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

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Abstract

Using a panel of tax data, we follow the earnings of individuals over business cycles. Compared to prior recessions, the Covid policy response and recovery were far more progressive. Among workers starting in the bottom quintile, median real earnings including fiscal relief *increased* 66 percent in 2020 and earnings increases offset relief decreases in the 2021 recovery. After the prior two recessions, this measure had *decreased* by 24 percent. Among those starting in the top quintile, median and average real earnings were approximately unchanged. This difference from prior recessions is largely attributable to larger Covid-era stimulus payments and unemployment insurance.

Keywords: Covid-19, wages, earnings, stimulus checks, unemployment insurance, countercyclical policy, government transfers

JEL: D31, E24, H53, J30, J65

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1. Introduction

The Covid recession was historically short, lasting just two months. Nevertheless, the severity of economic disruptions caused many low-earning workers' annual earnings to decline substantially in 2020. While employment rebounded in 2021, fiscal relief declined and inflation increased, offsetting some economic gains. Using a panel of administrative data, we measure the evolution of individual-level earnings over recent recessions and through the first year and a half of the Covid recovery, both with and without fiscal relief. Compared to prior recessions, the Covid recession was more regressive, but the Covid recovery and policy response were far more progressive.

The data we use offer several advantages relative to other sources. First, we follow the same individuals over time, contrasting with widely available cross-sectional estimates, which compare different individuals over time (see *e.g.* Semega and Kollar 2022).[1] Second, our estimates use extremely large samples—5 percent of workers—that exceed those of available survey data. Third, using independent reporting by employers and governments, we precisely measure earnings and direct fiscal relief (i.e., unemployment insurance benefits, stimulus payments, tax holidays, and various tax credits).

Using these data, we find that after declining markedly in 2020, earnings among low-earning workers increased in 2021 (after accounting for inflation). Despite these improvements, real earnings among those who were in the bottom quintile before the recession typically remained below their 2019 levels. In contrast, among top-quintile workers, real earnings increased in 2020, but declined in 2021 as inflation accelerated, leaving their median real earnings slightly below 2019 levels.

Incorporating the substantial and progressive direct fiscal relief during this period paints a different picture. For bottom-quintile workers, market earnings gains in 2021 mostly offset the partial withdrawal of direct fiscal relief. Consequently, earnings after fiscal relief for the bottom quintile remained high in 2021—on average, more than double pre-recession earnings. Top-quintile changes after relief increased only a few percentage points, even when accounting for the Payment Protection Plan with new estimates using administrative data. We perform a similar analysis on the 2001 and 2008 recessions and find substantially different patterns.

We consider four measures of the distribution of real earnings changes from the year before to the years after a recession: the share of workers whose earnings increased, the median earnings change by quintile, the share of workers with large changes in earnings, and the distribution-wide progressivity of earnings changes. Results are consistent across these measures: the initial distributional impacts of market earnings changes in the Covid recession were more regressive than in prior recessions, whereas both the Covid recovery and policy response have been far more progressive.

[1] Relative to cross-sectional estimates, panel data control for re-ranking due to earnings mobility and follow the trajectory of the same individuals. See online appendix Figure A5 for a comparison of panel and cross-sectional results.

2. Relation to Existing Research on Earnings During the Pandemic

This paper expands upon the research examining earnings trends in the pandemic. Research based on micro-level survey data (Moffitt and Ziliak 2020; Montenovo et al. 2020; Cortes and Forsythe 2022), macro-level administrative data (Berman 2020; Blanchet, Saez, and Zucman 2022), and data from state governments and private companies (Bartik et al. 2020; Cajner et al. 2020; Chetty et al. 2022) consistently show disproportionate initial losses among low-wage occupations in 2020. See Cortes and Forsythe (2022) for a review of the extensive literature on the 2020 downturn. Additionally, Cortes and Forsythe (2021) and Larrimore, Mortenson, and Splinter (2022a) found that low-earning workers received the bulk of the direct fiscal relief to households and families, offsetting increases in market earnings inequality. This existing research, however, has primarily focused on 2020 rather than medium-term trends into 2021.

