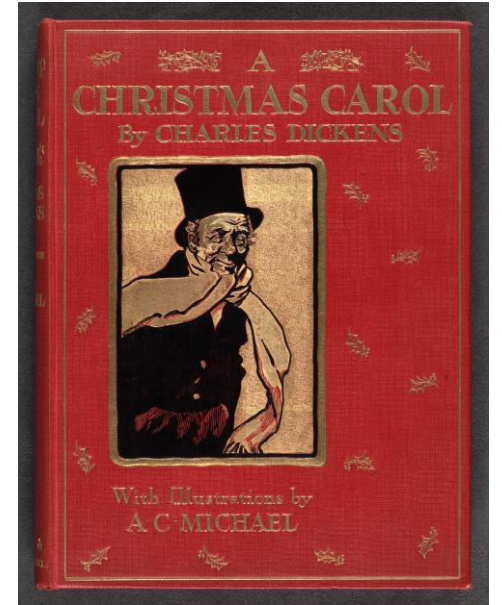


Productivity Growth: Past, Present and Yet to Come

Nick Bloom (Stanford) and Gregory Thwaites (Nottingham)

Joint OGWG-ECFIN-JRC Conference

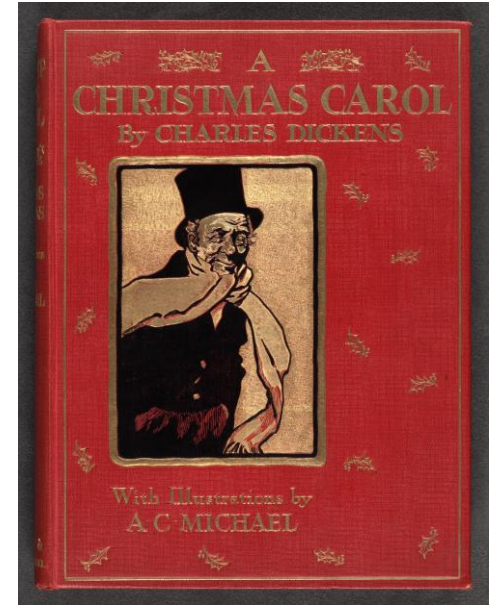
29-30 September 2021



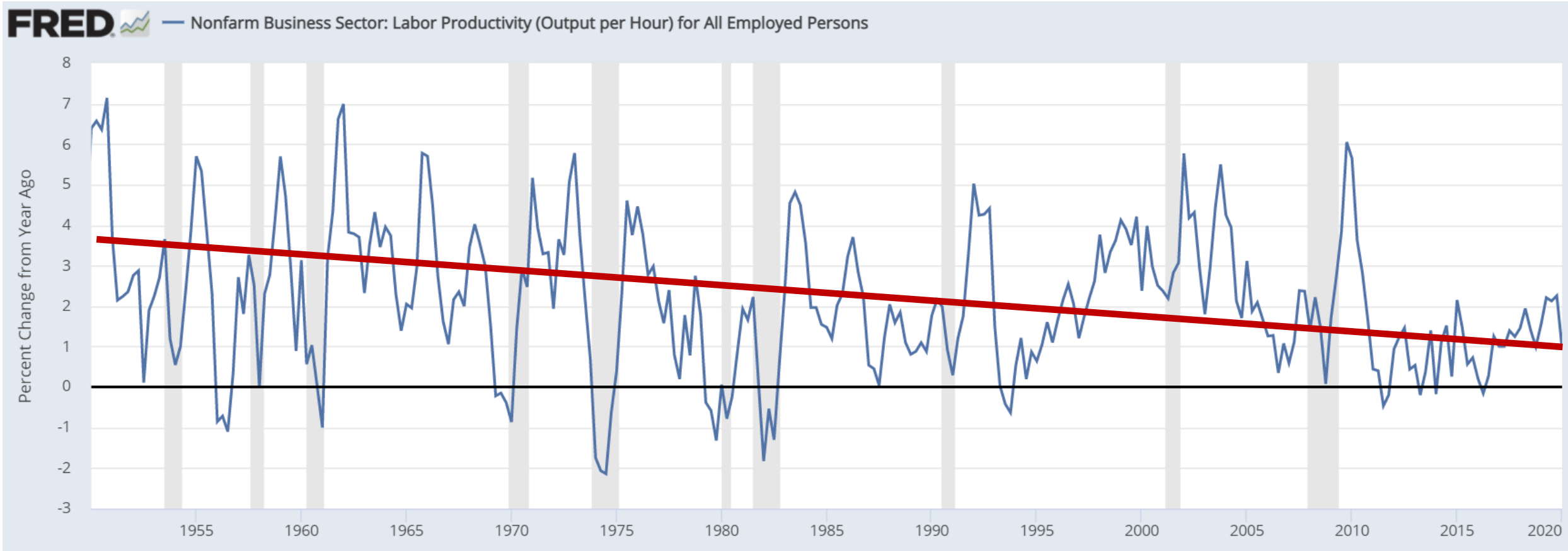
Productivity Past

Productivity Present: Covid-19

Productivity Yet to Come

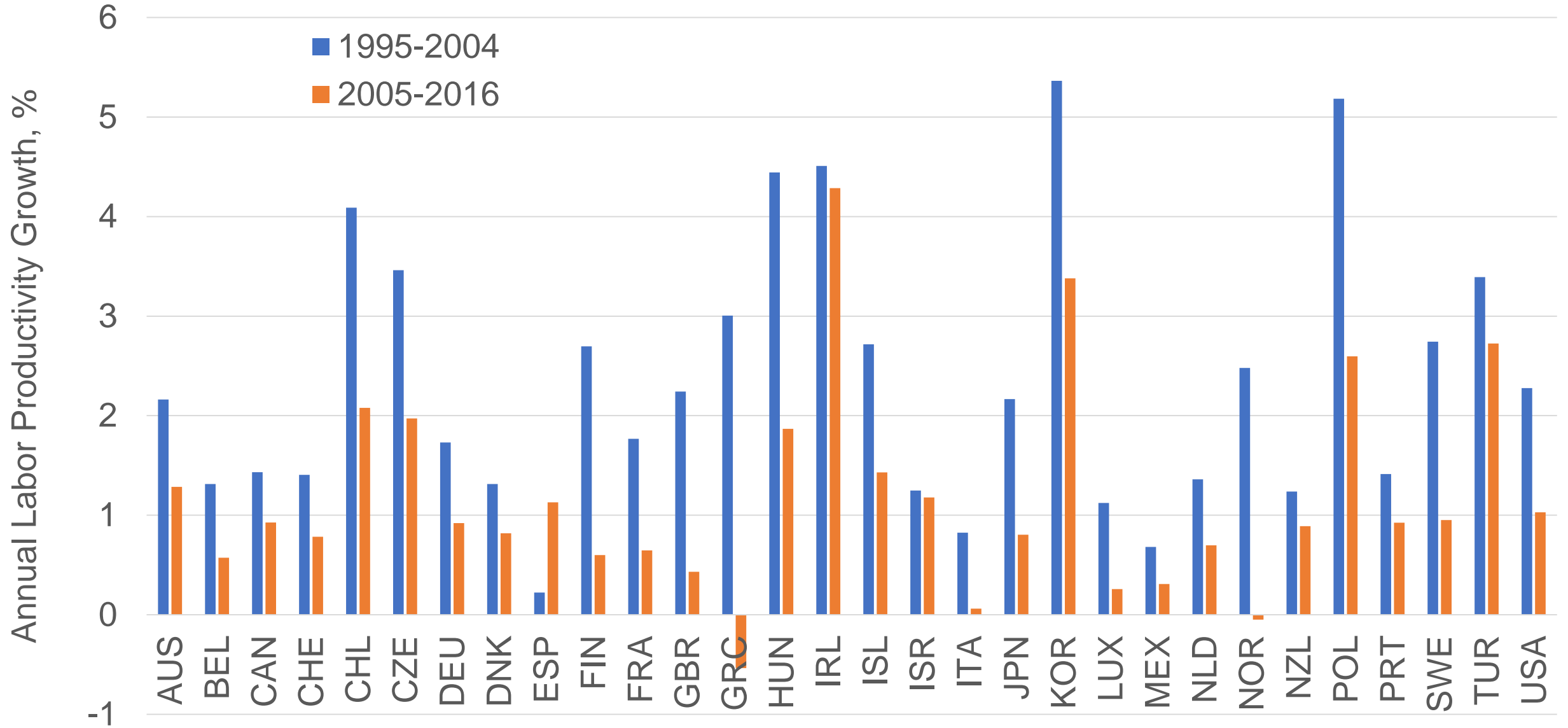


Growth - US Productivity Growth Has Been Slowing Since the 1960s



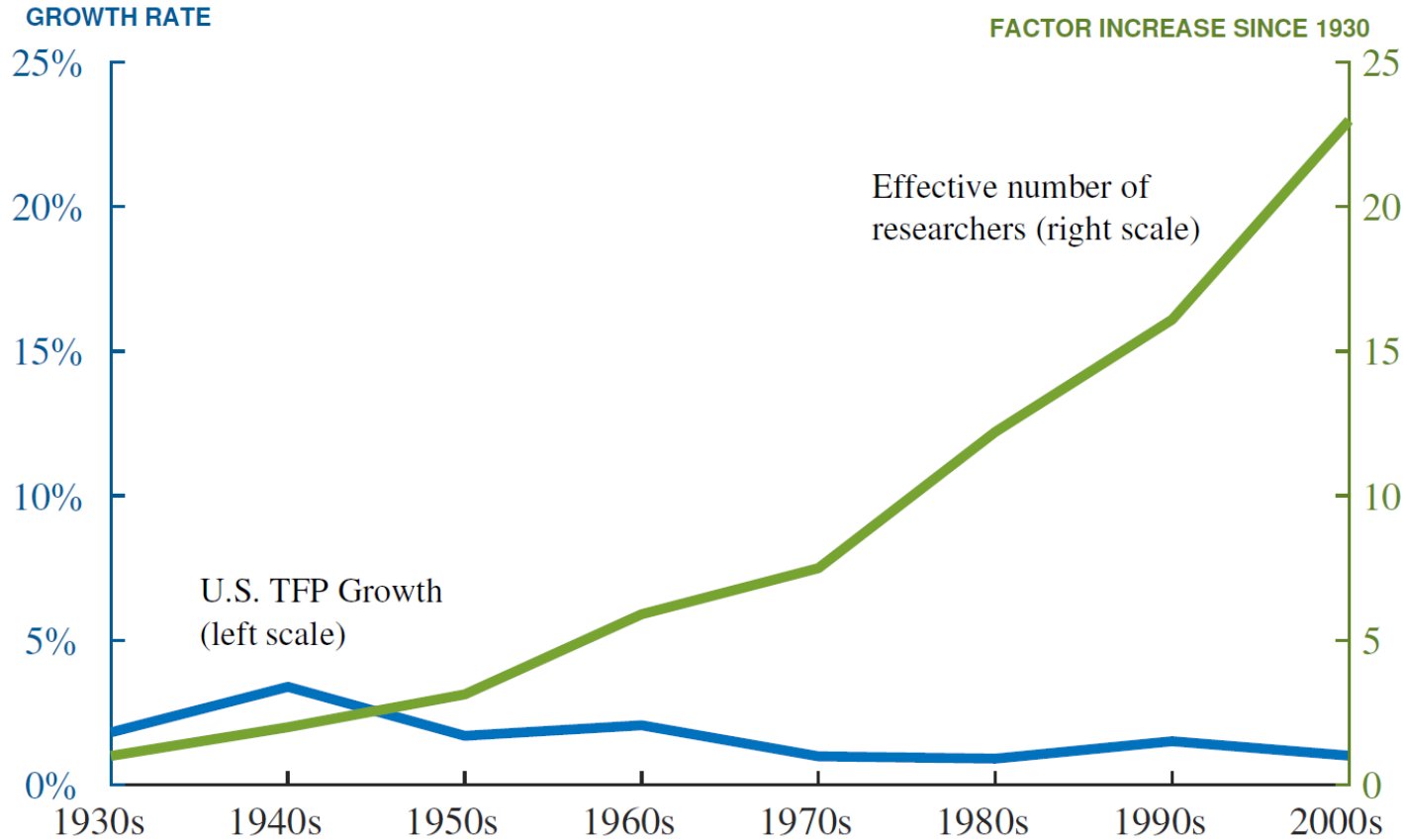
Source: US Bureau of Labor Statistics <https://fred.stlouisfed.org/series/OPHNFB#0>

Growth - Productivity growth has been slowing in most countries



Our paper argues this is because “Ideas are getting harder to find”

Aggregate Evidence



American Economic Review 2020, 110(4): 1104–1144
<https://doi.org/10.1257/aer.20180338>

Are Ideas Getting Harder to Find?[†]

By NICHOLAS BLOOM, CHARLES I. JONES, JOHN VAN REENEN,
 AND MICHAEL WEBB*

Long-run growth in many models is the product of two terms: the effective number of researchers and their research productivity. We present evidence from various industries, products, and firms showing that research effort is rising substantially while research productivity is declining sharply. A good example is Moore’s Law. The number of researchers required today to achieve the famous doubling of computer chip density is more than 18 times larger than the number required in the early 1970s. More generally, everywhere we look we find that ideas, and the exponential growth they imply, are getting harder to find. (JEL D24, E23, O31, O47)

