

ONLINE APPENDIX

Earnings Business Cycles: The Covid Recession, Recovery, and Policy Response

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APPENDIX A: Supplemental Tables and Figures

Table A1. Share of workers with real earnings at pre-recession level or higher, by income quintile

	Market earnings			With relief			Change from relief		
	Bottom quintile	Middle quintile	Top quintile	Bottom quintile	Middle quintile	Top quintile	Bottom quintile	Middle quintile	Top quintile
2001 recession									
2000 to 2001	48.7	54.8	52.5	52.2	57.2	53.9	3.5	2.3	1.4
2000 to 2002	47.2	55.4	52.5	47.8	56.1	52.7	0.6	0.7	0.2
2000 to 2003	45.5	53.6	50.6	46.0	54.2	50.7	0.5	0.6	0.1
2008 recession									
2007 to 2008	46.9	47.0	46.8	48.4	51.8	49.3	1.5	4.8	2.6
2007 to 2009	42.8	47.4	47.6	52.3	49.8	48.5	9.5	2.4	0.9
2007 to 2010	41.9	45.8	46.8	47.7	47.7	47.5	5.8	1.9	0.7
2020 recession									
2019 to 2020	40.9	53.8	56.7	71.7	73.3	61.3	30.8	19.5	4.6
2019 to 2021	44.5	52.8	50.5	69.1	65.1	54.5	24.6	12.3	4.0
2019 to 2022	49.1	52.5	45.0	49.2	52.7	45.1	0.1	0.1	0.1

Note: Among workers aged 24 to 99 with earnings or unemployment benefits in pre-recession year and alive at end of specific year. Earnings are indexed with the chained CPI-U. *Source:* Authors' calculations using tax data.

Table A2. Median real earnings relative to pre-recession year, by income quintile

	Market earnings			With relief			Change from relief		
	Bottom quintile	Middle quintile	Top quintile	Bottom quintile	Middle quintile	Top quintile	Bottom quintile	Middle quintile	Top quintile
2001 recession									
2000 to 2001	-8.8	0.7	-1.1	-2.4	1.0	-0.4	6.4	0.4	0.7
2000 to 2002	-19.0	0.5	-2.2	-11.4	1.5	-1.2	7.5	1.0	1.0
2000 to 2003	-24.7	1.1	-2.0	-23.7	1.1	-2.4	1.0	0.0	-0.4
2008 recession									
2007 to 2008	-8.1	-1.7	-2.1	-1.9	-0.6	-1.6	6.2	1.1	0.5
2007 to 2009	-36.2	-3.6	-3.7	-16.3	-2.3	-3.2	19.9	1.3	0.4
2007 to 2010	-48.4	-4.6	-4.4	-23.8	-3.5	-4.0	24.6	1.1	0.4
2020 recession									
2019 to 2020	-30.6	-0.2	0.3	65.9	8.8	1.8	96.5	9.0	1.5
2019 to 2021	-25.6	0.9	-0.8	63.9	7.8	0.6	89.4	6.9	1.4
2019 to 2022	-1.7	2.0	-2.1	-1.8	2.0	-2.1	-0.1	-0.1	0.0

Note: Among workers aged 24 to 99 with earnings or unemployment benefits in the pre-recession year and alive at end of specific year. Earnings are indexed with the chained CPI-U. Small negative changes from relief result from reranking between distribution of market earnings without and with relief. *Source:* Authors' calculations using tax data.

Table A3. Decomposition of share of workers with at least a 10% real earnings decline (2019-2021)

		All working-age adults	Among the bottom quintile	Among the top quintile	All working-age adults	Among the bottom quintile	Among the top quintile
		A: 2019–2020 (1-year)			B: 2019–2021 (2-year)		
Total Change (pp)		-14.3	-28.0	-2.2	-9.3	-22.9	-1.6
Share of change	Unemployment Ins.	65%	53%	50%	41%	42%	22%
	Stimulus checks	35%	47%	50%	50%	52%	56%
	Advanced CTC	---	---	---	8%	6%	22%
	Total	100%	100%	100%	100%	100%	100%
		C: 2019–2021 (2-year): No dependents			D: 2019–2021 (2-year): With dependents		
Total Change (pp)		-7.9	-19.5	-1.1	-11.8	-29.0	-2.6
Share of change	Unemployment Ins.	44%	42%	29%	33%	38%	12%
	Stimulus checks	54%	57%	69%	50%	48%	58%
	Advanced CTC	1%	1%	3%	17%	14%	31%
	Total	100%	100%	100%	100%	100%	100%

Note: Among workers ages 24 to 99 with wages or unemployment insurance in the initial year (t–1 or t–2) and alive at end of final year. Quintiles are based on wages in the initial year. Children include dependents younger than 17 years old claimed on tax returns.