The tax data used here track individuals over long time-periods and measure individual earnings changes before, during, and after the pandemic shock. These data allow all wage earners (whether they file a tax return or not) to be followed for multiple years, providing precise micro-level earnings changes. In contrast, the Current Population Survey (CPS) can only track individuals for one year, and even then, only for individuals who do not change residence. Major panel surveys, such as the Panel Survey of Income Dynamics, can track people over time but have delayed reporting, smaller samples, and must contend with sample attrition (Fitzgerald, Gottschalk, and Moffit 1988). Consequently, we are unaware of other research showing how the same workers from before the pandemic fared two-years later in 2021.

In addition to their ability to accurately track individual earnings over time, tax data also capture unemployment benefits and tax credits that are underreported in survey data (Larrimore, Mortenson, and Splinter forthcoming; Meyer et al. 2020). While underreporting of fiscal relief is a regular concern, survey errors were larger than usual during the Covid pandemic (Rothbaum and Bee 2021). Hence, this research using administrative data avoids the challenges that the pandemic caused for economic surveys.

Although we are unaware of other work documenting the extent to which individual workers saw earnings gains in 2021, our findings are consistent with Greig, Deadman, and Sonthalia's (2022) findings on checking account balances. They observed that at the end of 2021, balances were well above their 2019 levels, and these increases were most pronounced among low-income families with bank accounts. Similarly, Meyer, Murphy, and Sullivan (2022) observed that lower-income groups did not substantially reduce consumption since the pandemic began, suggesting that fiscal relief's income stabilization flowed through to consumption.

Our estimates on market earnings patterns in prior recessions are also consistent with earlier findings using administrative earnings data. Guvenen, Ozkan, and Song (2014) estimated that during recessions, earnings increases among high-earning worker become less frequent and earnings losses among low-earning workers become more frequent. McKinney, Abowd, and Janicki (2022) also observed procyclical skewness of annual earnings changes. Our findings on the effects of tax and transfer policies are also consistent with findings from other countries (Busch et al. 2022).

3. Administrative Tax Data Panel

This paper builds on the data and methods from Larrimore, Mortenson, and Splinter (2022a), which used a random 5-percent sample of all individuals appearing in IRS tax data (Internal Revenue Service and Joint Committee on Taxation 2022). We extend the analysis forward to 2021 to consider the Covid recovery and back to 1999 to allow for comparisons with the 2001 recession.

A. Tax Data Sources

Annual wages and salaries ("earnings") are measured from Form W-2, and unemployment insurance benefits are measured using Form 1099-G and Form 1040 tax returns (the latter is used if larger than the former). Estimates from IRS audit studies suggest that these information returns are extremely comprehensive and only miss an estimated one percent of earnings. To incorporate measures of stimulus payments and other fiscal relief observed in tax data, we use Form 1040 tax returns and other population-level data, as discussed below.

B. Panel of Individual-Level Earnings Measures

All main estimates are based on multi-year panels of earnings and direct fiscal relief. These panels include anyone in the initial year with wages or unemployment benefits, even if they have no income from either source in subsequent years. We focus on those with this labor market attachment in years just prior to recessions (2000, 2007, and 2019). While we allow for exits (earnings of zero dollars), we do not consider entry into the labor force during each recession.[2] The sample is limited to adults aged 24 or older in the initial year, excluding those who are deceased at the end of the year. This age range avoids large earnings fluctuations among young workers and retains earnings declines among retirees who were working before the pandemic.[3]

All data are at the individual level. Individual-level totals for earnings and unemployment insurance benefits are obtained by aggregating all W-2 forms and 1099-G forms.[4] Stimulus payments and other tax credits, as well as the self-employment portion of the payroll tax holiday, are determined at the tax-unit level and then divided equally between spouses for tax units filing joint returns. This equal split accords with the per-person basis of most of these policies, which are described below. Our individual-level earnings definition excludes other income sources and

[2] Entry and exit rates are largely similar each year from 1999 through 2021 and therefore do not appear to substantially affect our results. For example, entry rates range from 4.3 to 5.9 percent with an average of 5.4 percent. See online appendix Figures A2 and A3 and online data Tables B2 and B3.

[3] This captures accelerated retirements from the Covid recession (see Domash and Summers (2022) for estimates of retirements during the pandemic). Results for working-age adults (ages 25–59) in 2020 were similar to those for all adults over age 24 (Larrimore, Mortenson, and Splinter 2022a).