This paper applies the growth accounting of Solow (1957) to the production function for new ideas. The basic insight can be explained with a simple equation, highlighting a stylized view of economic growth that emerges from idea-based growth models:

$$\text{Economic growth} = \text{Research productivity} \times \text{Number of researchers.}$$

e.g., 2% or 5% (falling) (rising)

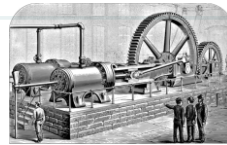
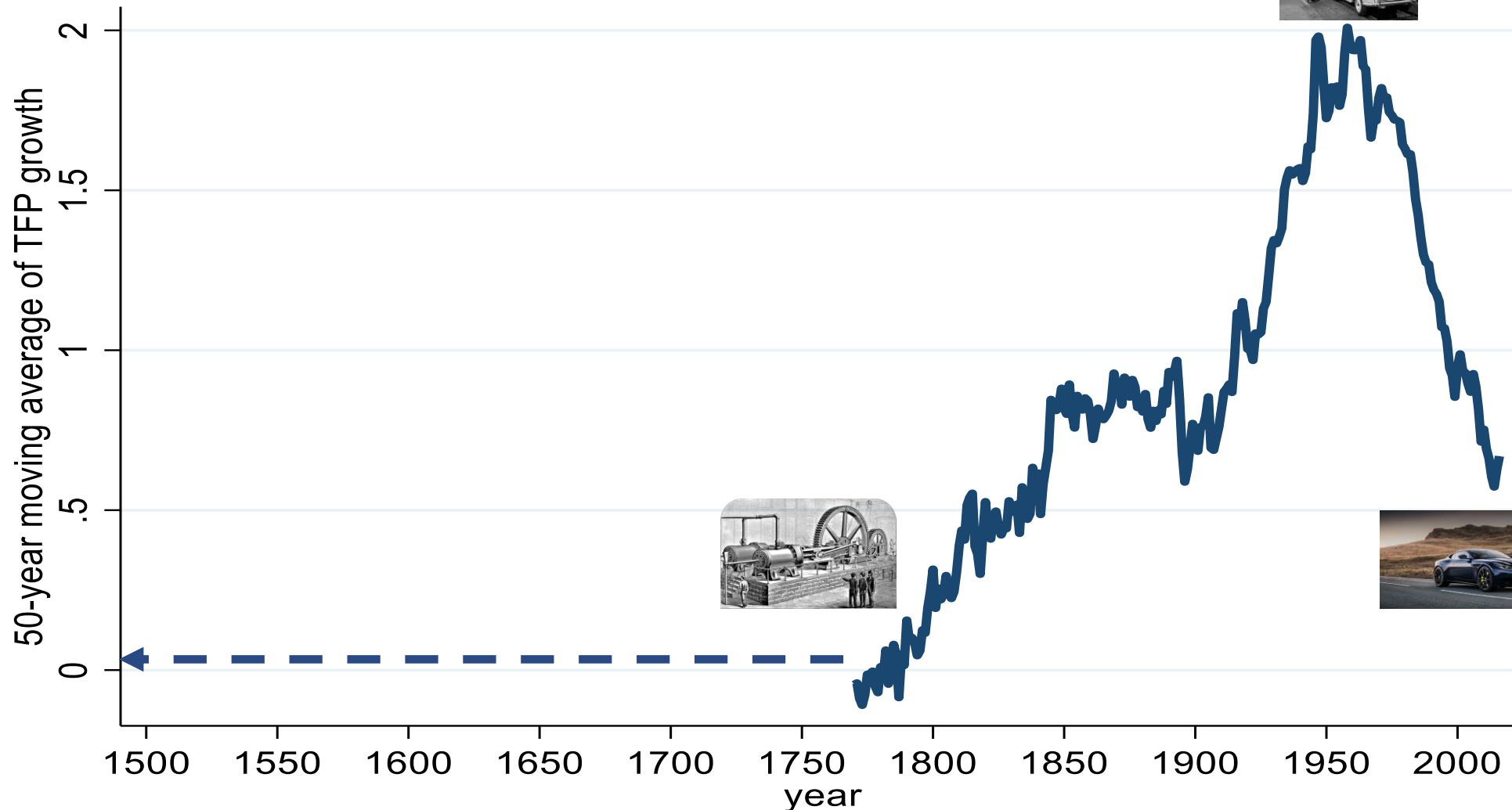
Economic growth arises from people creating ideas. As a matter of accounting, we can decompose the long-run growth rate into the product of two terms: the effective number of researchers and their research productivity. We present a wide range of empirical evidence showing that in many contexts and at various levels of disaggregation, research effort is rising substantially, while research productivity is

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[†]Go to <https://doi.org/10.1257/aer.20180338> to visit the article page for additional materials and author disclosure statements.

Productivity growth was very low (almost zero) pre-industrial revolution, increased until about 1950, and then started declining

Annual UK TFP growth



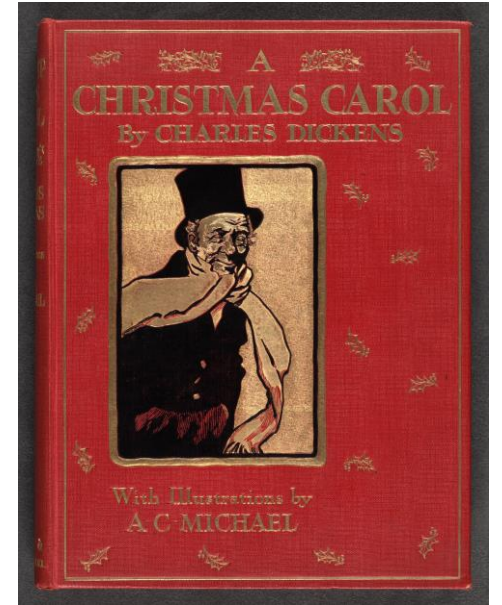
Notes: UK data used because of the long time series. Annual productivity growth smoothed with a centered 50 year moving average. Underlying data from 1761 onwards.

Source: Bank of England Three Centuries of Macroeconomic Data project via Fred, series TFPGUKA. Very long-run GDP per capita growth in UK of 0.1% from Maddison Project <https://www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2020>

Productivity Past

Productivity Present: Covid-19

Productivity Yet to Come



COVID productivity paper and more on the DMP website

The Impact of Covid-19 on Productivity

26 August 2021

Nicholas Bloom, Philip Bunn, Paul Mizen, Pawel Smietanka, Gregory Thwaites

Abstract: Productivity is a key determinant of the sustainability of the public finances. While the initial impact of Covid-19 on *labor* productivity growth shows a surprisingly positive impact, the impact on *total factor* productivity (TFP) is less clear. We evaluate this with new survey data on labor and capital inputs, outputs and prices from a UK firm panel survey. We find that Covid-19 reduced private sector TFP by up to 4% during the pandemic, with a projected 1% reduction over the medium term. These numbers comprise a large reduction in 'within-firm' productivity as intermediate costs increased due to measures like protective equipment, screens, hand sanitizer and lower capacity utilization. This was partly offset, however, by a positive 'between-firm' effects as less productive sectors, and less productive firms within them, contracted. This highlights how the Covid-19 shock has had large, but offsetting, within and between firm impacts on aggregate TFP.

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JEL No. L2, M2, O32, O33

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The screenshot shows the Decision Maker Panel website. At the top, there is a navigation menu with links for 'About us', 'Media', 'Research and Policy', 'Data', 'Methodology', and 'FAQs'. A 'JOIN TODAY' button is located in the top right corner. The main content area features a bar chart titled 'COVID-19 as source of uncertainty'. The chart displays the percentage of respondents who consider COVID-19 as a source of uncertainty from March 2020 to August 2021. The y-axis is labeled 'Per cent' and ranges from 0 to 100. The x-axis is labeled 'Importance as a source of uncertainty' and has four categories: 'Not important', 'One of many sources', 'Second or third largest source', and 'Largest current source'. The bars are color-coded by month, with a legend on the left. A 'DOWNLOAD' button is positioned below the chart. At the bottom of the page, a text box states: 'Next month's Decision Maker Panel data will be published Thursday 7th October 2021'. The 'DECISION MAKER PANEL' logo is prominently displayed at the bottom center.

Going to use data from the Bank-Nottingham-Stanford team started the Decision Maker Panel (DMP)

- Aim was to understand impact of Brexit and then COVID
- Monthly 5-10 minute online survey
- Surveys around 3000 firms monthly, covering about 10% UK employment



Quick monthly internet survey – e.g. sales question

Decision Maker Panel



BANK OF ENGLAND

In the first quarter of 2021 (January to March), what was the approximate sterling value of your SALES REVENUE (in £ THOUSANDS)?

Notes:

(a) Please reply to two significant figures (e.g. 15 thousand, 150 thousand, 1500 thousand)

(b) For businesses that finance themselves mainly from grants or donations, rather than sales, please provide figures from those sources instead.

(c) Please include sales of UK-based businesses only and not from any overseas part of the group.

£ ,000

Quick monthly internet survey – e.g. sales question

Decision Maker Panel



BANK OF ENGLAND

Looking back over the year from the first quarter of 2021, by what % amount has your SALES REVENUE changed since the same quarter a year ago (January to March 2020)?

5%

Quick monthly internet survey – e.g. sales question

Decision Maker Panel



BANK OF ENGLAND

Looking a year ahead from the first quarter of 2021 to the first quarter of 2022, by what % amount do you expect your SALES REVENUE to have changed in each of the following scenarios?

Notes:

(a) Please include sales of UK-based businesses only and not from any overseas part of the group.

(b) Sales growth scenarios should be ordered from the lowest to the highest.

The LOWEST % change in sales revenue would be about:

%

A LOW % change in sales revenue would be about:

%

A MIDDLE % change in sales revenue would be about:

%

A HIGH % change in sales revenue would be about:

%

The HIGHEST % change in sales revenue would be about:

%

Quick monthly internet survey – e.g. sales question

Decision Maker Panel



BANK OF ENGLAND

Please assign a percentage likelihood (probability) to the % changes in SALES REVENUE you entered (values should sum to 100%)

LOWEST: The likelihood of realising about -5% would be:

%

LOW: The likelihood of realising about 0% would be:

%

MIDDLE: The likelihood of realising about 5% would be:

%

HIGH: The likelihood of realising about 10% would be:

%

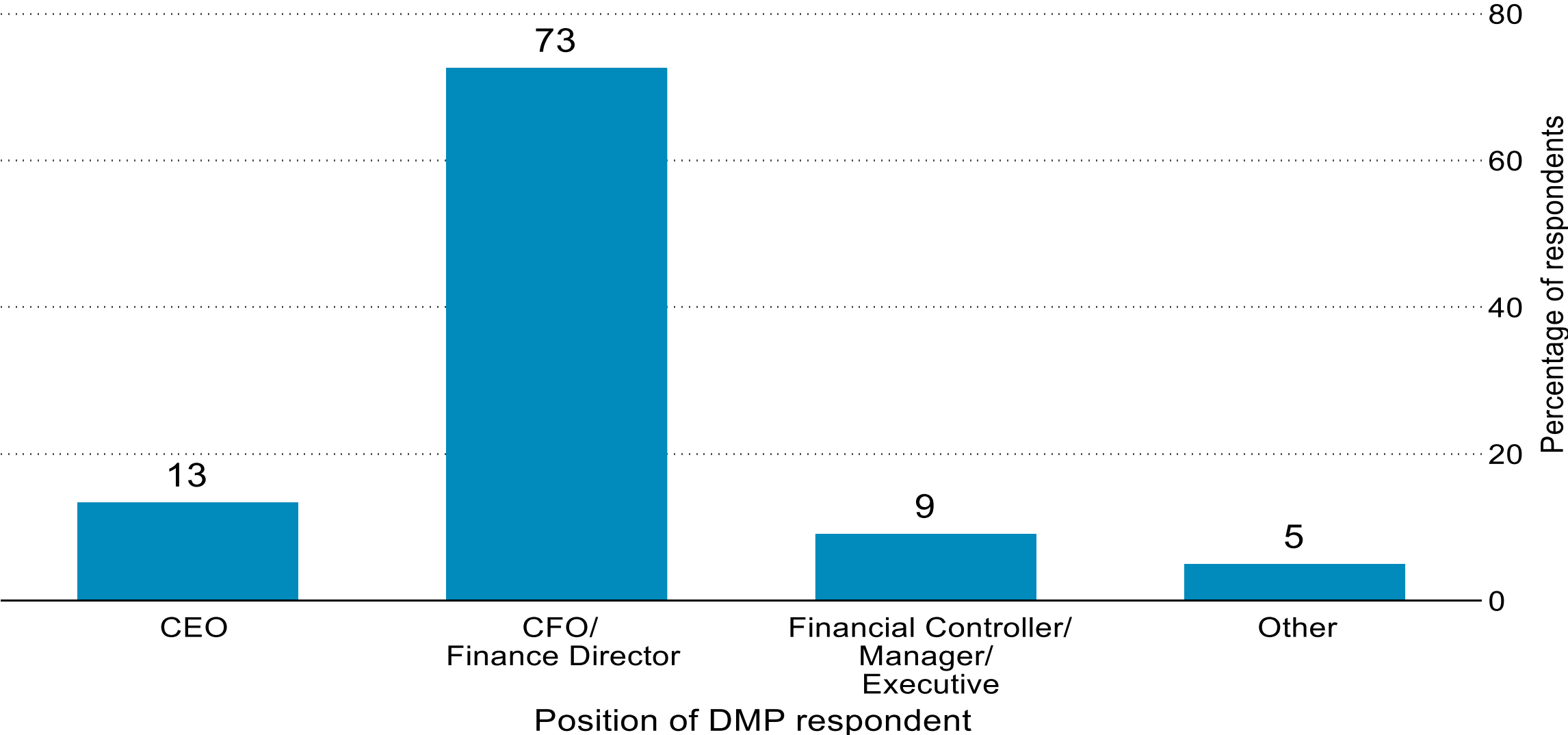
HIGHEST: The likelihood of realising about 15% would be:

%

Total

%

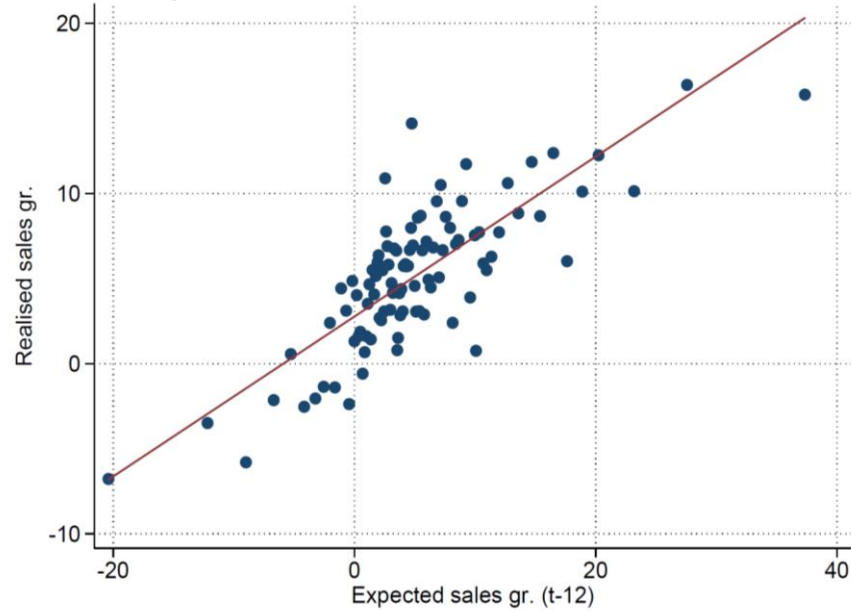
86% respondents CEOs or CFOs (median firm has 60 employees)



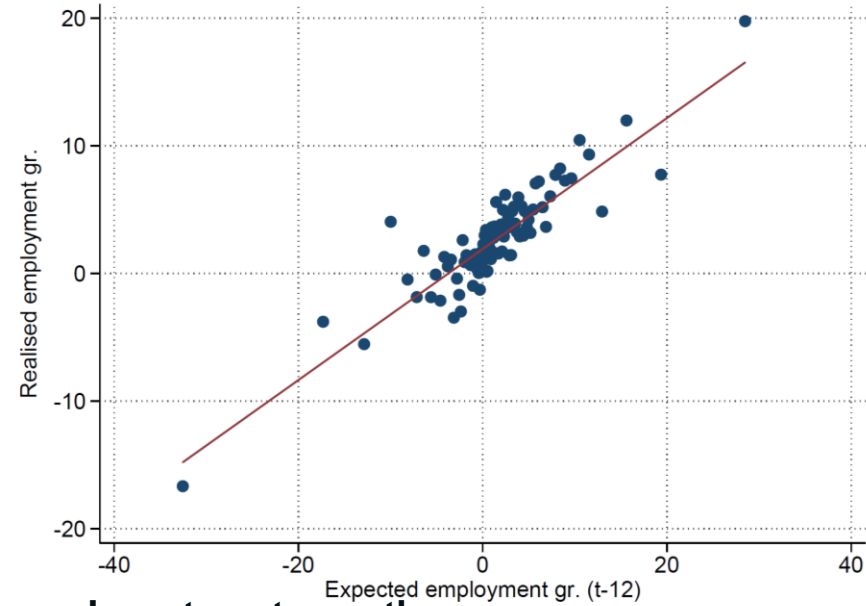
Source: Results are based on the question: 'Could you tell us the position of the person in your business that typically completes the Decision Maker Panel Survey?' and respondents were asked to choose from the following options: 'CFO', 'CEO', 'Other (please state): ...'

Forecasts that DMP respondents provide also appear accurate

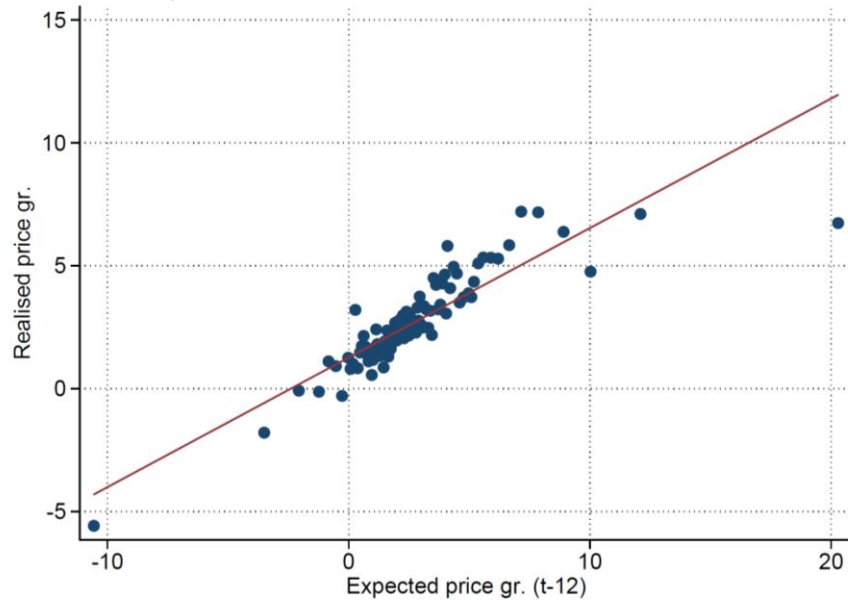
Sales growth



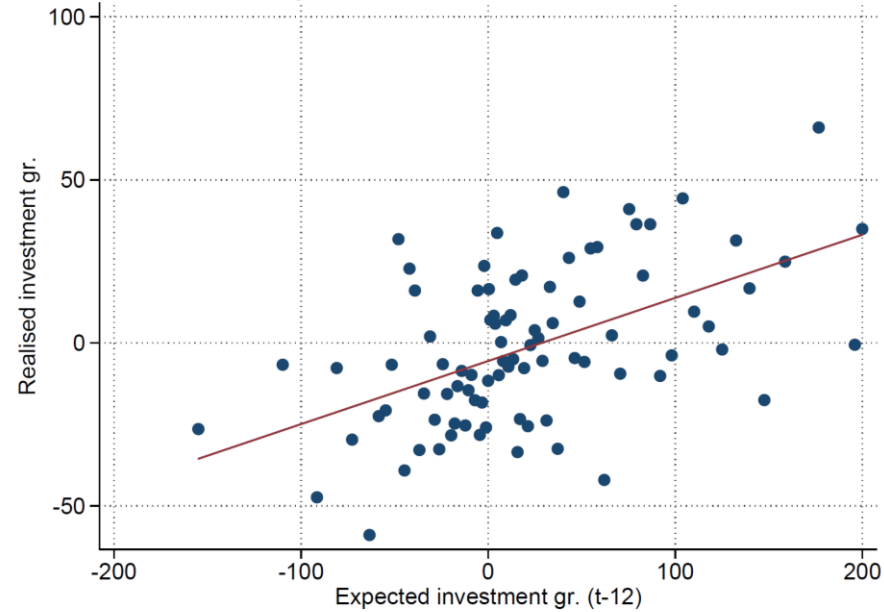
Employment growth



Price growth

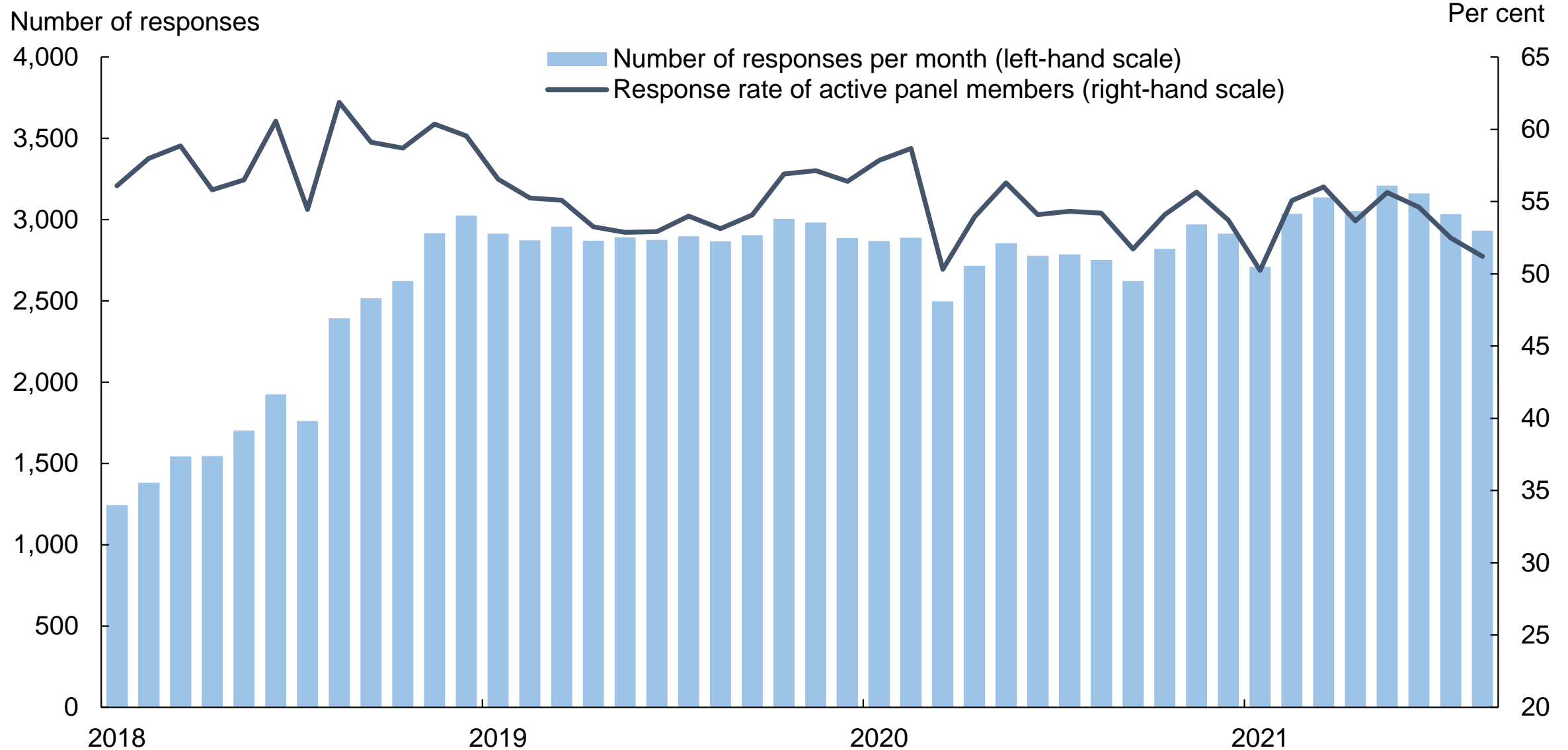


Investment growth



Notes: Y-axes show realised growth in sales, employment, prices, and investment. X-axes show expectations for year-ahead growth rates calculated from the 5-bin outcomes and probabilities. Forecasts made between September 2016 and June 2018. Binscatter plots which split responses into 100 groups

COVID: DMP response rate roughly flat during the pandemic



Notes: The response rate of active panel members is calculated as the percentage of panel members who had completed at least one survey over the twelve months who responded to the survey in a given month.