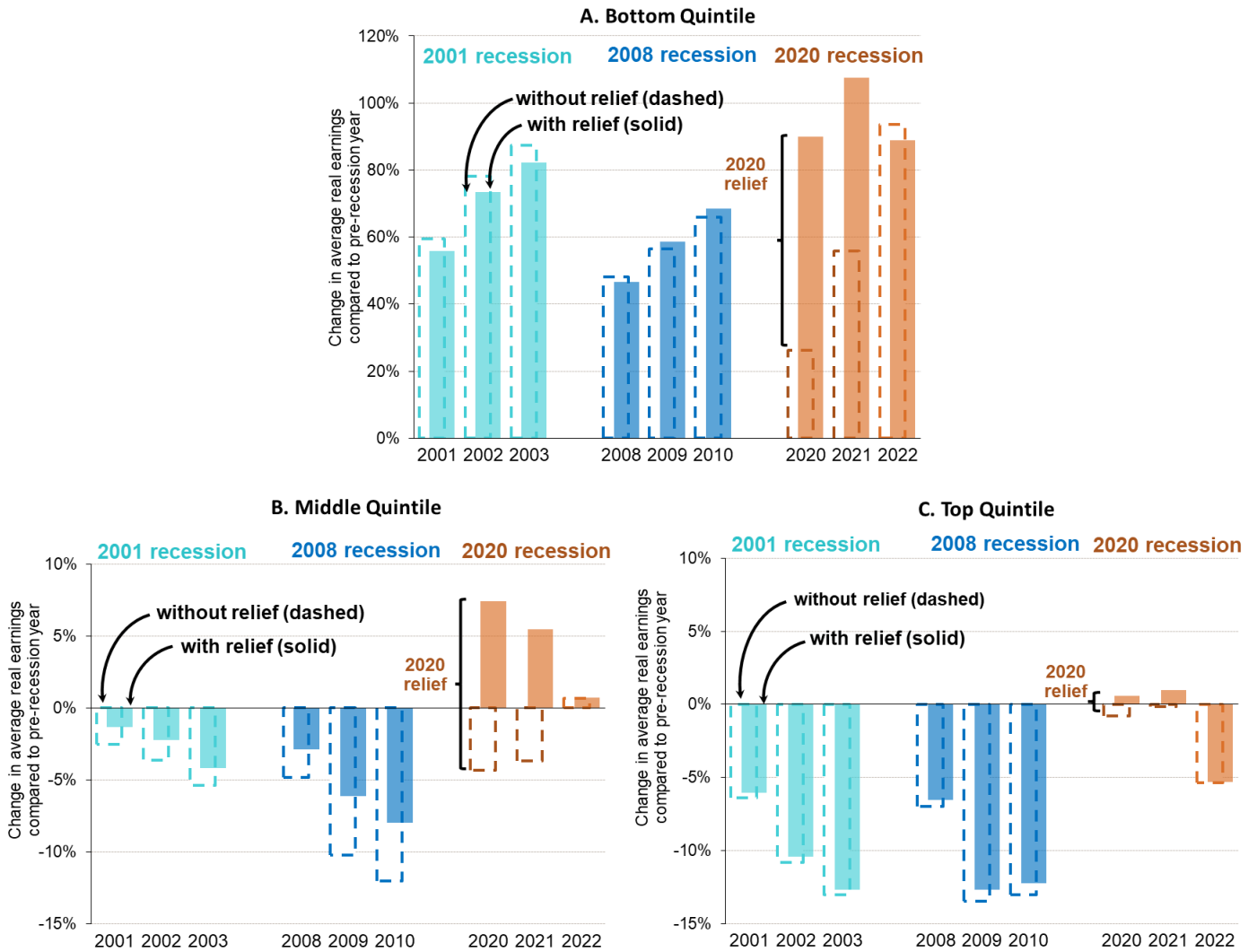
Source: Authors' calculations using tax data.

Table A4. Median real earnings changes using alternate data sources, by earnings quintile

	2019-20	2020-21	2020-22	2019-21	2019-22
IRS (Panel labor earnings, medians)					
Bottom Quintile	-30.6	7.3	32.0	-25.6	-1.7
2nd Quintile	-3.9	5.5	5.6	1.4	7.0
3rd Quintile	-0.2	1.1	1.1	0.9	2.0
4th Quintile	0.5	0.0	-0.5	0.5	0.0
Top Quintile	0.3	-1.1	-1.3	-0.8	-2.1
IRS (Cross-sectional labor earnings, medians)					
Bottom Quintile	-17.8	17.3	7.6	-3.7	3.7
2nd Quintile	-4.9	10.1	2.3	4.6	7.1
3rd Quintile	0.1	3.8	1.1	3.9	5.1
4th Quintile	1.4	1.8	0.8	3.2	4.0
Top Quintile	2.3	1.3	0.5	3.6	4.1
CPS (Cross-sectional wage earnings, medians)					
Bottom Quintile	-13.9	19.7	---	3.0	---
2nd Quintile	-1.1	8.5	---	7.3	---
3rd Quintile	1.0	-0.3	---	0.7	---
4th Quintile	1.5	-0.9	---	0.7	---
Top Quintile	-1.1	3.7	---	2.6	---
BSZ (Cross-section labor earnings, mean including zeros)					
Bottom Quartile	---	---	---	---	---
2nd Quartile	-6.4	8.5	5.5	1.6	7.2
3rd Quartile	0.5	2.0	0.6	2.5	3.1
Top Quartile	0.9	4.0	-0.1	4.9	4.7

Note: IRS panel results are among workers aged 24 to 99 with earnings or unemployment benefits in pre-recession year and alive at end of specific year. IRS cross-sectional results are among workers aged 24 to 99 and alive at end of the year who had earnings in the current year, with no restrictions on earnings in prior years. Panel data includes the same workers throughout each period while cross-section data has different workers in the bottom or top quintile each year due to mobility. CPS cross-sectional results are among workers aged 25 and older and include wage and salaries income reported on the survey. CPS results are only available through 2021. Blanchet, Saez, and Zucman (BSZ, 2022) cross-section results are for labor earnings among working-age adults (ages 20-64), including those with zero earnings. We omit the BSZ bottom quartile results because they caution that since many bottom quartile individuals have zero earnings, results for that segment of the population are volatile.

Figure A1. Average real earnings relative to pre-recession year, by income quintile



Note: Among workers aged 24 to 99 with earnings or unemployment benefits in the pre-recession year and alive at end of specific year. Earnings are indexed with the chained CPI-U.

Source: Authors' calculations using tax data.

Figure A2: Entry rates: Share of final-year workers without any earnings in prior year

