 \approx about 0.5 papers per year for bottom half of distribution Pre-Covid.

Top Half: 0.308 \implies 0.308 + 0.094 \approx about 1.5 papers per year for top half.

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Top Half: 0.308 \Rightarrow 0.308 + 0.094 \approx about 1.5 papers per year for top half.

During Covid

Covid: 0.130 bottom half of distribution nearly doubled its output (0.130 + 0.094).

Covid x Top Half : -0.125 + 0.130 = 0.005 \Rightarrow top half remained productive but unchanged.

Takeaway: Gains in output were driven by bottom half of distribution. Inequality declined.

Quarterly Output per Author: Female effect

	Linear	Poisson
Panel C: Combined		
Covid	0.069*** (6.00)	0.240*** (6.06)
Female	-0.009 (-0.63)	-0.037 (-0.62)
Covid x Female	-0.011 (-0.49)	-0.029 (-0.35)
Constant	0.255*** (35.41)	-1.367*** (-48.40)

Pre-Covid

Constant: 0.255 \approx about 1 paper per year for males Pre-Covid.

Female: -0.009 + 0.255 \implies insignificant difference for Pre-Covid (T-stat = -0.63).

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During Covid

Covid: 0.240 \implies males increased output by 24%.

Covid x Female: -0.029 + 0.240 \implies females increased by 21%, insig. diff. (T-stat = -0.35).

Takeaway: No significant difference between males and females (pre and during Covid).

Contrasts with evidence from university professors, which found significant difference.

Quarterly Output per Author: Years since PhD effect

	Under 8 years	8 to 22 years	Over 22 years
Panel C: Combined Poisson			
Covid	0.202*** (5.25)	0.340*** (6.50)	0.205*** (5.11)
Age group	-0.051 (-0.74)	0.428*** (8.50)	-0.476*** (-8.38)
Covid x Age group	0.160* (1.75)	-0.176** (-2.52)	0.084 (1.07)
exp(Constant)	0.255*** (3.93)	0.199*** (3.72)	0.291*** (3.77)

Under 8 Years Since PhD

Covid x Age Group: 0.160 \Rightarrow 16% more output than rest during Covid.

Covid + Covid x Age Group : 0.202 + 0.160 = 36.2% more output compared to Pre-Covid.

Takeaway: Youngest cohort gained most during the pandemic.

This goes against the view that youngest do poorly under fully remote.

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8 to 22 Years Since PhD

Covid x Age Group: $-0.176 \Rightarrow$ 17% less relative output than everyone else during Covid.

Covid + Covid x Age Group : $0.340 - 0.176 =$ 16.4% more output compared to Pre-Covid.

Takeaway: Although gains were not as large as other age groups, still significantly positive.

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More than 22 Years Since PhD

Covid x Age Group: 0.084 \Rightarrow 8% more output than others during Covid.

Covid + Covid x Age Group : 0.205 + 0.084 = 28.9% more output compared to Pre-Covid.

Takeaway: Gains relative to other cohorts were positive but insignificant.

Did we see similar increase around financial crisis?

- Gains could be driven by presence of new research ideas and not fully remote.
 - This view rests on the assumption that the constraining factor on researchers prior to Covid was not time, but limited number of research ideas.
- The Global Financial Crisis is another time period in which there was a new shock to do research on.
- Yet there were no changes in WFH policies over this time period.
- Could possibly serve as a good period for comparison.

Quarterly Output per Author: Excluding 2020

Fixed Effects	Poisson		Linear	
	No	Yes	No	Yes
Combined				
Covid	0.127*** (3.03)	0.109*** (2.68)	0.037*** (2.98)	0.032*** (2.65)
Constant	-1.296*** (-49.32)		0.274*** (38.05)	0.275*** (65.84)

- Covid: 10.9% significant increase.

Takeaway: Excluding 2020, effect remains economically large and significant.

Quarterly Output per Author: Excluding Covid Papers

Fixed Effects	Poisson		Linear	
	No	Yes	No	Yes
Combined				
Covid	0.102*** (2.84)	0.109*** (3.12)	0.027*** (2.82)	0.029*** (3.10)
Constant	-1.377*** (-55.51)		0.252*** (40.32)	0.252*** (58.62)

Takeaway: Excluding "Covid" or "Pandemic" papers, still significant positive.