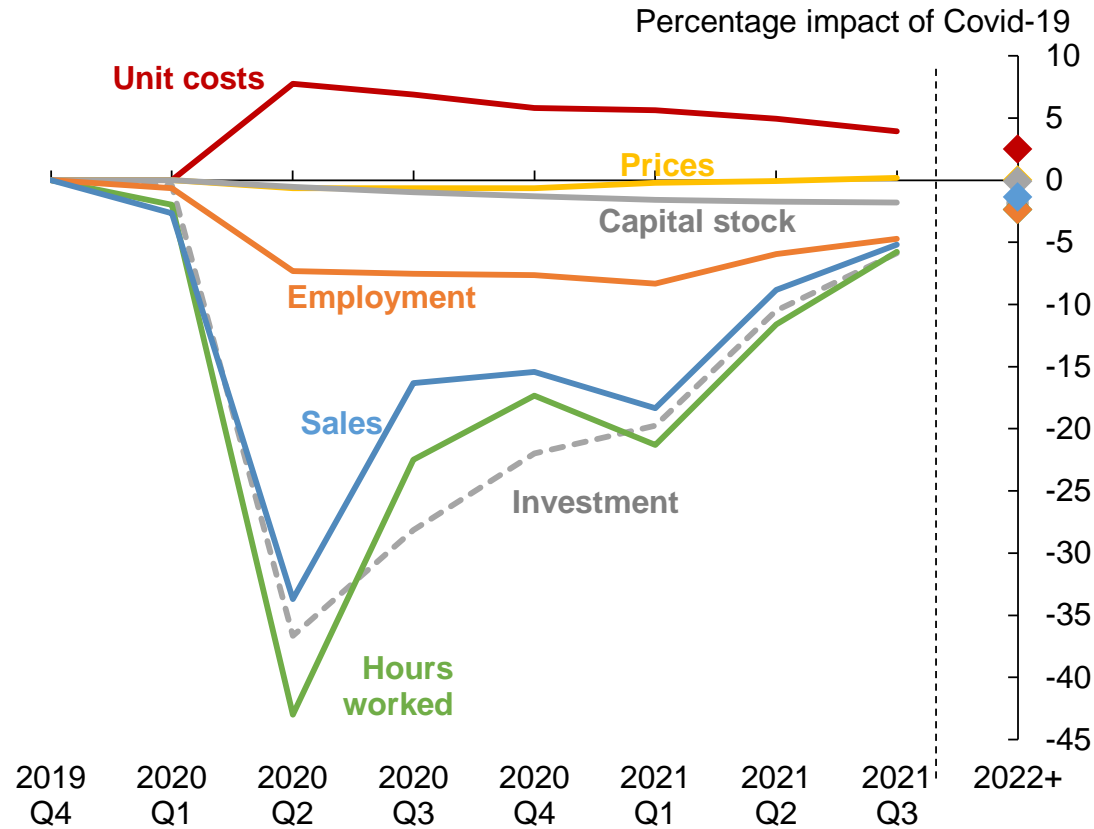
Standard productivity growth decomposition (e.g. Baily et al. 1992)

$$\begin{aligned}\Delta\Pi_t &= \sum_{i \in \text{Surv}} \bar{\varphi}_i \Delta\pi_{i,t} && \dots \text{ within firms} \\ &+ \sum_{i \in \text{Surv}} \Delta\varphi_{i,t} (\bar{\pi}_t - \bar{\Pi}) && \dots \text{ reallocation between surviving firms} \\ &+ \sum_{i \in \Delta\text{Entry}} \varphi_{i,t} (\bar{\pi}_t - \bar{\Pi}) && \dots \text{ reallocation to new firms} \\ &- \sum_{i \in \Delta\text{Exit}} \Delta\varphi_{i,t-1} (\pi_{i,t-1} - \bar{\Pi}) && \dots \text{ reallocation from exiting firms}\end{aligned}$$

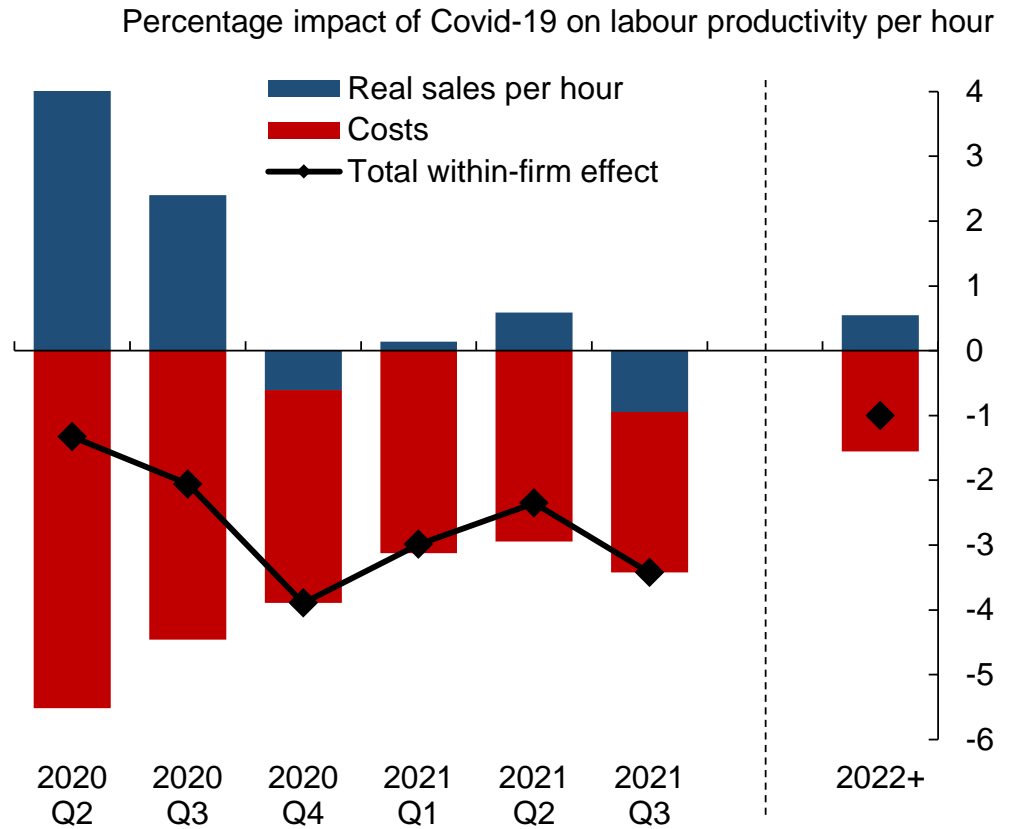
Where $\pi_{i,t}$ is GVA per head in firm i at time t , Π_t is aggregate GVA per head at time t , $\varphi_{i,t}$ is the employment share of firm i at time t and a bar over a variable indicates the average of the variables across times $t-1$ and t . Δ is with respect to Covid, not time. So ΔEntry and ΔExit denote the firms that, as a result of Covid, enter the set of entering and exiting firms.

Within firms costs have gone up – the main negative impact

Panel A: Impact of Covid-19 on businesses



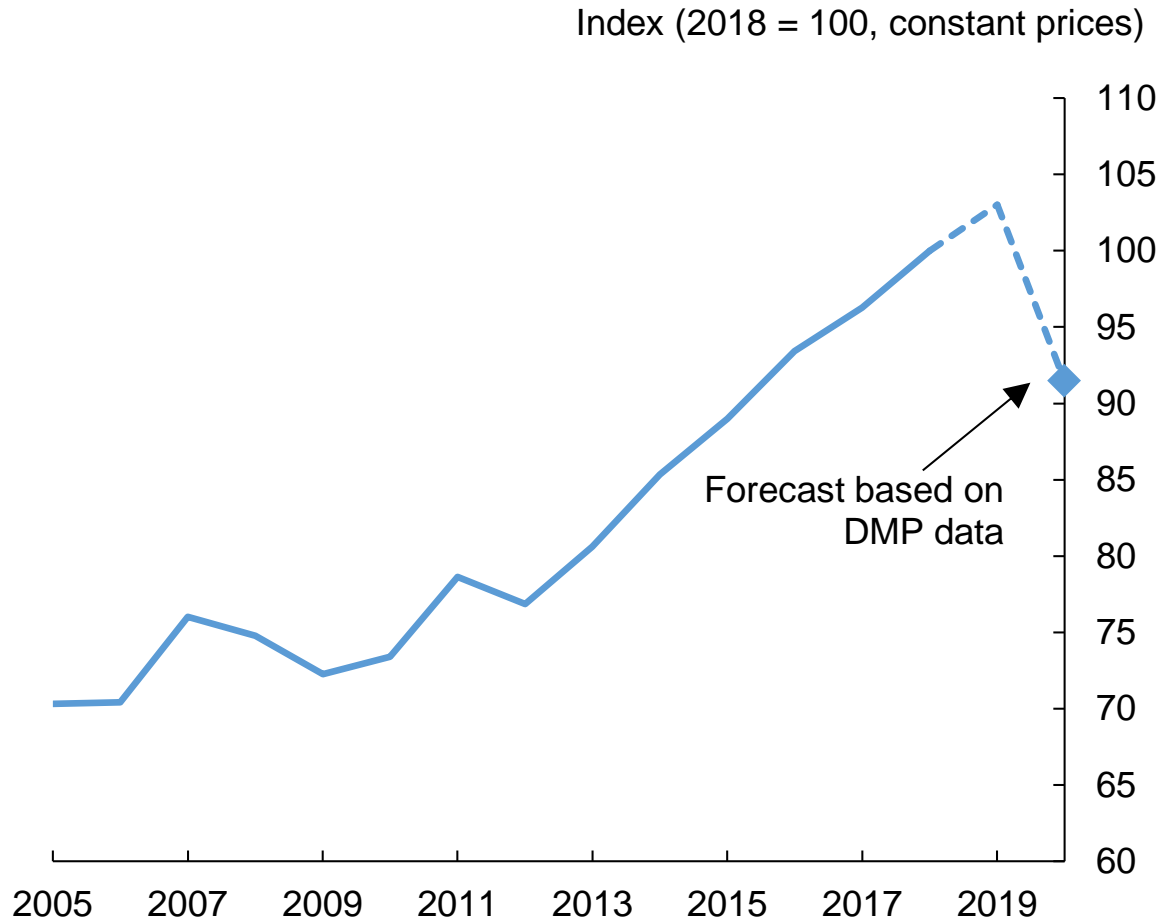
Panel B: Contributions to impact of Covid-19 on within-firm labour productivity per hour



Notes: The results are based on the questions: 'Relative to what would otherwise have happened, what is your best estimate for the impact of the spread of Covid-19 on the sales/employment/average hours worked per active employee/capital expenditure of your business in each of the following periods?'; 'Relative to what would otherwise have happened, what is your best estimate for the impact of measures to contain coronavirus (social distancing, hand washing, masks and other measures) on the average unit costs of your business in each of the following periods?'; and 'Approximately what percentage of your employees fall into the following categories in each of the following periods? (i) Still employed but not required to work any hours (eg 'on furlough'), (ii) Unable to work (eg due to sickness, self-isolation, childcare etc.), (iii) Continuing to work on business premises, (iv) Continuing to work from home'. Data are the most recent observation per firm for each period collected between July 2020 and June 2021. Data on the impact of Covid-19 in 2020 Q1 have not been collected in the DMP. Data shown for Q1 are absolute changes in aggregate ONS data for private sector output, business investment, private sector employment and hours worked between 2019 Q4 and 2020 Q1. The impact on unit costs is assumed to be zero in Q1. Effects on the capital stock are estimated using by cumulating the investment impacts. The effects on the price level are estimated using data from DMP questions on actual price inflation and expected year-ahead price inflation: the impact of Covid-19 is estimated as the difference relative to 2019 at the 1-digit industry level. See notes to Figure 1 for details on how the impact of Covid-19 on within-firm productivity is calculated.

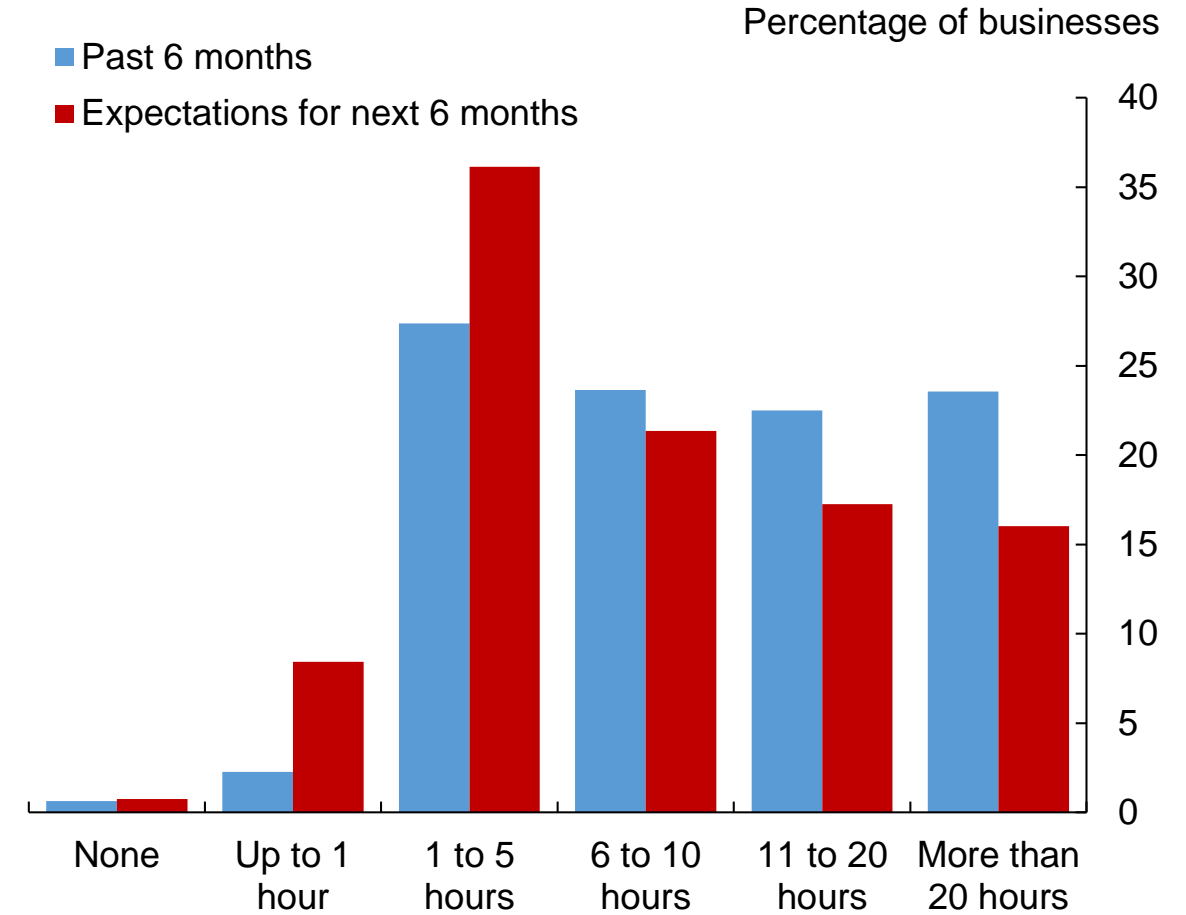
Covid may also damage long-run productivity growth?