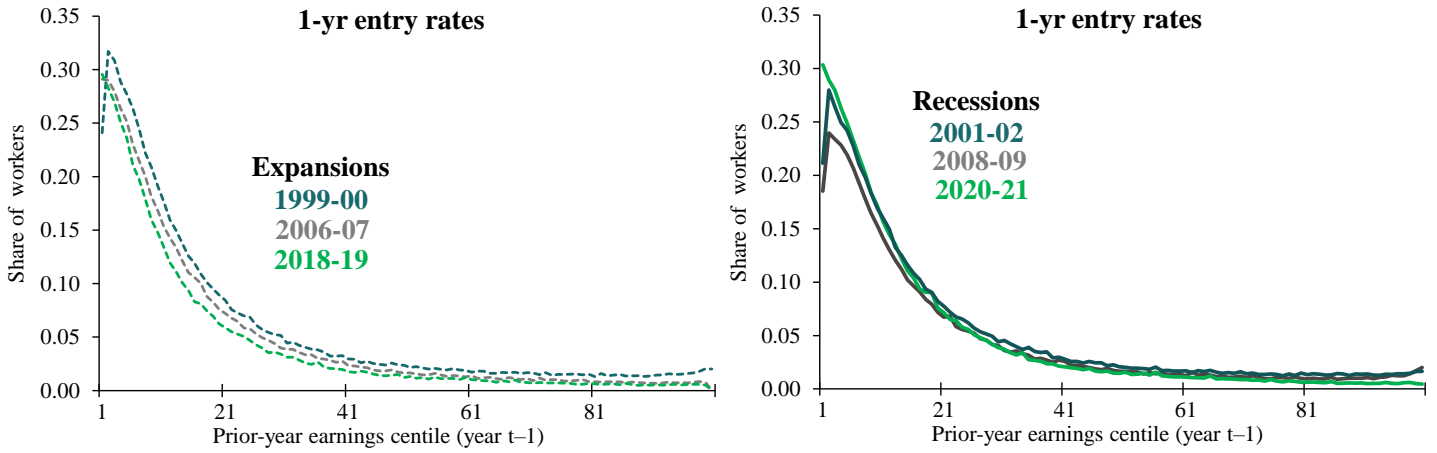
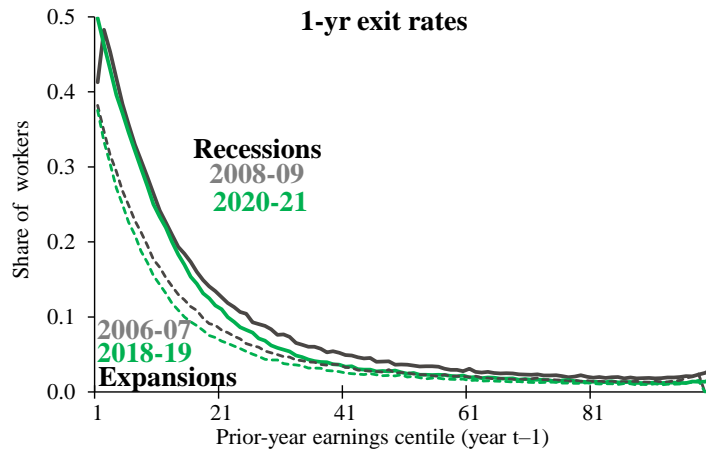
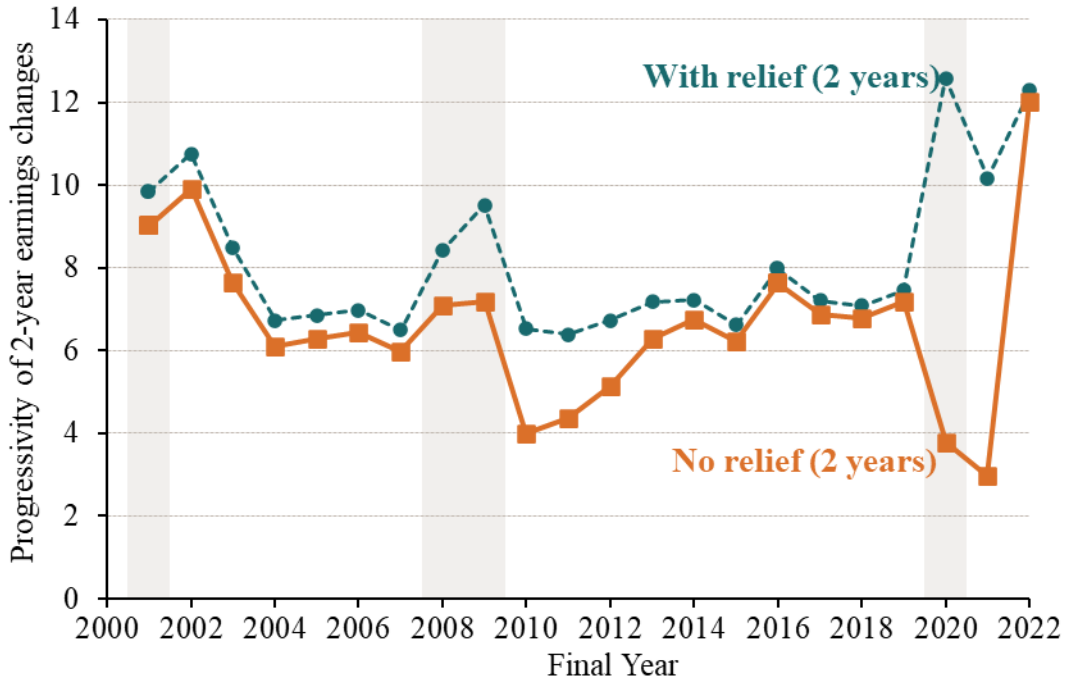
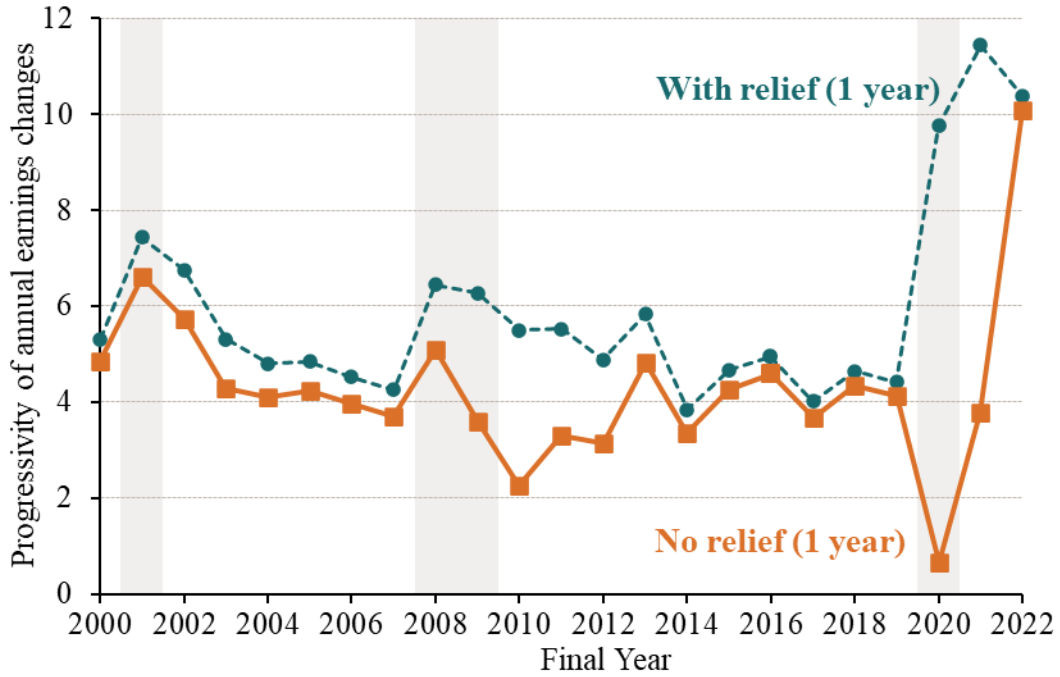