[4] We focus on Medicare Wages (Box 5) on Form W-2, which is the broadest wage measure on the form. We retain the most recent Form W-2 with a non-missing amount for each individual from each employer in each year. Expanded unemployment insurance included Pandemic Unemployment Assistance payments to independent contractors, although our sample definition means these recipients are only included if they had earnings or unemployment benefits in the initial year. W-2 forms exclude self-employment income, although we estimate transitions into and out of self-employment (as measured by having a Form 1099-MISC or 1099-NEC) and find similar patterns during the pandemic as in earlier years.

generally ignores tax-unit sharing, which requires tax return data that is not yet sufficiently available for 2021 (for estimates accounting for tax-unit sharing in 2020, see Larrimore, Mortenson, and Splinter 2022b). Inflation-adjusted values are based on the chained-CPI.

Once the IRS data are complete, they represent a population-level panel. To provide timely estimates, we use current data even though some 2021 forms are yet to be processed by the IRS. In these data, some workers with 2021 earnings appear to have no earnings and some with multiple jobs have just one processed Form W-2, resulting in artificially lower earnings. We account for this by estimating the number of people with not-yet-processed 2021 W-2 forms and the earnings on those forms. This imputation is based on historical patterns of late-processed forms based on age, prior-year wages, and W-2 presence in the current tax year (see online appendix B for details). Since our data (from August 2022) are nearly complete, the imputation has relatively small effects, increasing 2021 median earnings by $100 within the bottom-quintile and about half that for higher earnings. In our final data, aggregate real wage earnings increased by 4.9 percent between 2019 and 2021, which is close to the 4.7 percent increase in aggregate real earnings in the National Income and Products Accounts over this period.

C. Direct Fiscal Relief Considered During Recent Recessions

Total direct fiscal relief observed in tax data increased across the last three recessions.[5] This relief was about $200 billion in 2001–2003, $500 billion in 2008–2010, and $1,800 billion in 2020–2021.[6] The effects of indirect relief programs, such as the Paycheck Protection Program, are discussed in section 4.F.

Larger Covid-era fiscal relief mostly resulted from expanded unemployment insurance benefits and stimulus payments. Unemployment insurance benefits increased from $140 billion and $350 billion in the earlier periods to $880 billion in the Covid era.

Stimulus payments also increased over the last three recessions. The 2001 stimulus checks totaled $38 billion and approximately two-thirds of tax units received a payment of $300 per adult (Kaplan and Violante 2014). The 2008 checks totaled $96 billion and maximum amounts were generally $600 per adult and $300 per child younger than 17 years old (Parker et al. 2013). The 2020 checks totaled $413 billion. Combining the first and second rounds, total checks were usually $1,800 per adult and $1,100 per child. In 2021, additional stimulus checks were distributed, including $408 billion from third-round payments that were usually $1,400 per adult and dependent.[7] Additionally, we account for stimulus check "true ups" on 2001, 2008, and 2020 tax returns in the year when the payment is received (Splinter forthcoming).

[5] Some direct fiscal relief measures, such as SNAP benefits, do not appear in tax data because they are not taxed and are not administered by the IRS. Since SNAP and other untaxed benefits are generally received by low-income families and increase during recessions, including these benefits would further increase the progressivity of relief.

[6] Note that our panel focuses on employees and therefore excludes relief going to non-employees, such as stimulus payments to retirees. Among workers in our data, fiscal relief was about $170 billion in 2001–2003, $490 billion in 2008–2010, and $1,380 billion in 2020–2021 (in 2021 dollars: $240 billion, $600 billion, and $1,420 billion).

[7] Most second-round payments were made in 2020 and are allocated to 2020 based on actual payment dates. The 2008, 2020, and 2021 stimulus checks were subject to income phase outs starting at $75,000 for single filers and $150,000 for married filers. For details, see Splinter (forthcoming).