Panel A: Aggregate R&D investment



Notes: The solid line is real business sector R&D expenditure from the UK National Accounts. For 2019, for which we do not have data, we extrapolate an average growth between 2005 and 2018. For 2020, we extrapolate again and then adjust according to the response to the following DMP question: 'Relative to what would otherwise have happened, what is your best estimate for the impact of the spread of coronavirus (Covid-19) on spending on research and development of your business in 2020?'. DMP data were collected between August and October 2020.

Panel B: Average hours per week spent by CEOs managing effects of Covid-19

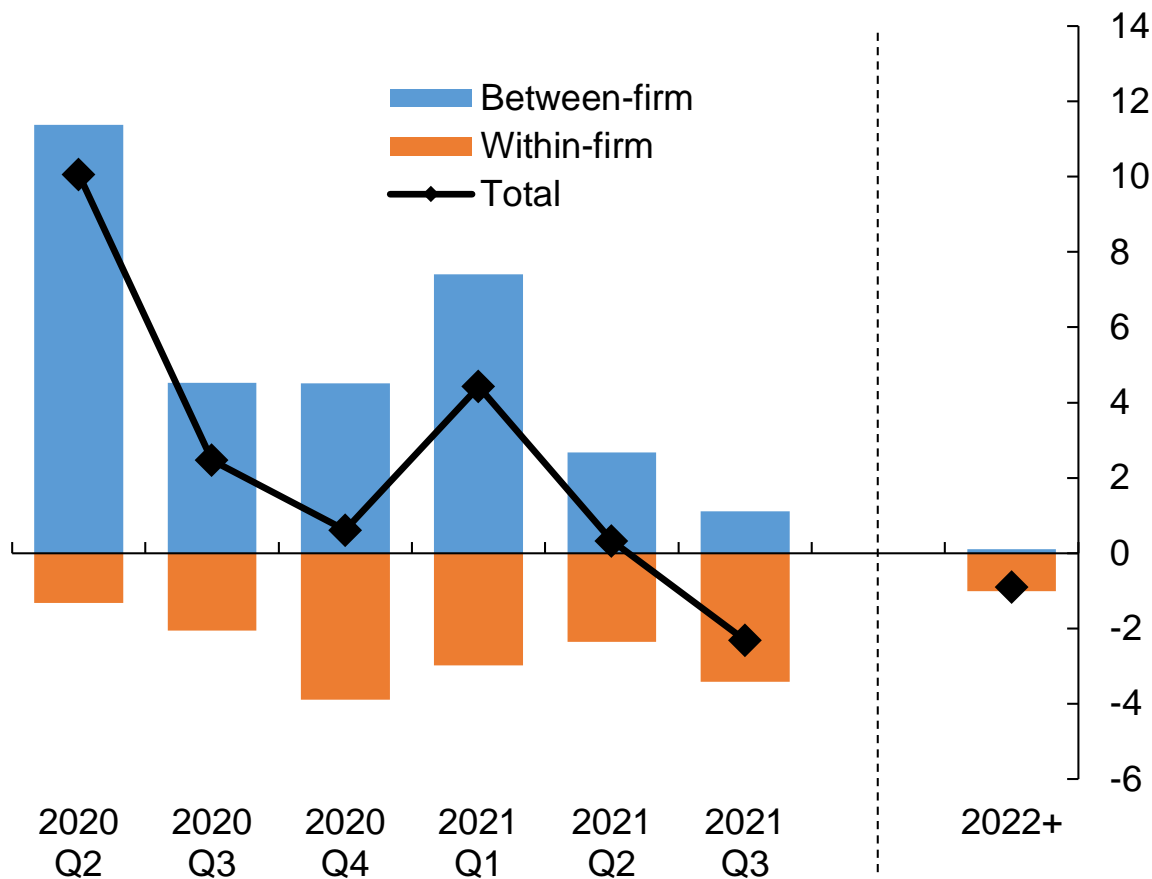


Notes: Based on the question 'Approximately how many hours a week has the CEO of your business spent managing the effects of Covid-19 on your business over the past six months? And how many hours a week do you expect them to spend on this over the next six months?'. Data were collected between November 2020 and January 2021.