Figure A3: Exit rates: Share of initial-year workers without any earnings in next year



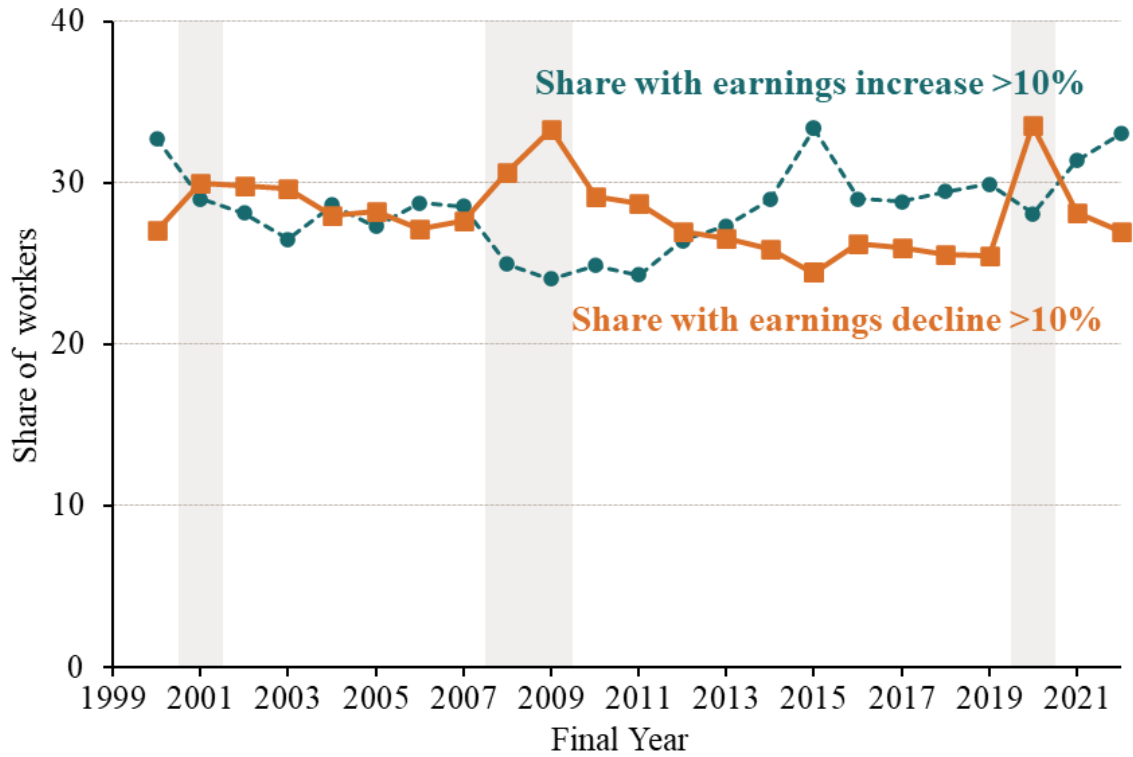
Note: Entry includes adults with no initial-year earnings and any next-year earnings. Exit includes adults with any initial-year earnings and no next-year earnings. Relative to earnings if adults worked the entire year, part-year employment increases the share of entry and exit appearing at the bottom of the earnings distribution. Among those aged 24 to 99 and alive at end of next year. *Source:* Authors' calculations using tax data.

Figure A4: Progressivity of earnings changes with and without fiscal relief



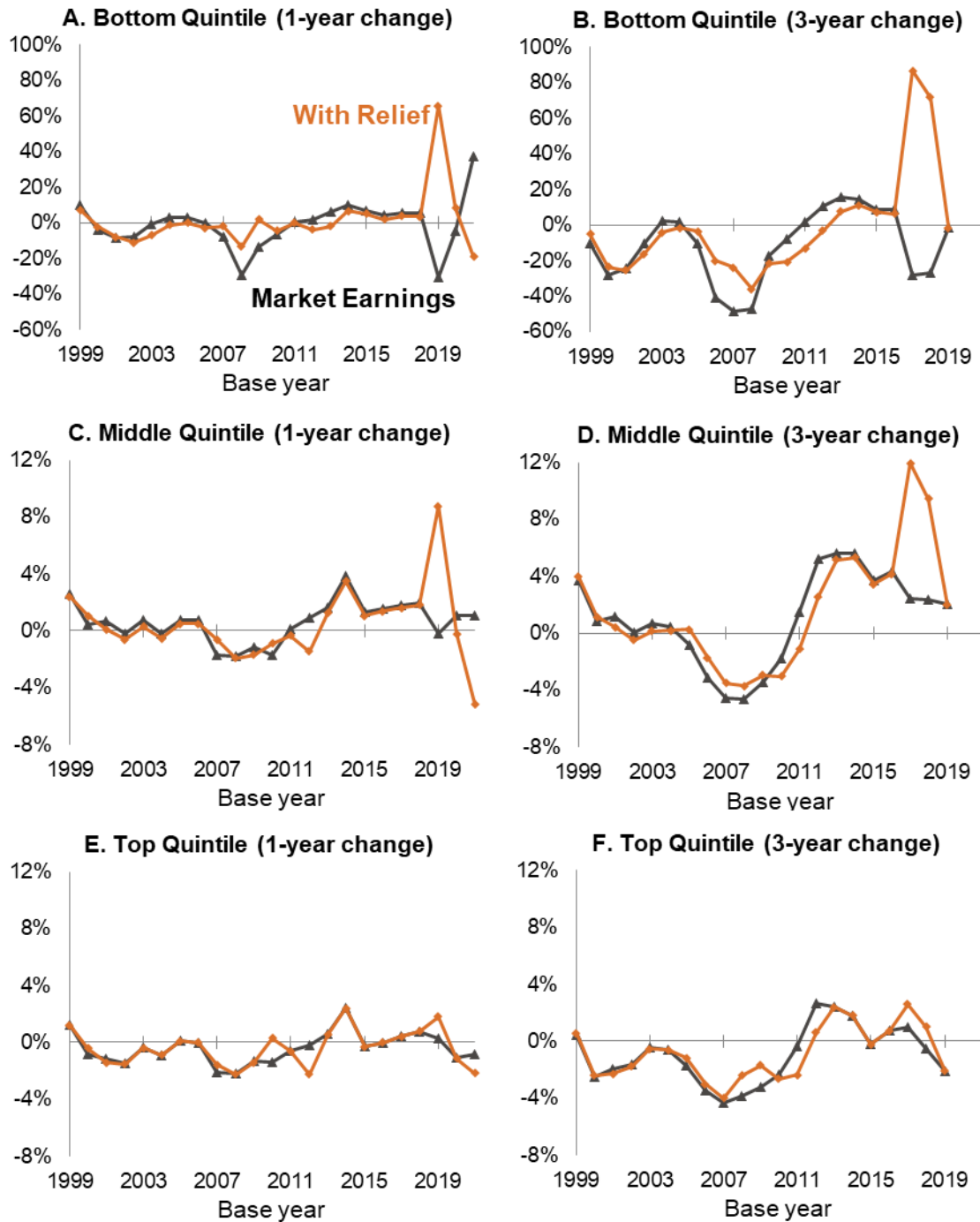
Note: Among workers aged 24 to 99 with earnings or unemployment benefits in pre-recession year and alive at end of specific year. The progressivity of earnings changes is defined as the initial-year Gini coefficient of earnings (with or without relief) less the final-year concentration index (essentially the final-year Gini but ranking workers by initial-year earnings) divided by the initial-year Gini coefficient. *Source:* Authors' calculations using tax data.