Authors per Paper: Collaboration

Table: Collaboration: Authors per Paper

	Poisson	Linear	Poisson	Linear
Combined				
Covid	0.0713*** (4.07)	0.224*** (4.04)	0.105*** (3.92)	0.331*** (3.93)
Trend Effect			-0.0184 (-1.56)	-0.0573 (-1.56)
Constant	1.111*** (97.51)	3.038*** (87.74)	1.126*** (73.99)	3.083*** (65.40)

- Constant: 3.083 \approx 3 authors per paper for pre-Covid.
- 10.5% increase in authors per paper during Covid.

Takeaway: Significant increase in collaboration across the system (even when controlling for trend).

Some reasons WFH may increase output

The following items listed in Bloom et al (2022):

- Average U.S. employee saves about 70 minutes a day by avoiding having to commute and prepare for work, which is split into both additional work and leisure.
- Home working is often better for individual focused activities like coding or writing as it is usually quieter.
- Allows for greater time flexibility.

Choudhury et al (2021)

- WFH allows workers to control ambient workspace such as clothing, layout, ventilation, etc.
- Theorizes that those that self-select into WFH will experience greater satisfaction and utility, and will exert greater productivity-enhancing effort in appreciation of this nonpecuniary benefit.

General Equilibrium Model

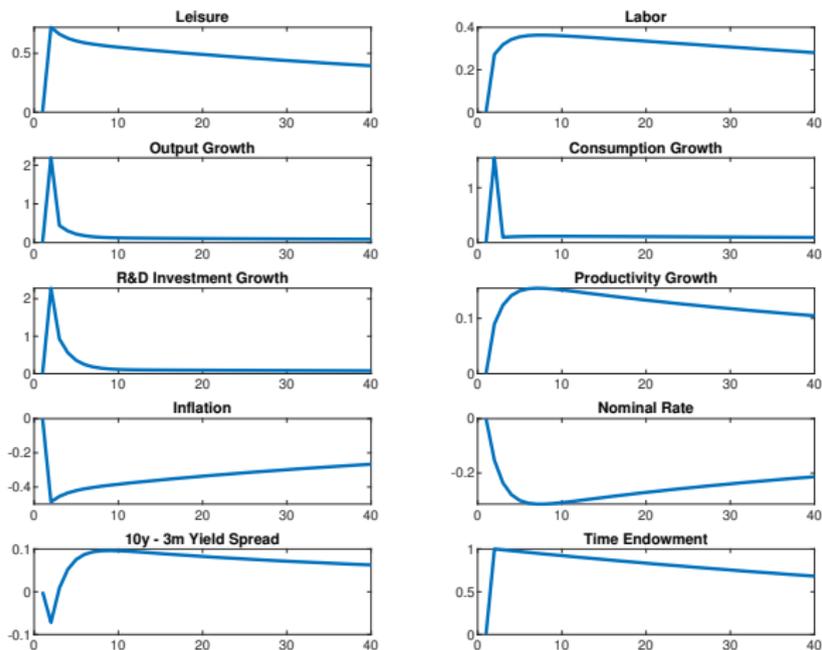
We use a standard New-Keynesian model with endogenous growth.

- Endogenous growth allows for potential effects on productivity.