Use Survey & Accounting Data to Estimate to impact of Covid-19 on productivity

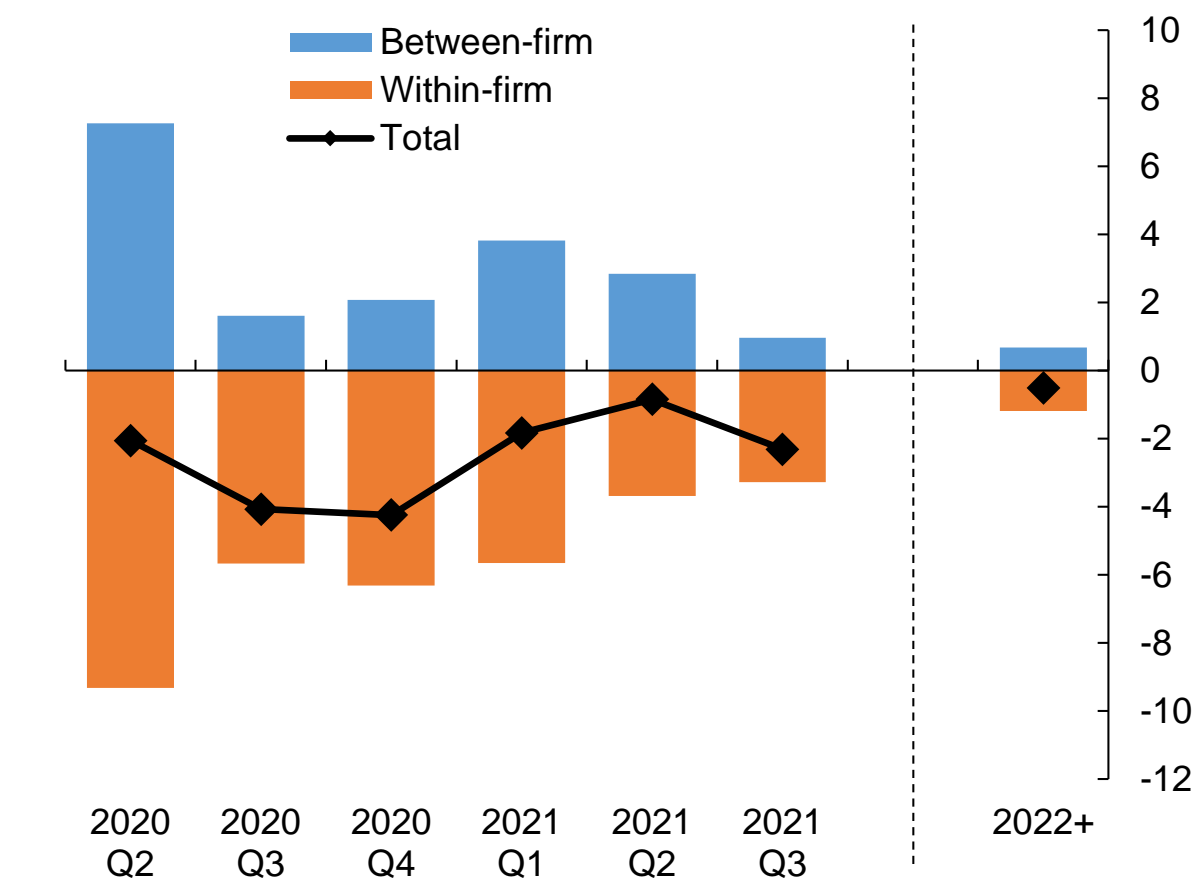
Panel A: Labour productivity per hour

Percentage impact of Covid-19 on labour productivity per hour



Panel B: TFP

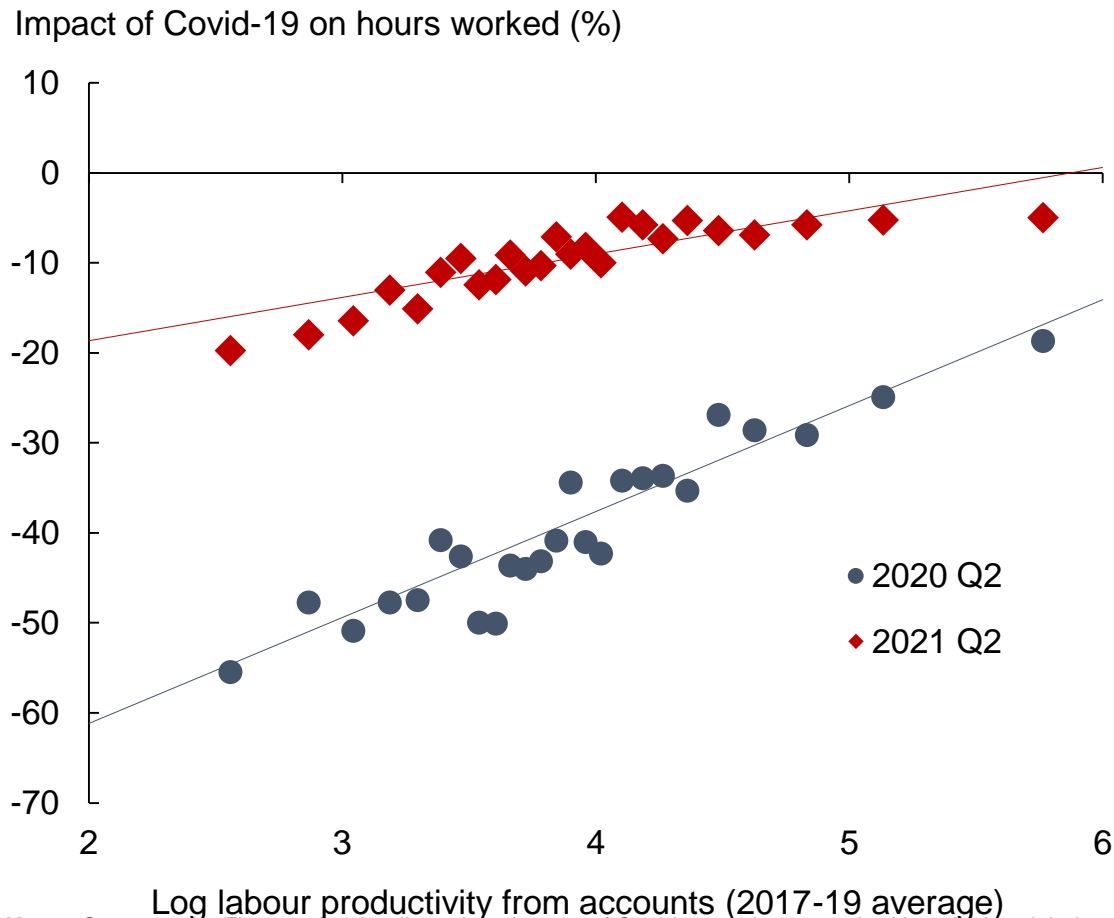
Percentage impact of Covid-19 on TFP



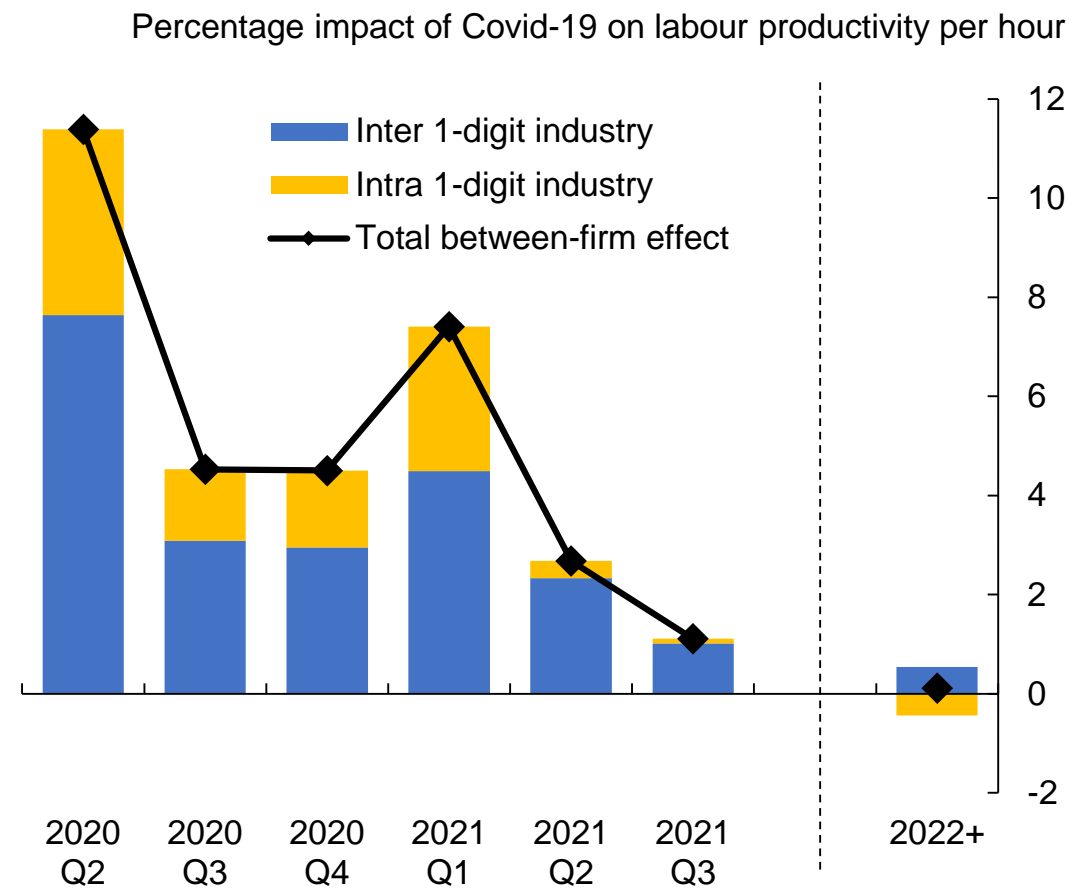
Notes: Impacts on productivity are estimated as $\Delta \Pi_t = \sum_{i \in \text{Surv}} \bar{\varphi}_i \Delta \pi_{i,t} + \sum_{i \in \text{Surv}} \Delta \varphi_{i,t} (\bar{\pi}_t - \bar{\Pi})$ where $\pi_{i,t}$ is productivity in firm i at time t , Π_t is productivity at time t , $\varphi_{i,t}$ is the labour input share of firm i at time t and a bar over a variable indicates the average of the variables across times $t-1$ and t . Changes between t and $t-1$ are changes due to Covid-19 only. The first term represents the within-firm effects. The second term represents between-firm effects. The impact of Covid-19 on labour productivity for each firm is calculated as $\frac{dLP}{LP} = \frac{dY}{Y} - \frac{dP}{P} - \frac{dL}{L} - \frac{dM}{M}$ where $\frac{dM}{M} = \frac{M}{Y-M} \frac{dM^U}{M^U}$. The impact of Covid-19 on TFP for each firm is calculated as $\frac{dTFP}{TFP} = \frac{dY}{Y} - \frac{dP}{P} - \beta \frac{dL}{L} - \alpha \frac{dK}{K} - \frac{dM}{M}$. LP is labour productivity, TFP is total factor productivity, Y is nominal sales, P is the price level, L is labour input, M are non-labour intermediate costs, M^U are intermediate unit costs and K is capital input.

Figure 4: Impact of Covid-19 on between-firm productivity

Panel A: Impact of Covid-19 on hours worked and labour productivity

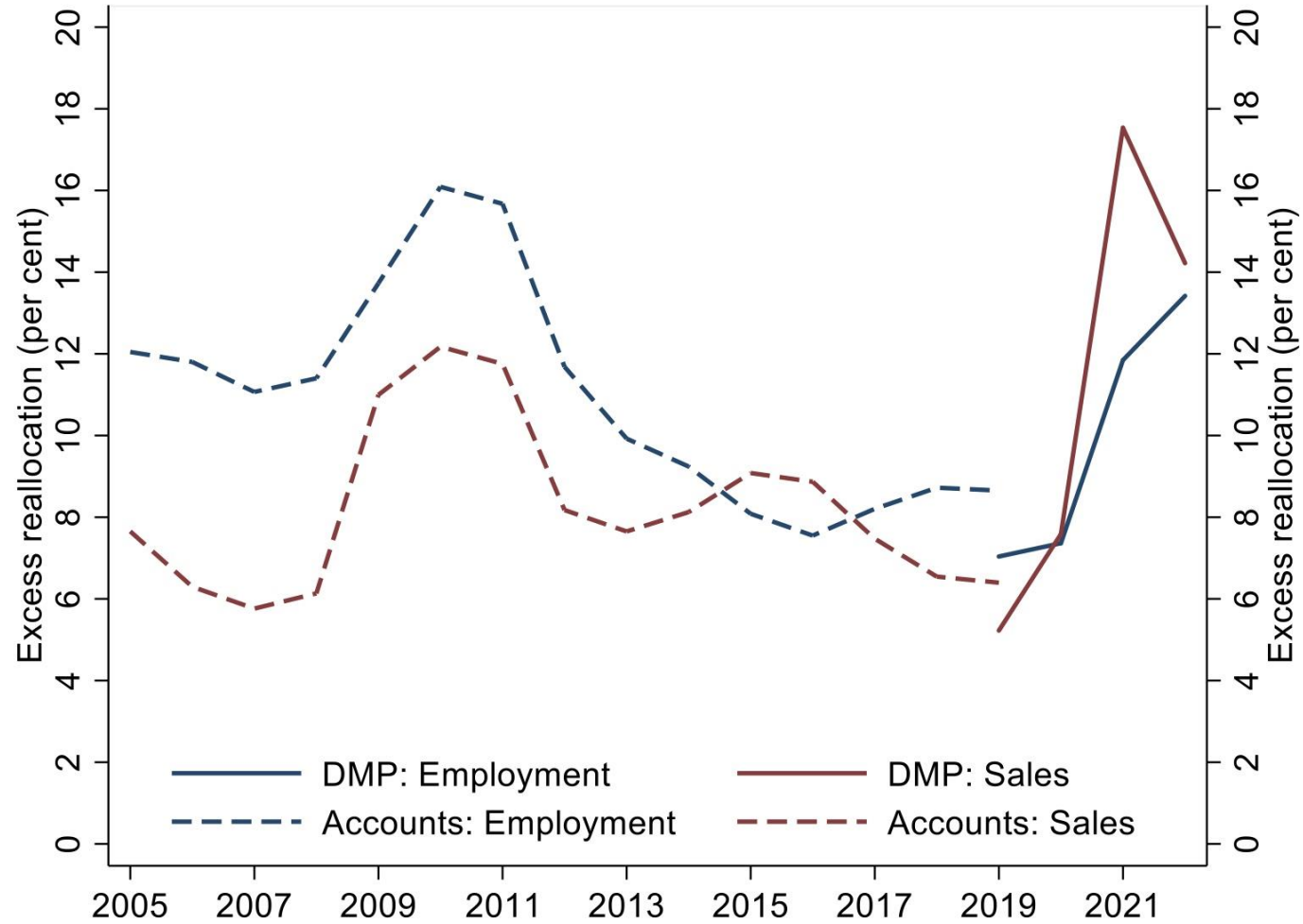


Panel B: Contributions to impact of Covid-19 on between-firm labour productivity per hour

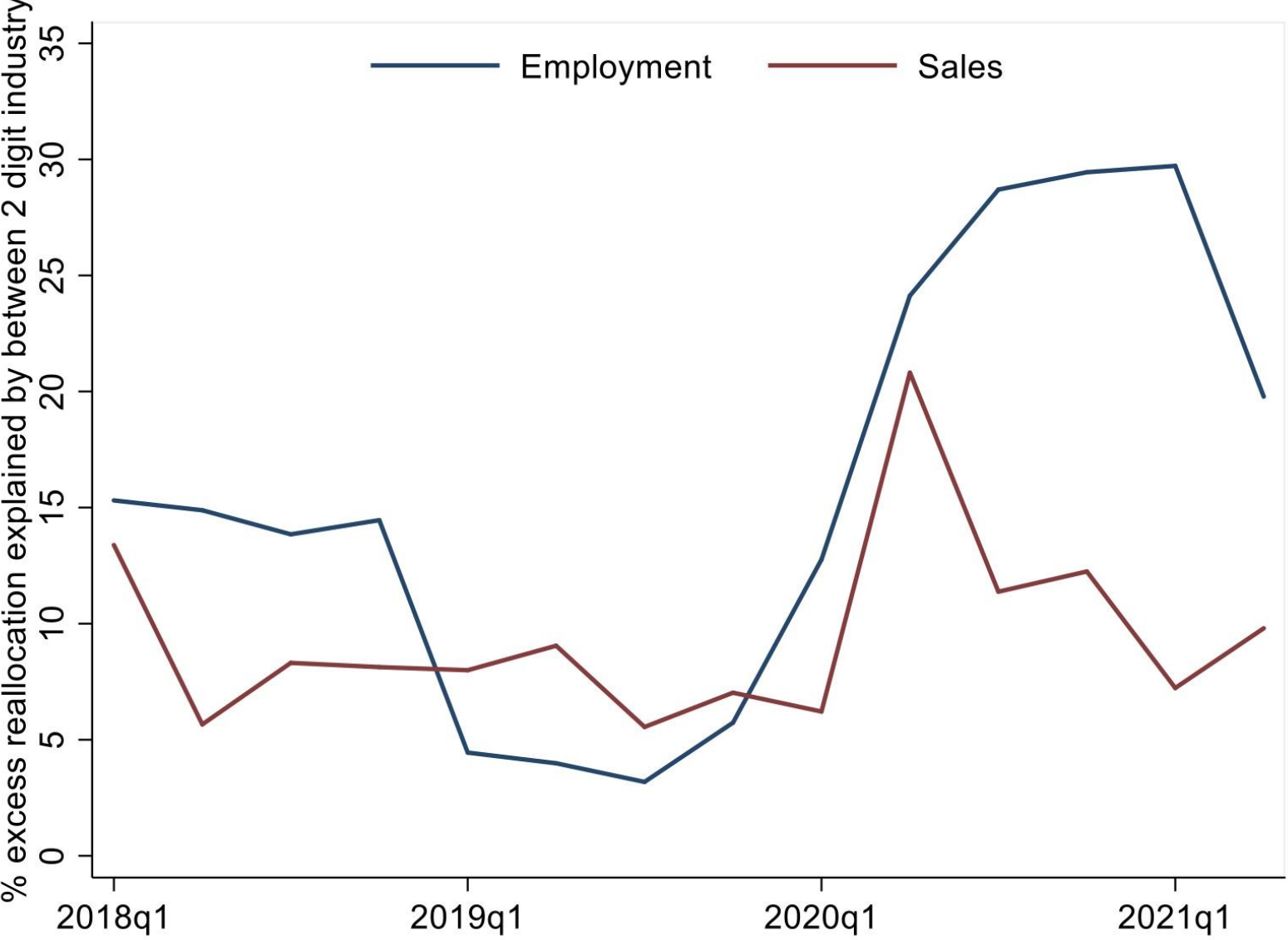


Notes: See notes to Figure 2 for details on how impact of Covid-19 on hours worked is calculated. Labour productivity is defined as real value-added (operating profits plus total labour costs divided by the aggregate GDP deflator) per employee using accounting data from Bureau van Dijk. Between-firm impacts are estimated as $\sum_{i \in \text{Surv}} \Delta \varphi_{i,t} (\bar{\pi}_t - \bar{\pi}) = \sum_{j \in \text{Sectors}} \sum_{i \in \text{Surv}} D_i^j \bar{\rho}_j \Delta \bar{\theta}_{i,t} (\bar{\pi}_i - \bar{\pi}_j) + \sum_{j \in \text{Sectors}} \Delta \rho_{j,t} (\bar{\pi}_i - \bar{\pi})$ where $\pi_{i,t}$ is productivity in firm i at time t , $\varphi_{i,t}$ is the labour input share of firm i at time t , $\bar{\rho}_j$ is sector j 's share of labour input at time t , $\rho_{j,t}$ is the share of firm i 's labour input in its sector at time j , $\theta_{i,t}$ is the share of firm i 's labour input among surviving firms in its sector at time t , $\bar{\pi}_{i,t}$ is productivity of firms in sector j at time t , D_i^j is a dummy variable that takes the value of 1 when firm i is located in sector j , and a bar over a variable indicates the average of the variables across times $t-1$ and t . Changes between t and $t-1$ are changes due to Covid-19 only. The first term on the right hand side represents reallocation effects within industry – intra industry effects. The second term on the right hand side represents reallocation effects between industries – inter industry effects.