Figure A5: Share of workers with real annual earnings changes of at least 10%



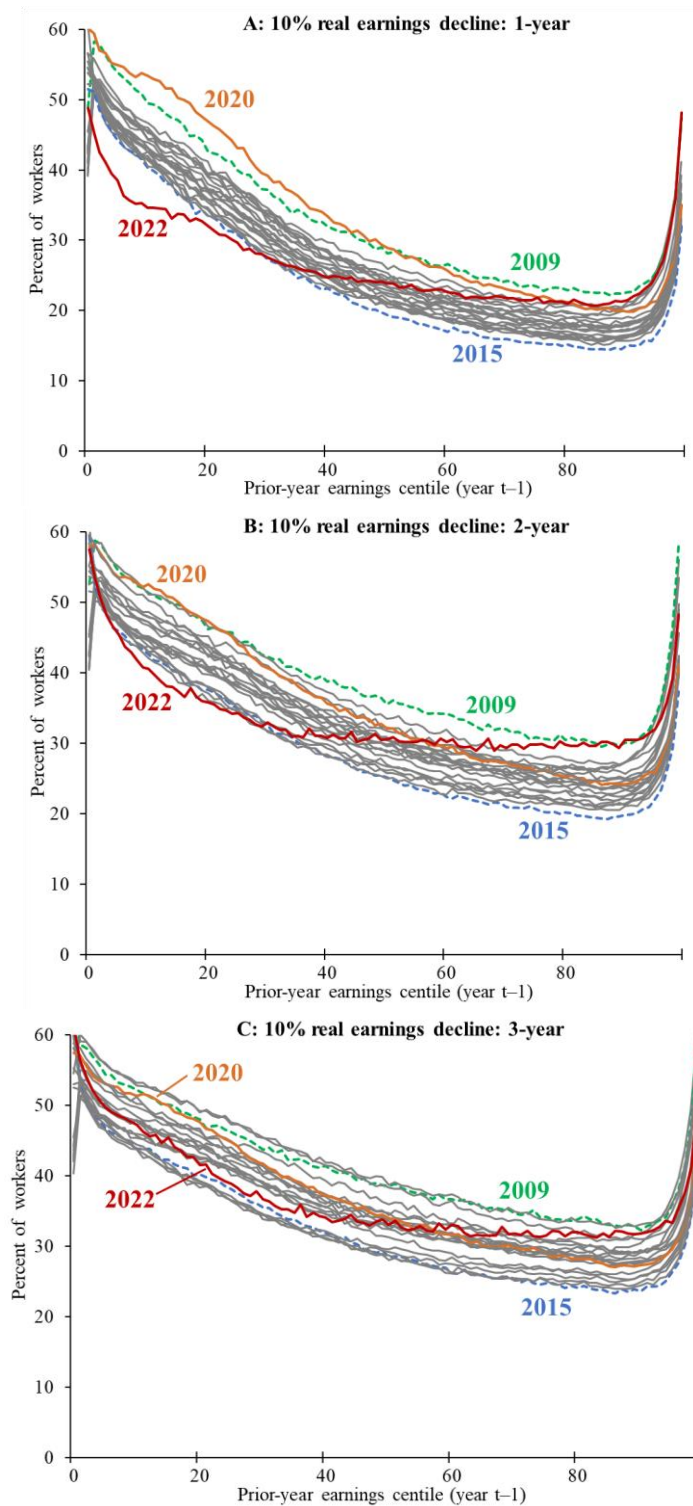
Note: Among workers aged 24 to 99 with earnings or unemployment benefits in year $t-1$ and alive at end of next year. Earnings are indexed with the chained CPI-U. Shaded years have NBER-designated recessions anytime during the year. *Source:* Authors' calculations using tax data.

Figure A6. Percentage Change in Real Median Earnings with and without Fiscal Relief from Base Year to One or Three Years Later, by Earnings Quintile



Note: Among workers aged 24 to 99 with earnings or unemployment benefits in the pre-recession year and alive at end of specific year. Earnings are indexed with the chained CPI-U. Quintiles (with and without relief) are based on wages in the specified base year. *Source:* Authors' calculations using tax data.

Figure A7: Share of workers with large real earnings decline by final year



Note: Among workers aged 24 to 99 with earnings or unemployment income in the initial year ($t-1$, $t-2$, or $t-3$) and alive at end of final year. Percentiles are based on wages in initial years. Earnings are indexed with the chained CPI-U. *Source:* Authors' calculations using tax data.

APPENDIX B: Imputation Procedure for Late 2022 Form W-2 Data

This appendix describes our procedure to account for yet-to-be-processed Form W-2s for 2022. The W-2 data underlying the analysis in this paper is a 5-percent sample drawn from all W-2 forms processed by the IRS on or before June 2nd, 2023. Form W-2 data currently spans tax years from 1999 to 2022 and includes a processing date. We use patterns in W-2 processing in the two prior years, 2020 and 2021, to impute missing data for individuals that received W-2s in 2022 that have not been processed. As of June 2nd, 2023, there were 260.7 million W-2 forms for tax year 2022. At the same point in 2022 (2021), there were 245.5 (234.5) million W-2 forms from tax year 2021 (2020), which was 94.5 (94.6) percent of all W-2 forms for that year. Note that by June 2023, more Form W-2s were observed for 2022 than for all of 2020 or 2021, that is, including late-filed forms for those earlier years. The imputation procedure consists of three steps.