Several other provisions that provided relief during the Great Recession and Covid Recession are also included. The making work pay credit for 2010 and 2011 totaled $60 billion each year and was $400 per adult worker (subject to an income phase out). The payroll tax holiday for 2012 and 2013 reduced employee payroll taxes by $100 billion each year and consisted of a two-percentage point tax rate reduction, which we estimate using individual-level W-2 earnings. In 2021, most parents received advance child tax credits (CTCs) of $1,800 per qualifying child under age six and $1,500 per qualifying child under age 18.[8]

4. Estimates of Earnings Changes and Relief Across Business Cycles

To show the evolution of earnings over recent business cycles, we follow individual workers over time. For each recession, workers are grouped into quintiles or percentiles of the pre-recession earnings distribution (including wages plus unemployment insurance to reflect their usual pre-recession earnings). These rankings into quintiles and percentiles are consistent across all figures, maintaining the same rankings when looking at earnings changes with and without relief. Importantly, our panel approach differs from evaluating trends using repeated cross-sections because individuals are always classified into quintiles or percentiles based on their pre-recession earnings, thereby allowing us to focus on individual-level earnings mobility.

Relative to prior recessions, market earnings changes in the Covid recession were more regressive, but both the policy response and the Covid recovery have been more progressive. This is seen with each of our four measures: (a) the share of workers whose earnings increased; (b) median earnings changes within earnings groups; (c) the share of workers with large (10 percent or more) changes in earnings; and (d) Gini-based measures summarizing the progressivity of changes across the distribution. Finally, we show how specific fiscal relief programs, especially unemployment insurance and stimulus payments, offset earnings declines in the Covid recession and recovery.

A. Frequency of Earnings Increases and Declines During the Covid Recession

Across the entire population, market earnings for most workers were resilient through the Covid recession, as 51 percent had real earnings increases in 2020. With rising inflation, the share with real earnings above pre-recession levels ticked down slightly in 2021, but just over half (50.4 percent) still had higher earnings than in 2019. In the Great Recession a slightly smaller share, 47 percent, had earnings above their pre-recession levels in both 2008 and 2009.

Yet earnings trends differ through the distribution. When considering market earnings by quintile of pre-recession earnings in Figure 1 (dashed lines), low-earning workers were typically making less in 2021 than they were in 2019 before the recession. Of these bottom-quintile workers, 44 percent had higher real earnings in 2021 than two years earlier, while the rest had lower earnings. This reflects frequent earnings declines in 2020, followed by a partial recovery in 2021. Just 41

[8] Much smaller advance payments of child tax credit expansions sent in mid-2003 are not included as relief.

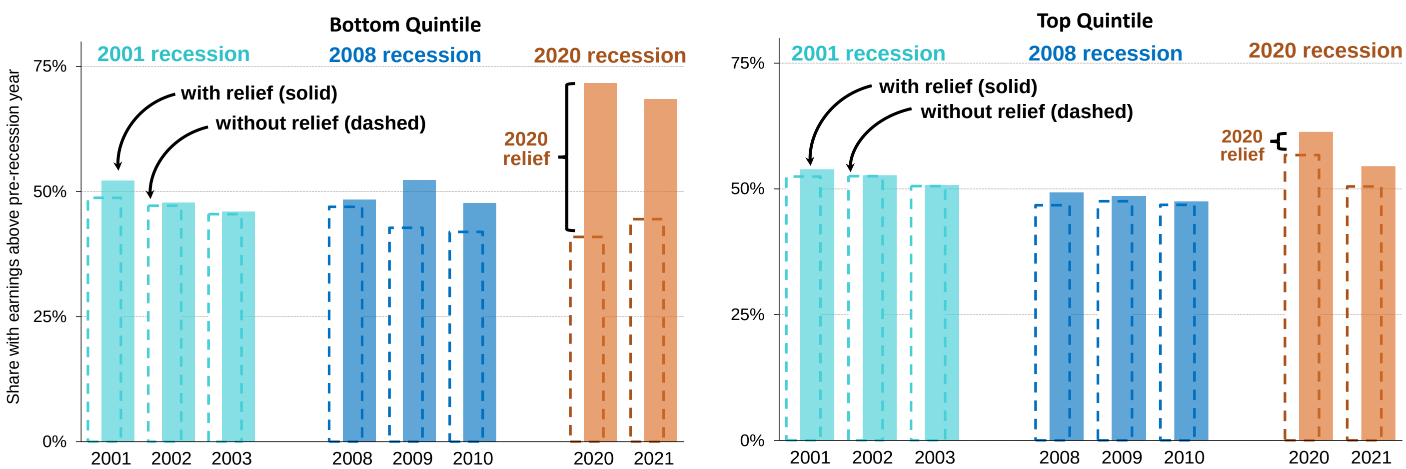
percent of bottom-quintile workers had increases in real market earnings in 2020. For comparison, in the first year of the Great Recession, 47 percent had earnings increases in 2008. But the Covid recession was also historically short, and the share of bottom-quintile workers with real earnings above their pre-recession level increased slightly in 2021. In contrast, during the Great Recession, the share of bottom-quintile workers with earnings above pre-recession levels fell in the second and third year after the start of the recession—past the official end date of the recession. Hence, a larger share of low-earning workers made more in 2021 than before the Covid recession than was the case in 2009 or 2010 following the Great Recession.