Large rise in excess employment and sales reallocation following COVID



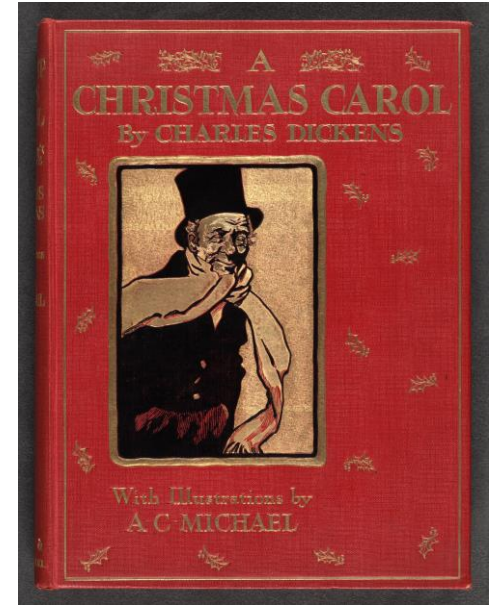
Large rise in fraction of reallocation between industries



Productivity Past

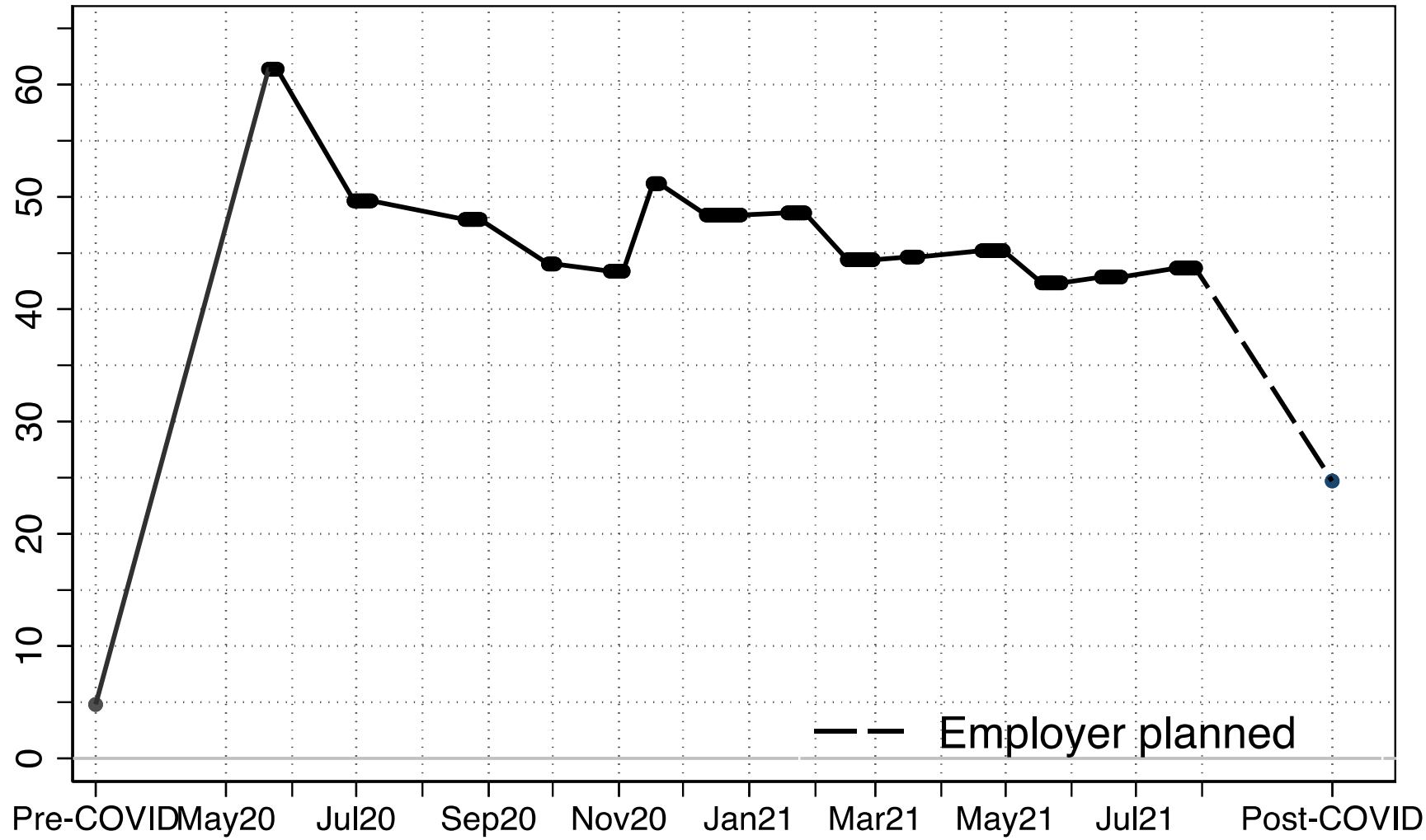
Productivity Present: Covid-19

Productivity Yet to Come



Days WFH go from 5% (pre-COVID) to 50% (now) to ≈25% (post-COVID)

Percentage of paid full days worked from home



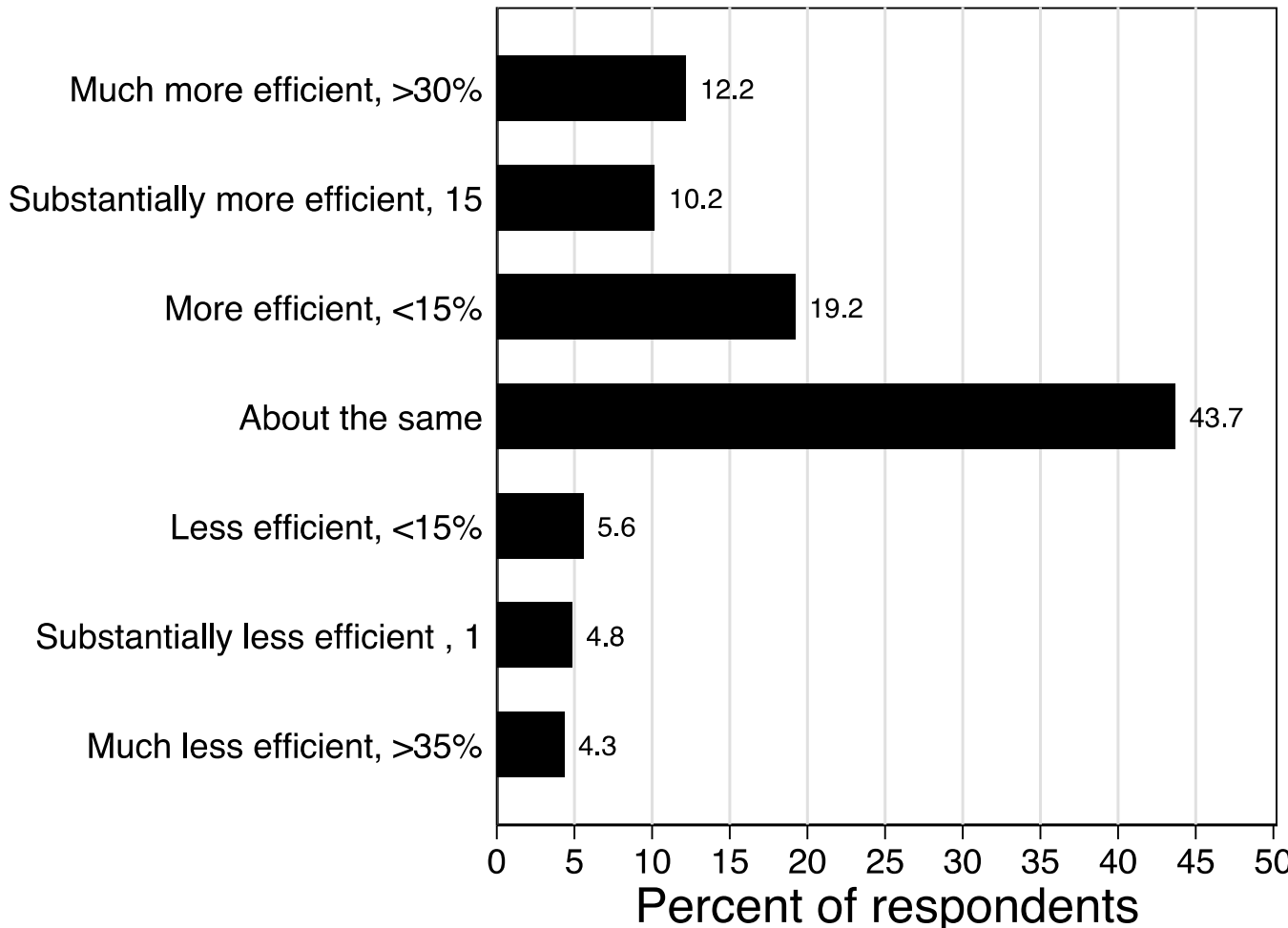
Notes: Data are from the survey waves carried out by QuestionPro and IncQuery with 2,500 to 5000 responses per month. We re-weight raw responses to match the share of working age respondents in the 2010-2019 CPS in each {industry x state x earnings} cell.

Source: “Why working from home will stick”, Jose Barrero, Nick Bloom and Steve Davis (2021, NBER WP)

*Pre-COVID estimate taken from the 2017-2018 American Time Use Survey

**Post-COVID estimate based on the latest survey wave

Growth - WFH could potentially raise productivity by 3%-5%

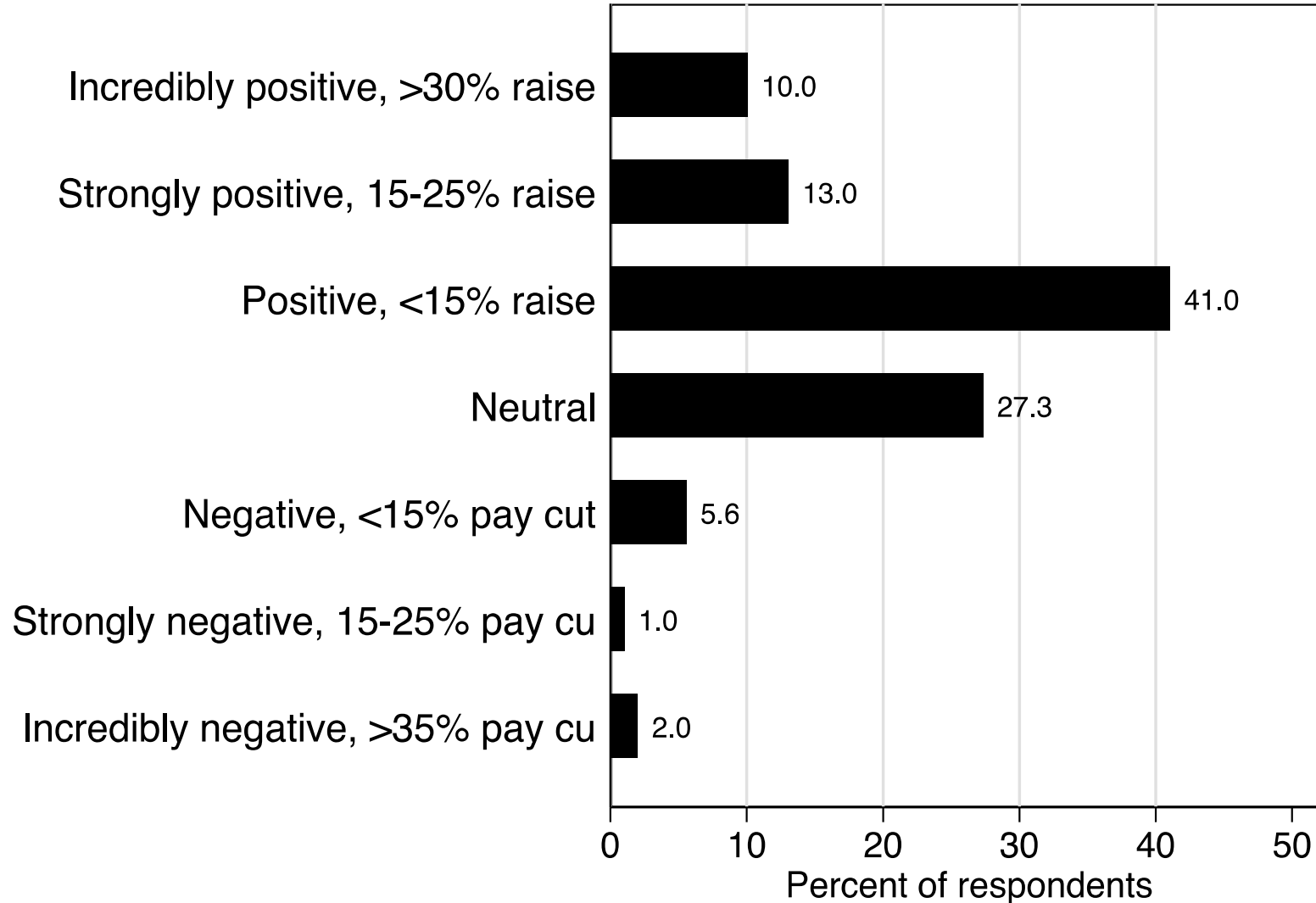


How does your efficiency working from home ***during the COVID-19 pandemic*** compare to your efficiency working on business premises ***before the pandemic?***

Notes: From August to October 2020, we surveyed 7,500 Americans aged 20-64 with labor earnings > \$20,000 in 2019. We re-weight raw responses to match the industry-state-earnings shares of working-age persons in the CPS from 2010 to 2019. The right chart also uses responses to questions about employment status (selection), pay levels (for earnings weights) and, for the blue bar, how much their employer plans for them to work from home after the pandemic ends. **Source:** "Working from Home Will Stick" by Jose Maria Barrero, Nick Bloom and Steven J. Davis, October 2020.

Inequality - Working from Home is a Valuable Perk

Value of the option to WFH 2 - 3 days/wk, % of current pay?



Response to a two-part question.