The first step generates a prediction for whether a given individual is likely to receive a W-2 after a given date. We estimate a logistic regression, with “received at least one W-2 after date D ”—referred to in this appendix as a “late W-2”—as the dependent variable, and \$4,000-wide prior-year W-2 wage bins, single-year age bins, and an indicator for receiving a Form W-2 prior to date D as the dependent variables. These regressions are estimated using Form W-2 data from tax years 2020 and 2021, and D corresponds to June 2nd, 2021 (for the tax year 2020 data), or June 2nd, 2022 (for the tax year 2021 data), where all dollar amounts are inflation-adjusted to 2022 price levels using chained-CPI.

The coefficient estimates are then used to generate predicted values for individuals in 2022, including individuals who have received a W-2 in that year and many who have not received a Form W-2 yet in the year. A random number is drawn for each of these individuals from a uniform distribution ranging from 0 to 1, and if the random number is below the predicted probability of receiving at least one late W-2 the individual is assigned a late W-2. Approximately 347,000 individuals (unweighted in a 5-percent sample, so representing about 6,940,000 individuals) are assigned late W-2s. This is below the 597,000 individuals that received W-2s processed after June 2nd in tax year 2020 and 543,000 in 2021, an indication that IRS may have increased the speed at which W-2s are processed. The remaining steps determine the amounts of wages corresponding with the assigned late W-2s.

The second step splits late W-2 recipients into four bins by the amount of wages contained on late W-2s. The distribution of these wages is highly right-skewed, with a large amount of W-2s with small dollar amounts. Reflecting this distribution, the four late W-2 wage bins are: \$1 to \$2,000; \$2,001 to \$20,000; \$20,001 to \$100,000; and \$100,001 or more. Using data from tax years 2020 and 2021, we estimate an ordered logistic regression where the dependent variable is a binned variable described in the preceding sentence, with the same independent variables that were used in the first step’s regression.

We use the estimated coefficients to produce predicted probabilities for individuals assigned a late-processed W-2 in the first step, with a separate predicted probability for each individual for each of the four bins. Next, we randomly assign individuals to late W-2 wage bins based on their predicted probabilities. To accomplish this, we calculate “cumulative” probabilities—the probability of belonging to the first bin, probability of belonging to the first or second bin, and

probability of belonging to the first, second, or third bin—to partition the 0 to 1 range in four separate regions representing each of the four bins. We then draw a random number from 0 to 1 and for each individual and assign them a late W-2 wage bin based on which region containing their random number. Table B.1 contains a summary of the assignment produced in this step, as well as the (observed) distribution across bins in tax years 2020 and 2021.

The third step assigns a wage amount to those individuals assigned a late W-2 in the first step. Using tax year 2020 and 2021 late-processed W-2 recipients, late W-2 recipients in 2022 are randomly assigned a wage value drawn from the pooled distribution of 2020 and 2021 W-2 recipients. The random assignment is done within the bins created in the second step, where individuals in a given bin receive a wage assignment randomly drawn from the analogous bin from the empirical distributions in 2020 and 2021. The sampling is done with replacement.

The imputation procedure is designed such that the number of individuals being assigned imputed wages and the distribution of these wages are similar to the counts and distributions of late W-2 wages in tax years 2020 and 2021, and so that the population assigned late wages are similar (by age and prior-year wages) to the analogous populations in prior years. The statistics displayed in this sub-section indicate the output from the procedure match this design.

1. *Counts.* Table B2 contains counts of individuals receiving late processed W-2s in 2021, 2022, and 2023 before and after June 2nd, for tax years 2020, 2021, and 2022, respectively. The counts after June 2nd, 2023, for tax year 2022 are the result of the imputation procedure described above.

2. *Distribution.* Figure B1 displays the distribution of W-2 wages for W-2s processed after June 2nd, for those with wages below \$50,000. The series for tax year 2022 is the result of the imputation procedure.

Table B1: Counts of Sampled Individuals Receiving Late W-2 Forms by Wage Bin

Wage Bin	2020	2021	2022 (imputed)
\$1 to \$2,000	74,184	69,055	43,895
\$2,001 to \$20,000	207,804	185,456	118,731
\$20,001 to \$100,000	270,302	254,776	162,879
\$100,001 or more	45,208	33,634	21,733
Total	597,498	542,921	347,238

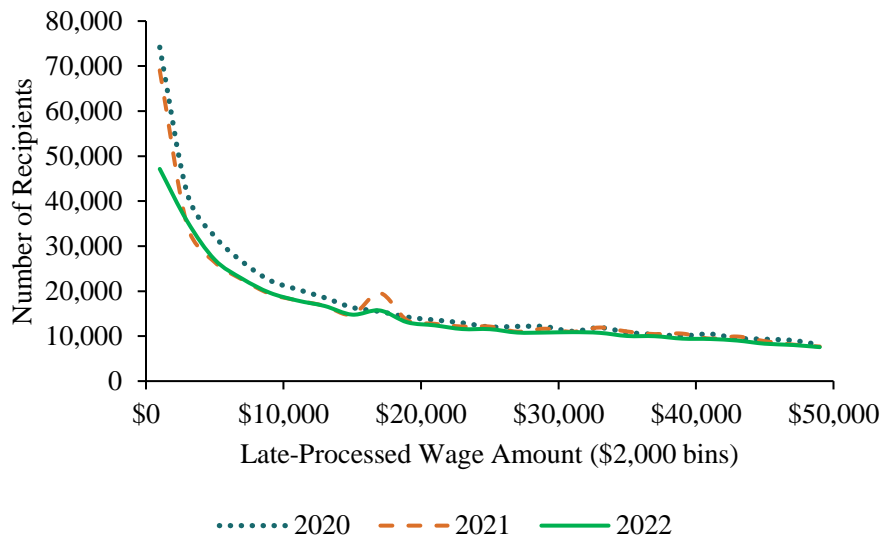
Note: Late forms are processed after June 2nd of the following year. Among workers aged 24 to 99 with earnings or unemployment benefits in the prior year and alive at end of each year. Wage earnings are indexed with the chained CPI-U. *Source:* Authors' calculations using tax data.