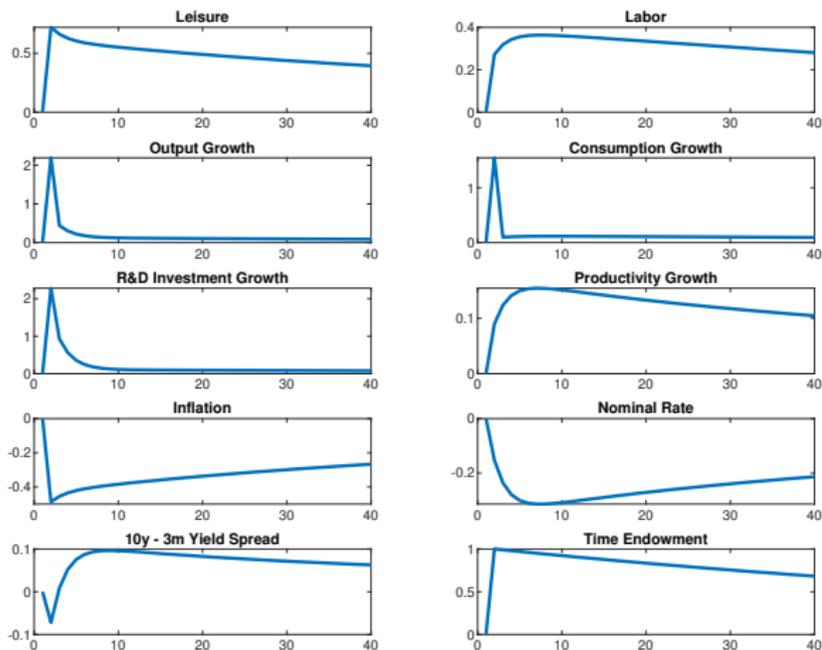
Given Bloom et al. (2022) finds 70 minutes a day in savings....

We simulate a 1% exogenous increase in the time endowment.

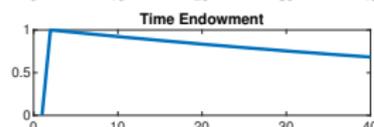
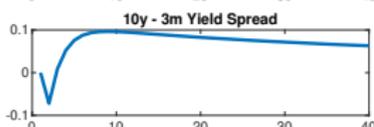
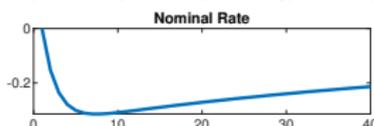
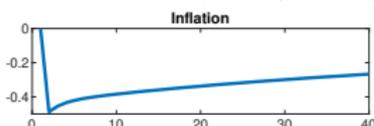
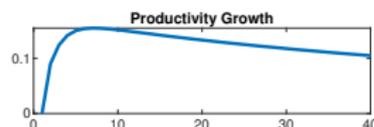
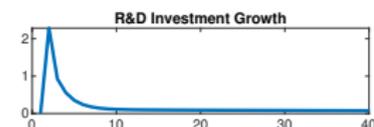
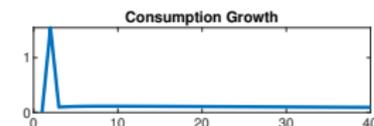
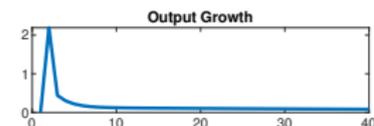
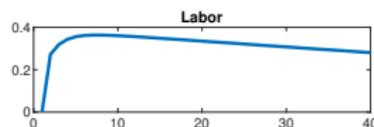
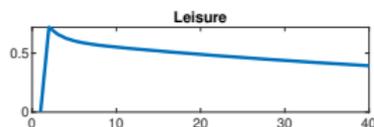
- Given typical model has households working a third of the time, the total endowment is typically 120 hours a week, 40 of which are devoted to labor.
- A one percent increase is roughly an additional hour per week, consistent with the findings of Aksoy et al. (2023).



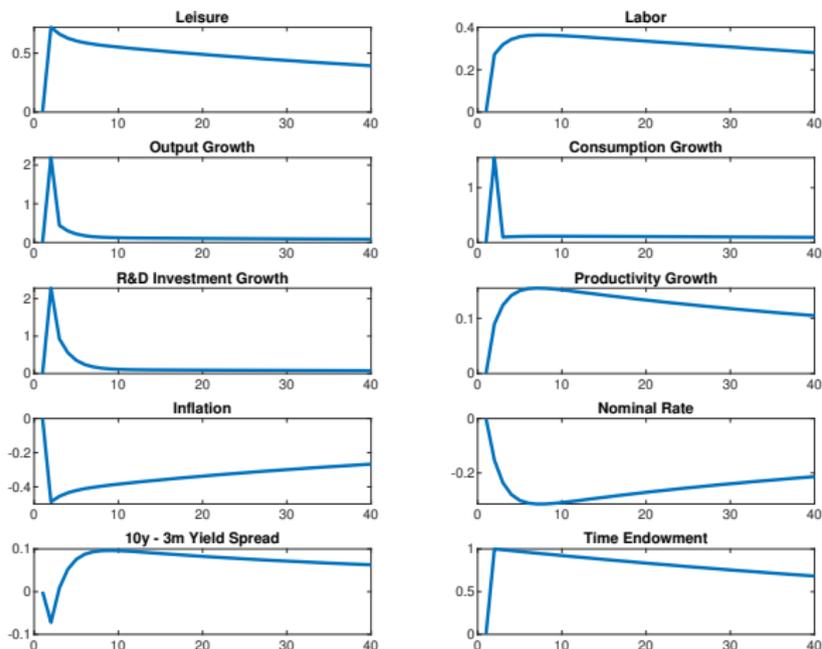
Time endowment persistently rises (lower right).