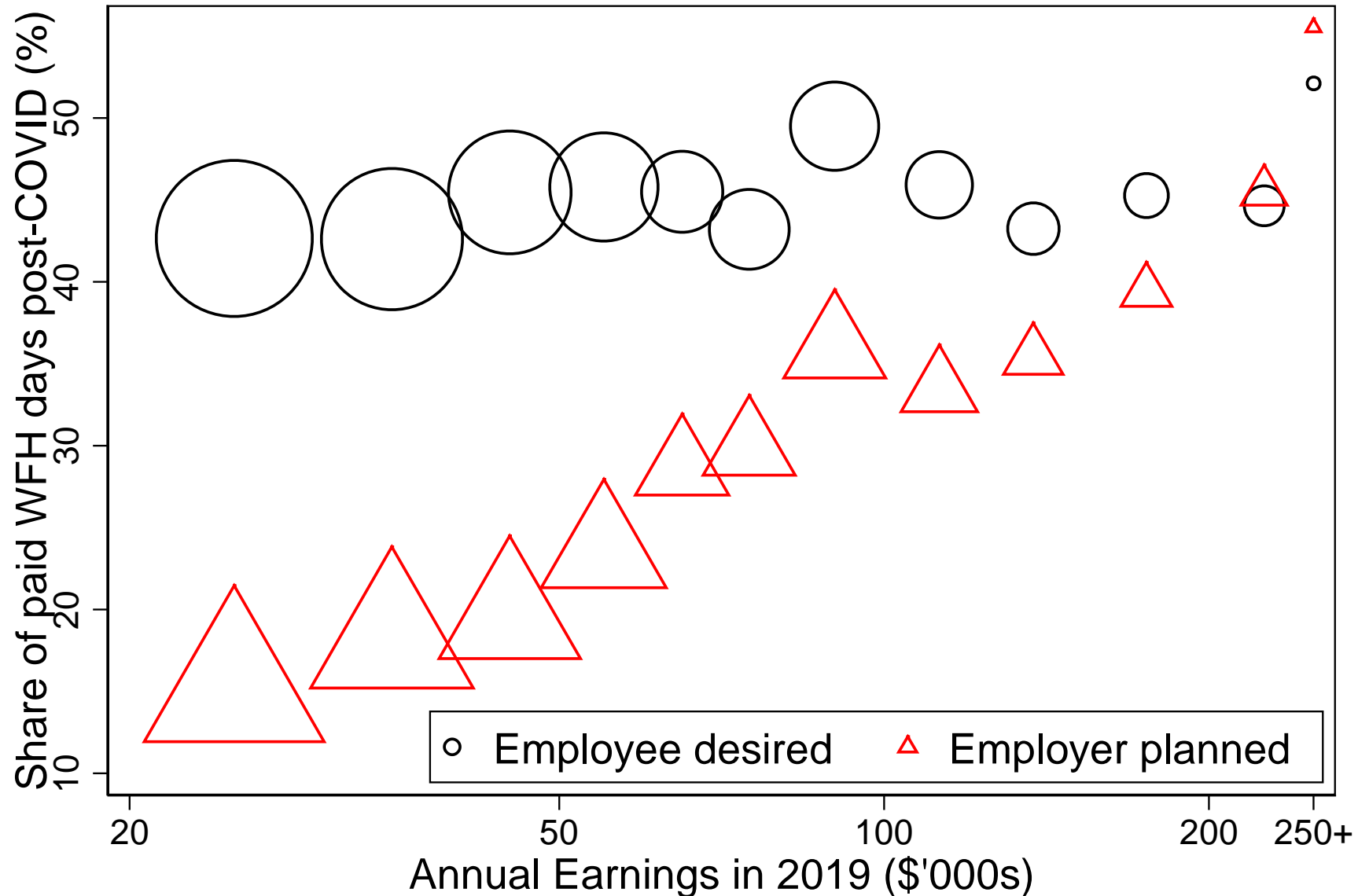
Part 1: “**After COVID, in 2022 and later**, how would you feel about working from home **2 or 3 days** a week?”

- Positive: I would view it as a benefit or extra pay
- Neutral
- Negative: I would view it as a cost or a pay cut

Part 2: “How much of a **pay raise [cut]** (as a percent of your current pay) would you value as much as the option to work from home 2 or 3 days a week?”

Source: “Working from Home Will Stick” by Jose Maria Barrero, Nick Bloom and Steven J. Davis, October 2021.

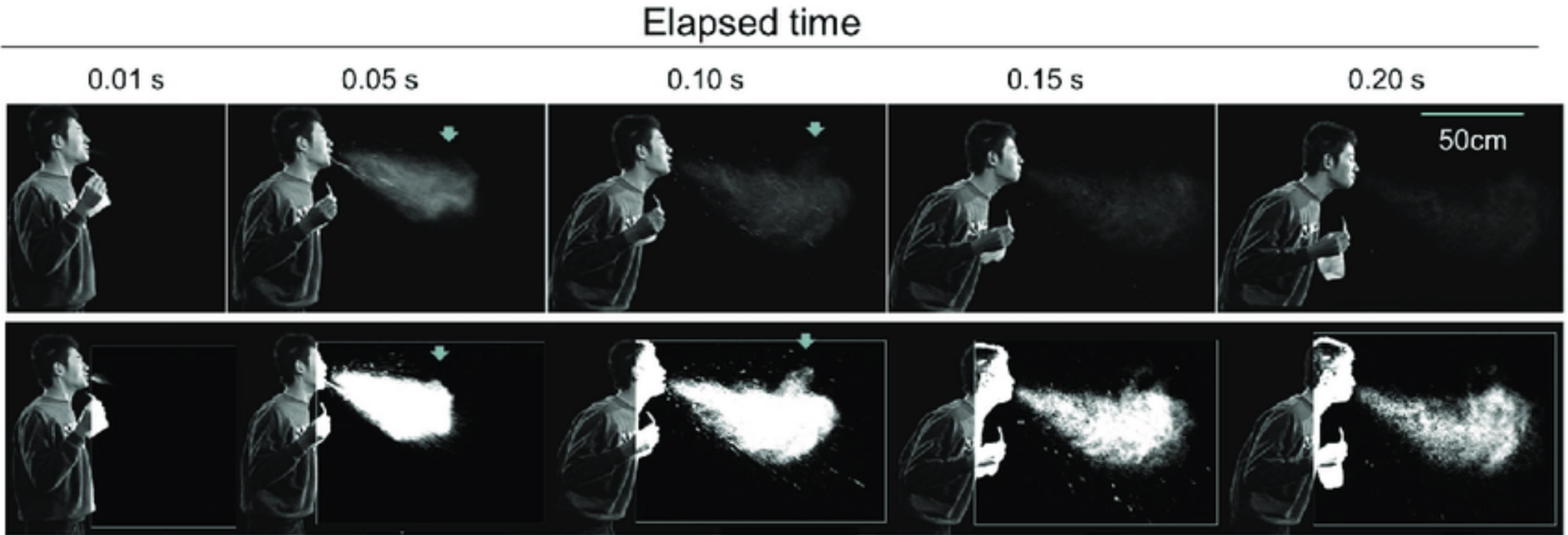
Inequality – Mostly Higher Paid Employees Get to WFH



Notes: Data are from four survey waves carried out by QuestionPro and IncQuery in May, July, August, and September/October 2020 with 2,500 responses in the first two and the last, plus 5,000 in August. We re-weight raw responses to match the share of working age respondents in the 2010-2019 CPS in each {industry x state x earnings} cell.

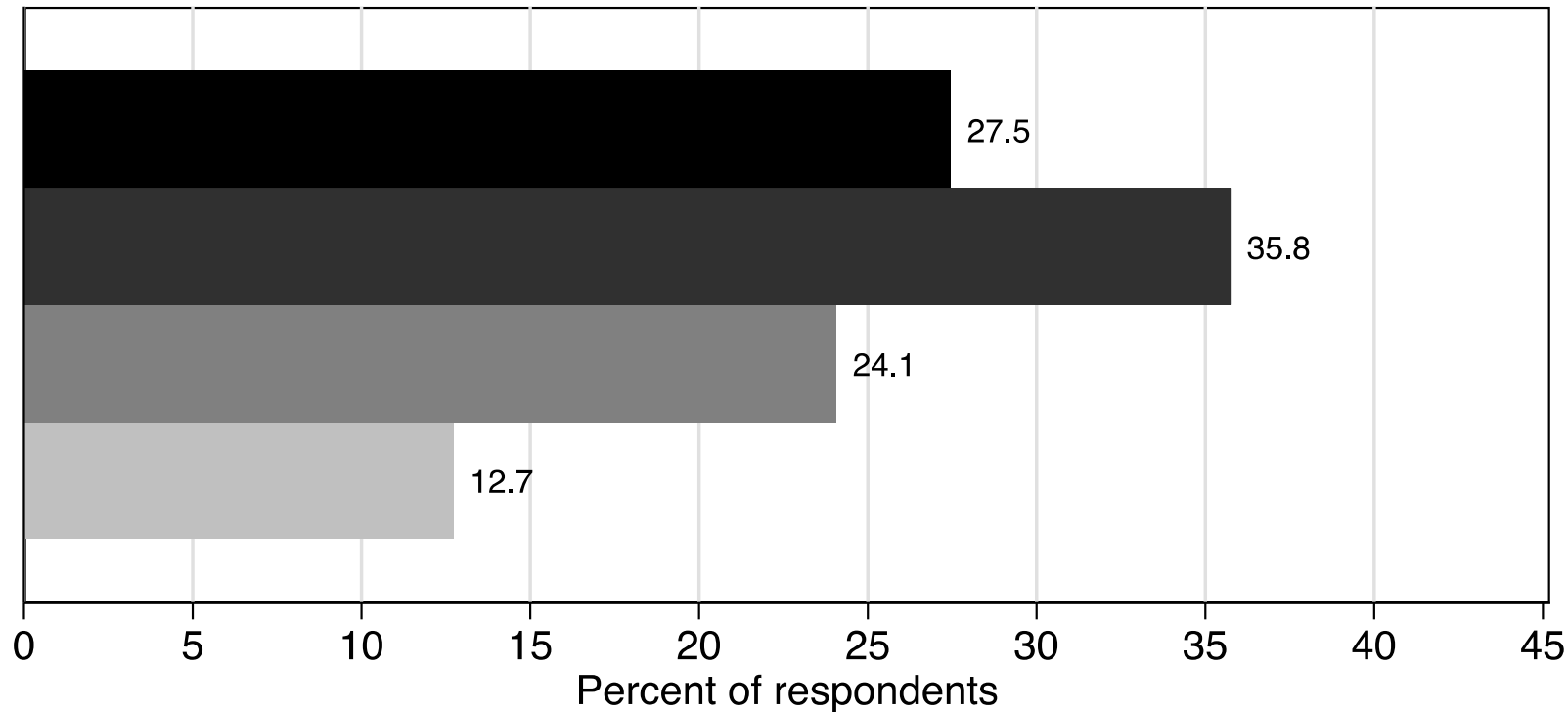
Note: Marker size is proportional to the number of respondents per income level.

Density - Residual Fear of Proximity to Other People...

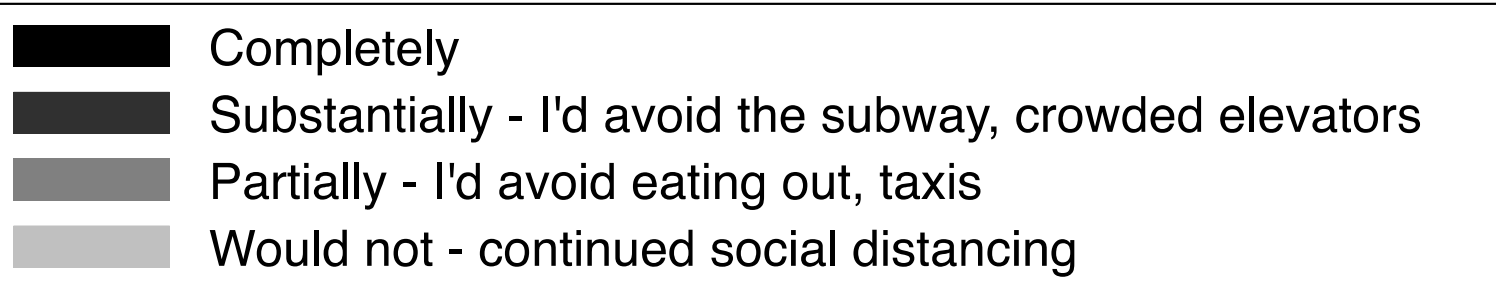


Source: Nishimura, Sakata and Kaga (2013, PLoS ONE), "A New Methodology for Studying Dynamics of Aerosol Particles in Sneeze and Cough Using a Digital High-Vision, High-Speed Video System and Vector Analyses"

....and this Residual Fear of Proximity to Other People May Stick



Which of the following would best fit your views on return to activity post-pandemic (in 2022+)?



Notes: Data are from four survey waves carried out by QuestionPro and IncQuery in May, July, August, 2021. We re-weight raw responses to match the share of working age respondents in the 2010-2019 CPS in each {industry x state x earnings} cell.

Density – it makes me wonder longer-run TFP impact that will have



In summary, we do not see any long-run productivity boosters

- Productivity will not move much due to COVID (costs and WFH roughly offset)
- Hence, the short-run COVID-era burst in productivity will be reversed (“corrected”)
- So looking forward hours will rise faster than GDP, so TFP growth will slow (reverse)
- Of course we could be wrong: robots/AI/VR/apps may generate a TFP revolution...
....but they do not happen often (twice since 1750) so we’re not optimistic