The effects of the Covid recession on market earnings were also particularly regressive. Contrast the bottom-quintile results in the left panel with those for the top quintile on the right, still focusing on the dashed lines (results for all quintiles are in the online data). In 2020, a majority (57 percent) of those who started in the top quintile had market earnings gains despite the economic downturn. In 2021, the share with real earnings gains among this group fell, although slightly over half of these workers still had earnings above pre-recession levels.

Once incorporating fiscal relief (solid bars), however, the pattern is quite different. Comparing the solid and dashed lines in Figure 1 highlights the progressive effect of relief in offsetting earnings losses. Among workers who were in the bottom quintile before the Covid recession, relief increased the share with earnings increases in 2020 by 31 percentage points—from 41 percent to 72 percent. For the middle quintile (not shown) and the top quintile, this increase is only 19 and 5 percentage points, respectively—an indication of progressive fiscal relief.

In 2021, the total amount of direct fiscal relief fell by about one-third relative to 2020. Nevertheless, most low-earning workers had higher earnings with relief than before the recession. From 2019 to 2021, earnings with relief increased for 69 percent of the bottom quintile.

Figure 1. Share of workers with real earnings at pre-recession level or higher, by income quintile

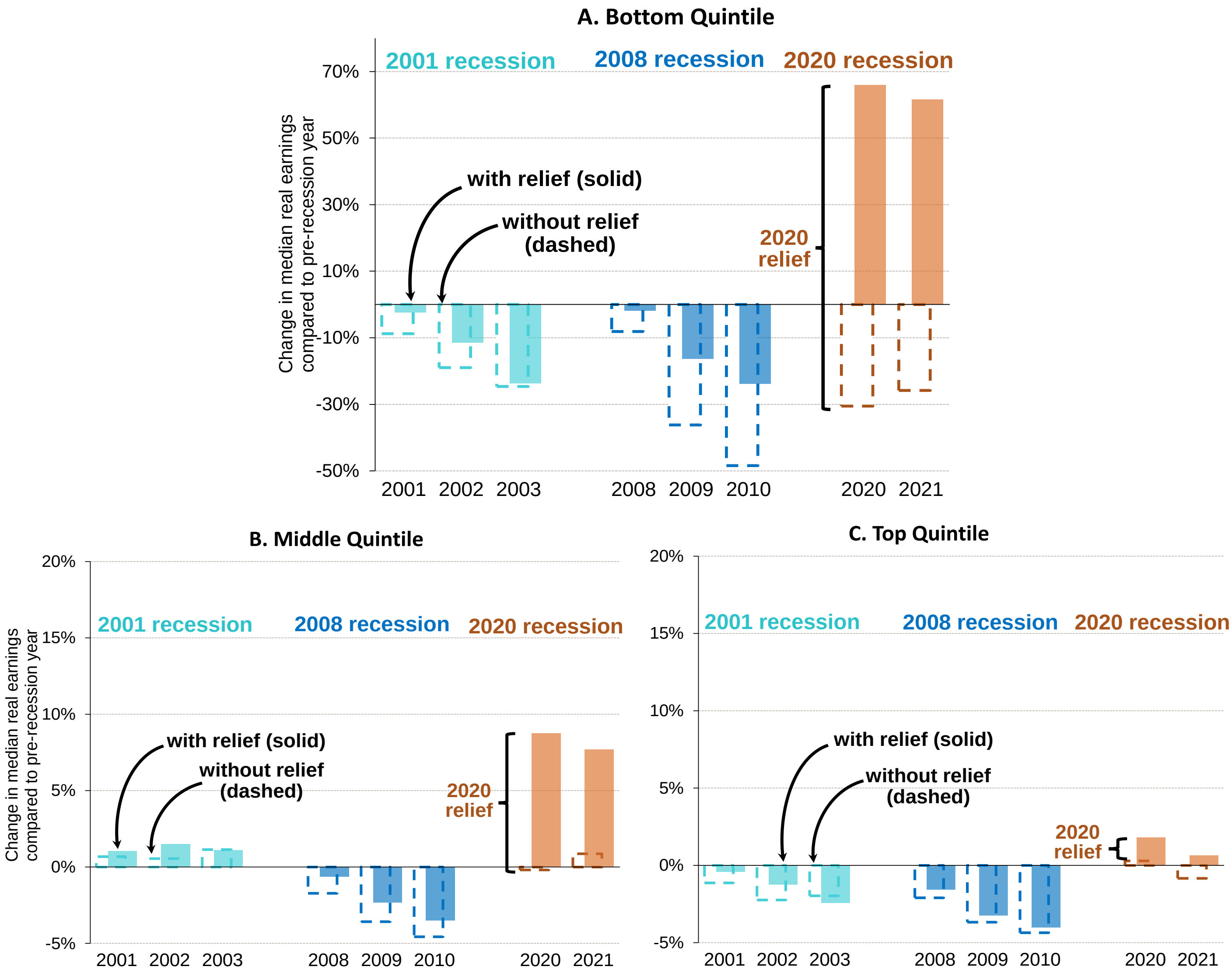


Note: Among workers aged 25 to 99 with earnings or unemployment benefits in pre-recession year and alive at end of specific year. Quintiles (with and without relief) are based on wages plus unemployment benefits in pre-recession years (2000, 2007, and 2019). Earnings are indexed with the chained CPI-U. *Source*: Authors' calculations using tax data.

B. Magnitudes of Earnings Changes

Figure 2 goes beyond the share with earnings increases to also consider the magnitude of earnings changes. It displays median real earnings of workers in each quintile relative to their median earnings in the year before each recession. Once again, the dotted bars only include market earnings, and the solid bars add fiscal relief.

Figure 2. Median real earnings relative to pre-recession year, by income quintile



Note: Among workers aged 25 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 plus unemployment benefits in pre-recession years (2000, 2007, and 2019). Median real earnings without relief (2021 dollars) for pre-recession years (2000, 2007, and 2019)—bottom quintile: \$5,800, \$5,910, \$7,560; middle quintile: \$38,390, \$39,480, \$42,770; top quintile: \$100,350, \$106,850, \$120,450. Relief increases median real earnings in 2021 by \$6,980 for the bottom quintile, \$3,120 for the middle quintile, and \$1,860 for the top quintile. *Source*: Authors' calculations using tax data.