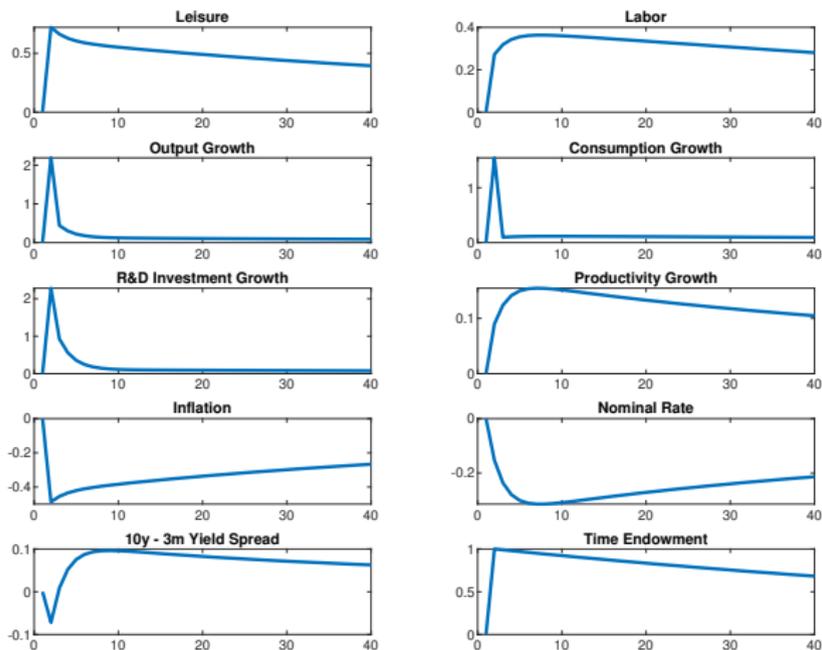
Labor supply rises by about 0.35% and leisure rises 0.65% (top row).



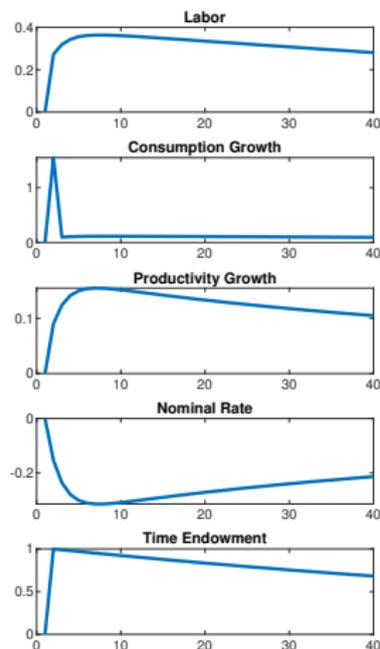
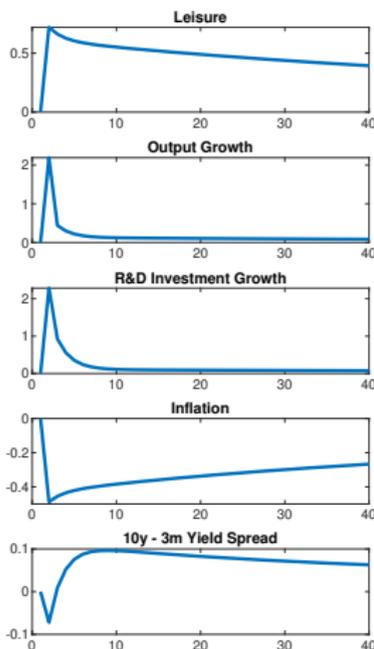
Increased labor supply translates to higher output and consumption growth.