Table B2: Unweighted Counts of Sampled Workers with W-2 Forms Processed Before or After June 2nd

Tax Year	Before	After
2020	6,489,102	597,498
2021	6,526,816	542,921
2022	6,741,080	347,238

Note: Among workers aged 24 to 99 with earnings or unemployment benefits in the prior year and alive at end of each year. June 2nd is the following calendar year (*e.g.*, tax year 2020 processing before and after is relative to June 2nd, 2021). Tax year 2022 after counts are imputed. Counts are based on the 5 percent sample, so each observation represents 20 individuals. *Source:* Authors' calculations using tax data.

Figure B1: Distribution of Sampled, Late-Processed W-2 Amounts Below \$50,000



Note: Among workers aged 24 to 99 with earnings or unemployment benefits in the prior year and alive at end of each year. Earnings are indexed with the chained CPI-U. Tax year 2022 counts are imputed. *Source:* Authors' calculations using tax data.

APPENDIX C: Progressivity of Earnings Changes and Fiscal Relief

To summarize the progressivity of earnings changes across the entire distribution, we estimate percentage decreases in inequality for the same population. Figure A4 shows that the market earnings changes (orange line) were more regressive in the 2020 recession than in prior recessions while the 2022 recovery was much more progressive. Moreover, after fiscal relief (blue line) earnings in 2020 and 2021 was much more progressive than in past recessions.

This new measure extends Gini coefficients to a panel framework. We define the progressivity of earnings changes as the initial-year earnings Gini coefficient less the final-year concentration index (the final-year Gini modified to rank workers by initial-year earnings) divided by the initial-year Gini coefficient. In the years for which data is available, this measure is always positive because earnings changes among initial-year workers are always sufficiently progressive to overcome any increases in cross-sectional inequality. Progressive changes partly result from mean reversion but persist even when controlling for observable differences such as age (Berman 2022).

Our progressivity of earnings changes measure differs from cross-sectional Gini coefficients in two ways. First, it follows the same individuals over time, rather than incorporating population changes due to death or entry into the labor market. Second, it ranks individuals based on their initial-year earnings rather than current-year earnings. Hence, this progressivity measure can be thought of as the negative of the change in cross-sectional Gini coefficients if holding the population constant, plus the progressivity from individuals changing their rank in the distribution. The reranking effect is positive by definition (because it reduces the correlation between the ranking variable and earnings), so the progressivity measure will be positive if either the (population constant) cross-sectional Gini falls or if the reranking effect exceeds any cross-sectional Gini increase.

Figure A4, Panel A shows that the experience during the Covid recession stands in contrast to recent years and recent recessions. From 1999 through 2020, the average progressivity of one-year earnings changes was four percent, meaning earnings inequality fell by this percentage when following workers for one year. Yet between 2019 and 2020, at the start of the Covid recession, progressivity fell to a two-decade low of one percent. In contrast, at the start of the 2001 recession, annual progressivity was seven percent; and at the start of the Great recession, annual progressivity was five percent. Hence, the Covid recession was more regressive than these prior recessions and more regressive than all other years since 1999 (two-year changes show similar patterns, see Panel B of Figure A4). The 2022 recovery, however, shows the most progressive annual market earnings change observed with an annual progressivity of 10 percent, or more than twice the average.

The regressive market earnings changes in the Covid recession were offset by progressive fiscal relief. Between 2019 and 2020, the annual progressivity with relief was 10 percent, or nine percentage points above progressivity without relief. Between 2019 and 2021, the two-year progressivity with relief was 10 percent, or seven percentage points above the two-year progressivity without relief (see Panel B of Figure A4). Hence, once again we observe the extent to which the fiscal relief during the Covid recession and recovery reduced inequality by reaching those lower in the distribution. By 2022, after the withdrawal of relief, the annual and two-year progressivity of changes with and without relief were the same.

APPENDIX D: Indirect Fiscal Relief Effects (state and local aid & PPP)

Our estimates focus on *direct* relief going to individuals. *Indirect* fiscal relief, such as aid to state and local governments and the Paycheck Protection Program (PPP), also affected earnings during the pandemic. To the extent these programs resulted in higher wages, they are already in our pre-relief earnings measures, although not broken out. Previous research can inform how these programs may have affected the earnings we observe and the distribution of relief.

Aid to state and local governments should have reduced earnings losses—although Clemens, Hoxie, and Veuger (2022) estimated a cost per job-year saved of about \$855,000 with modest economic spillovers. Hence, state and local aid likely had minor effects on our results.

The PPP should reduce earnings losses by incentivizing employee retention. Dalton (2023) estimated a PPP cost per job-year saved of \$141,000 implying it was far more effective at increasing employment per dollar spent than was aid to state and local governments. The PPP also reduced direct fiscal relief, as some workers who would have received unemployment insurance instead continued to work.

The distribution of PPP effects is more ambiguous. PPP employment retention disproportionately benefitted workers in smaller businesses, who tend to have lower earnings (Dalton 2023). Consequently, PPP effects on *wage earnings* were likely progressive. But only about half of PPP relief flowed through to earnings.¹⁶ The rest was used for other business expenses, distributed as profits, or retained in the businesses—suggesting PPP non-wage “owner” effects were likely regressive.

We use population-level tax data to estimate non-wage “owner” PPP effects. First, based on the number of employees and total employee compensation, we estimate all 2020 PPP loans to eligible businesses. Our totals approximate Small Business Administration loan totals and distributions (see online appendix C). Next, we allocate half of PPP loans to individual tax returns based on direct measures of business ownership. Our results suggest the top quintile of tax filers (ranked by adjusted gross income) received 81 percent of non-wage 2020 PPP. This resembles the assumed top share in Autor *et al.* (2022a), which was based on capital income shares. However, our approach implies the bottom quintile received 6 percent of non-wage “owner” PPP, which is much more than prior assumptions. Ranking by wages, this implies top-quintile and bottom-quintile incomes increased by only 3 percent while middle-quintile incomes increased by only 1 percent. Overall, indirect PPP relief caused relatively small percentage changes to income and had a U-shaped distribution. This suggests indirect PPP relief (at least the non-wage “owner” portion) had little effect relative to the larger sources of strongly progressive direct relief, and post-relief trends remain strongly progressive in 2020 and 2021.