The Covid recession stands out for its severe effects on market earnings of low-earning workers as well as its progressive recovery. For workers starting in the bottom-quintile in 2019, real median market earnings in 2021 were 26 percent below 2019 levels (see dashed lines). This reflected a decline of nearly one-third in 2020 followed by a slight increase in 2021. Among those who started in the middle quintile, median earnings remained relatively flat, and among the top quintile, real median earnings declined slightly in 2021. Hence, despite a progressive recovery in 2021, the combined effect on market earnings since 2019 was regressive.

Low-wage workers benefited greatly from progressive policy responses in the Covid recession and recovery—especially from expanded unemployment benefits and stimulus checks. When including fiscal relief, as shown in the solid bars in Figure 2, bottom-quintile workers saw their real median earnings with relief increase by 66 percent in 2020 and then remain up 62 percent in 2021 as market earnings gains largely offset the withdrawal of fiscal relief. Middle-quintile real median earnings with relief increased by 9 percent in 2020 and remained 8 percent above 2019 levels in 2021 (note the change in scale in Figure 2 for the middle and top quintiles). Top quintile median earnings with relief increased by only 2 percent in 2020, and then returned to near-2019 levels in 2021.[9]

The 62 percent median increase after fiscal relief from 2019 to 2021 for this group was remarkably large and far exceeded that seen even during recent non-recessionary periods, highlighting the magnitude of the progressive policy response. Since 1999, the median increase in bottom-quintile real earnings (after relief) over a two-year period never exceeded 11 percent prior to the Covid recession. Frequently, the median two-year change for this group was slightly negative.[10]

C. Frequency of Large Earnings Changes during Covid

For some workers, increases or decreases in earnings may be small. To consider the more dramatic effects of recessions and recoveries on workers, we also consider the share of workers with large real annual earnings changes, excluding small changes. Large changes are defined as 10 percent or more, where large declines include those exiting the workforce (i.e., going from positive to no earnings). Consistent with the earlier discussion, those entering the workforce are excluded. Over the last two decades, an average of 28 percent of workers had large earnings increases and 28 percent had large declines each year. Other estimates using administrative tax data find similarly high shares of workers with large short-term earnings changes (Congressional Budget Office 2008).