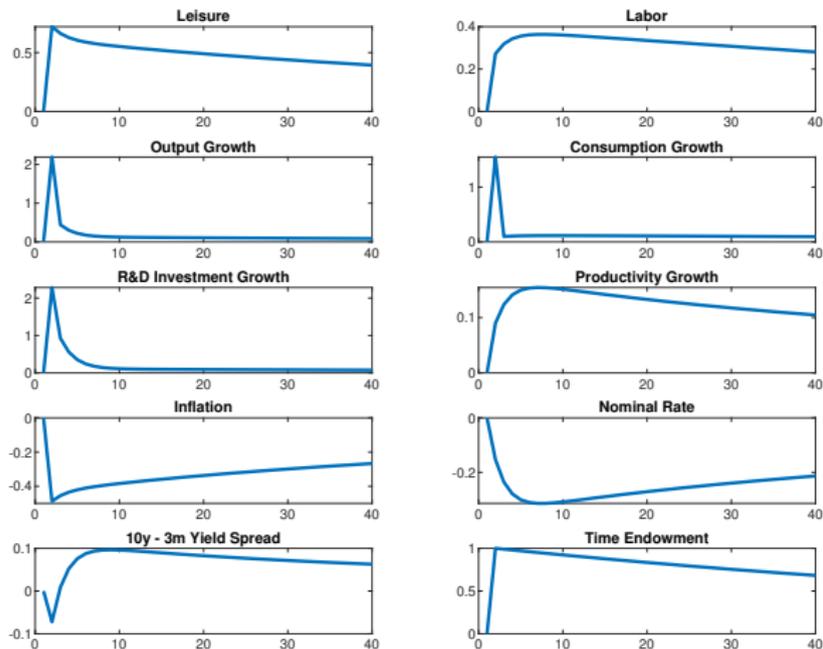
Also associated with higher R&D investment and idea accumulation.



Higher idea accumulation spills over to aggregate productivity (third row).

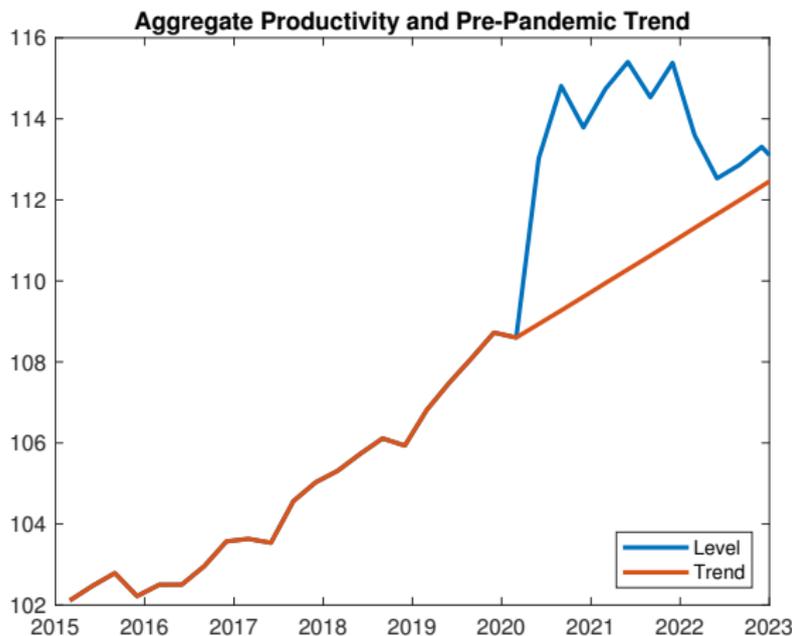


Higher labor supply is associated with lower real wages and lower inflation.