A. Imputation Procedure for PPP Relief

This section describes our procedure to estimate the distribution of PPP loans that do not accrue directly to worker wage earnings. The “wage” portion of PPP is already observed in our main results via Form W-2 wages. Dalton (2023) estimated that 43 percent of PPP loans flowed through to worker wages, while the rest was used for other business expenses, distributed as profits, or retained in the businesses. Autor *et al.* (2022) estimated a smaller share flowing through and Dalton (2023) discusses reasons for differences.

¹⁶ An estimated 43 percent of PPP loans accrued to wages but this is a lower bound “because the proportion...will continue to increase as more months are added to the analysis.” (Dalton 2023)

While the PPP wage effect was likely progressive, as it limited job loss, the PPP relief non-wage effect flowed to business owners who are more frequently high income. Using population-level tax records, we first estimate business-level PPP loans (which match external totals and distributions of loans) and then allocate these loans' non-wage "owner" portion to individual tax returns. This is then used to estimate distributional effects. We limit our current analysis to 2020 PPP loans. The 2021 PPP loans were more targeted, limited to businesses with fewer employees and with revenue losses.

PPP loans totaled about \$520 billion in 2020, which includes the first two "tranches." The approach described below approximates the \$520 billion total as well as the distribution of 2020 PPP loan counts and amounts shown in Small Business Administration (2021).

The 2020 PPP loans were received by most businesses with fewer than 500 full-time equivalent employees. The 2020 loan amount was up to 2.5 months of payroll costs up to \$100,000 per worker, with a total maximum of \$10 million. For non-governmental employers with fewer than 500 employees, 2020 PPP loan amounts are estimated as the lesser of (1) \$10 million, \$100,000 times the number of employees, and an employer's fourth-quarter 2019 taxable compensation (line 2 of Form 941) increased by 10 percent to account for non-taxable compensation (*e.g.*, health insurance) and then multiplied by 10 and divided by 13 to convert from quarterly to 2.5-month (10-week) amounts. To account for sole proprietors filing Schedule C with no employees, those with 2019 net profits of at least \$53,000 (set to target small loan counts from the Small Business Administration) and are given the possible PPP, where PPP loans are annual profits divided by 12 and then multiplied by 2.5 with a maximum profit of \$100,000 applied. Note that this Schedule C allocation assumes essentially none went to the bottom quintile and therefore underestimates the PPP's progressivity.

Our estimated loan counts and amounts are very similar to the counts and amounts reported by the Small Business Administration (2021), as seen in Table D1. Given the near complete forgiveness of loans, we do not directly account for incomplete forgiveness, although our total estimated PPP loans of \$508 billion are between the total loan value of \$520 billion and the approximately \$500 billion in total forgiveness requested as of Dec. 26, 2021. Of the loans amounts requested to be forgiven, essentially all were quickly forgiven, with 94 percent of total 2020 PPP loans forgiven as of Dec. 26, 2021 (Small Business Administration 2021). Autor *et al.* (2022, pg. 58) summarized the four requirements to qualify for PPP loan forgiveness: "1) spend at least 60 percent of the loan amount on payroll expenses; 2) spend (at least) the full loan amount on total qualifying expenses, including payroll, utilities, rent, and mortgage payments; 3) maintain average full-time equivalent employment at its pre-crisis level; and 4) maintain employee wages at least 75 percent of their pre-crisis level."

The business-level estimates of the "owner" portion of PPP loans are linked to individual tax returns (for income distributions) or W-2 forms (for wage distributions). Businesses may have different entity types and different numbers of owners. Sole proprietors or self-employed taxpayers reporting income on Schedule C have one owner and are directly linked with the businesses-level PPP loans. Partnership and S corporation PPP loans are allocated across individual tax returns or W-2 forms in proportion to the ownership or income shares received by those individuals (using amounts reported on schedules K-1). C corporations with estimated PPP loans, however, cannot be linked with this method. In addition, it is unclear how to allocate any "owner" portions of PPP loans for non-profits. With this approach, almost two-thirds of estimated PPP loan amounts are linked. Approximately half of the gap is explained by unlinked loans for C corporations and non-profits and half explained by incomplete links of loans for partnerships and S corporations.

The estimated distributions of the “owner” portion of PPP loans among tax filers are shown in Table D2. When ranking by incomes (2019 adjusted gross income) among tax return filers, 81 percent of linked PPP loans are associated with business owners in the top quintile of the income distribution, similar to the 86 percent assumption based on total capital income share in Autor *et al.* (2022). When ranking by wages among workers, the group considered in this paper, a similar distribution is seen in column 2. However, we estimate a modest U-shaped distribution of non-wage “owner” PPP loan benefits in column 3. This contrasts with the monotonically increasing share assumed by Autor *et al.* (2022) due to using capital income (much of which is from large corporations who could not benefit from PPP loans). Column 4 shows “owner” portions of PPP as shares of wages ranked by wages. Results are similar, except percentage changes are larger because wages are smaller than income.

Table D1: 2020 PPP loan counts and amounts by loan size

Loan Size	PPP loan counts (thousands)		PPP loan amounts (\$billion)	
	SBA	Tax Data Estimate	SBA	Tax Data Estimate
>2M	29	31	102	118
\$150K-\$2M	628	577	272	251
\$40K-\$150K	969	1,042	85	82
<\$0K	3,496	3,514	62	57
Total	5,123	5,164	520	508

Notes: SBA loan amounts scaled up to match total PPP loans. Source: Authors' calculations with tax data and SBA.

Table D2: Distribution of 2020 PPP non-wage “owner” portion of loans by AGI or wage quintile of business owner

Quintile	PPP share ranked by income (1)	PPP share ranked by worker wages (2)	PPP share of positive income ranked by wages (3)	PPP share of wages ranked by wages (4)
1	6%	3%	3%	8%
2	2%	5%	1%	2%
3	5%	7%	1%	1%
4	6%	12%	1%	2%
5	81%	74%	3%	4%
Total	100%	100%		

Notes: For rankings by income (adjusted gross income), each quintile has an equal number of filers (*i.e.*, adults) on 2019 tax returns. For rankings by wages, each quintile has an equal number of workers with at least \$1,000 on a Form W-2 in 2019 (wages are aggregated across forms from different employers). PPP share estimates are scaled to assume that half of total PPP loans flow through to business owners. Source: Authors' calculations with tax data.

APPENDIX REFERENCES

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