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[9] Small business owners benefitted from forgiven Payment Protection Plan loans. Since this paper focuses on employee wages and these loans are not captured on individual tax records, they are not included here, although we provide preliminary estimates of this indirect relief in section 4.F below..

[10] As is standard in panel-based studies, average earnings growth was larger for low-wage workers than their median earnings growth (see online appendix Figure A1). This is because the panel includes people who are just starting in the workforce and because there is mean reversion among those with temporary earnings declines. This earnings growth, however, is offset somewhat by workers aged 60 or older with large declines (online data Table B1). When removing initial-year workers with earnings below $5,000, bottom-quintile median earnings decreases were less common and smaller (online data Tables B4 and B5).

Expansions often coincide with more workers having large increases. In the 2012–2019 expansion, the share with large increases exceeded the share with large declines by an average of 3 percentage points. In 2021, the first full year of the Covid recovery, the share of workers with a large earnings increase before relief was 3 percentage points above the share with a large earnings decline. However, one-year improvements include mean reversion of prior-year losses, which is why we also consider two-year changes. Over the two-year period from 2019–2021, large earnings increases before fiscal relief were 1 percentage point less common than large earnings declines (34 percent vs. 35 percent). For comparison, in the pre-Covid expansion years from 2017 to 2019, large increases were 7 percentage points more frequent than large decreases.

The distribution of large earnings changes is considered next. Figure 3 displays the share of workers with at least a 10 percent real earnings decline or increase by earnings percentile.

Panel A displays the share with large annual *decreases* for 2019, before the Covid recession, and for 2020 and 2021. As previously illustrated by Larrimore, Mortenson, and Splinter (2022a), the share with large market earnings declines during the 2020 recession was elevated throughout the distribution relative to 2019, but especially so among the bottom half of the distribution. In 2021, the share of workers with large earnings declines for the bottom quintile is above the 2019 analog for each earnings percentile, although the shape is similar.