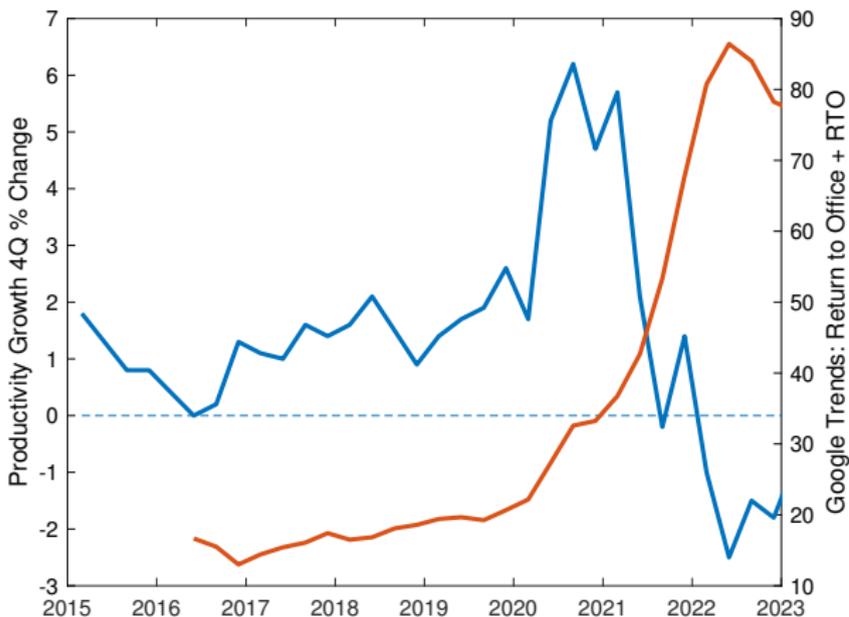


The lower inflation leads to lower risk-free rate which causes the 10y-3month spread to rise.

Aggregate Productivity



Aggregate productivity jumped well above trend and then came back to trend.



Rise in productivity and recent decline are consistent with model implications based on increase in time endowment and decrease associated with RTO.

Conclusion

- We find that research output significantly increased during fully remote.
- The bottom half of the distribution was responsible for the large gains.
- In addition, the increase was driven by under 35 and 50 plus.
- There was no significant difference between males and females.
- Collaboration as measured by authors per paper significantly increased.
- Findings can be rationalized in GE model with exogenous increase in time endowment.
- Caveat: This study is just about productivity, there's other important aspects.

Final Thought

- There exists a scenario that combines positive aspects of **fully remote** and **hybrid**:

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Cluster Hybrid

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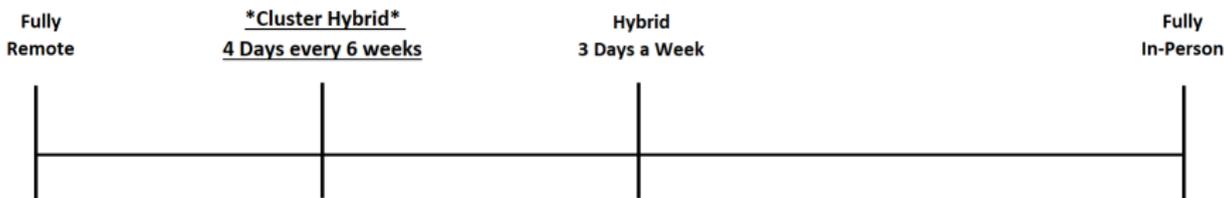
- **Cluster Hybrid brings everyone together for 4-5 days every 6 or so weeks.**
 - Many of the benefits of fully remote work.
 - Cost savings. Nationwide talent search. People can live where they want.

Final Thought

- There exists a scenario that combines positive aspects of **fully remote** and **hybrid**:

Cluster Hybrid

- Cluster Hybrid brings everyone together for 4-5 days every 6 or so weeks.**
 - Many of the benefits of fully remote work.
 - Cost savings. Nationwide talent search. People can live where they want.
 - Also have the in-person culture building of hybrid.



- Hire talent nationwide.
- Save real estate costs.
- Minimize daily commute.

-Establish in person connections and culture.

- Can only hire within driving distance of office.
- Workers must frequently commute, higher real estate costs.