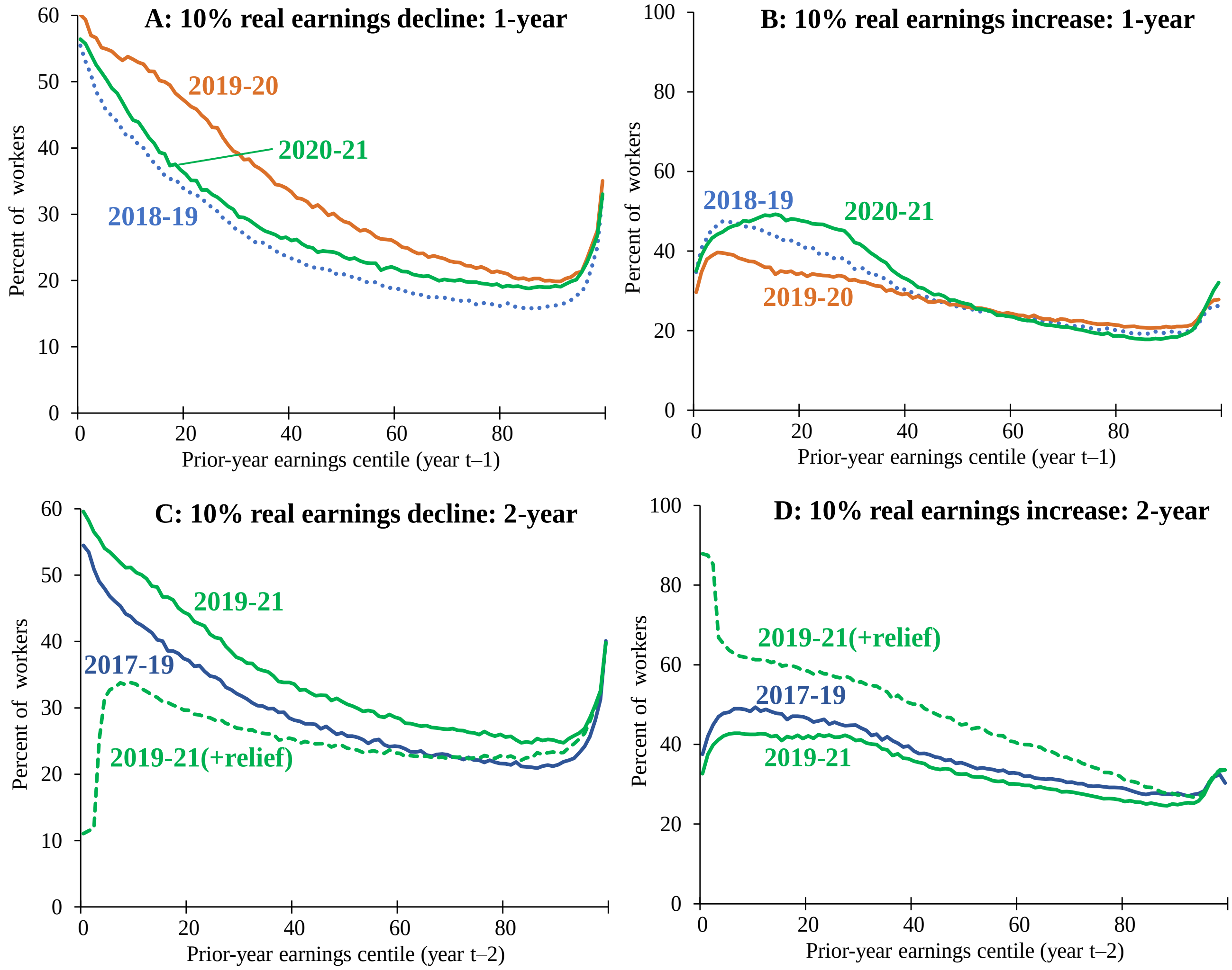
Panel B shows the share of workers with large earnings *increases*. In 2020, the share experiencing a large earnings increase before relief was similar to that in 2019 for the top of the distribution but depressed for the bottom half. The 2021 pattern was also similar for those in the top half of the distribution, but there was a notable surge in earnings increases for those with earnings between the 10^{th} and 40^{th} percentiles.

Shifting to two-year changes in Panels C and D, the progressive recovery in market earnings somewhat offset the regressive nature of the recession. Between 2019 and 2021, 51 percent of workers who were in the bottom quintile had a large earnings decline. This is 7 percentage points above the 44 percent with large two-year earnings declines from 2017 to 2019. Among the top quintile, the 27 percent of workers with large earnings declines between 2019 and 2021 was 3 percentage points above the share with large earnings declines from 2017 to 2019. Similarly, large earnings increases among the top quintile were 2 percentage points less likely between 2019 and 2021 than in the two preceding years.

However, despite being smaller than in 2020, fiscal relief continued to be extremely progressive into 2021. Once incorporating fiscal relief, large earnings declines were far less common among the bottom half of the distribution from 2019 through 2021 than during the most recent expansion, and large income gains were far more common for everyone outside of the top decile.[11] Among the bottom quintile, relief decreased the share with large declines from 51 percent to 29 percent and increased the share with large increases from 41 percent to 65 percent.

[11] Note that the progressivity of relief in 2020 is not contributing to this observed progressivity in 2021, since it only compares calendar years 2019 and 2021.

Figure 3: Share of workers with large real earnings decline or increase



Note: Among workers aged 25 to 99 with earnings or unemployment income in the initial year (t–1 or t–2) and alive at end of final year. Percentiles are based on wages plus unemployment benefits in initial years. Earnings are indexed with the chained CPI-U. *Source*: Authors' calculations using tax data.

D. 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. 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.[12] Progressive changes partly result from mean reversion but persist even when controlling for observable differences such as age (Berman, 2022).

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 4 percent, meaning that 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 1 percent. In contrast, at the start of the 2001 recession, annual progressivity was 7 percent; and at the start of the Great recession, annual progressivity was 5 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 online appendix Figure A4).

As discussed above, however, the regressive market earnings changes in the Covid recession were offset by progressive fiscal relief. Between 2019 and 2021, two-year progressivity with relief was 10 percent, or 7 percentage points above the two-year progressivity without relief. 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.

E. Which Direct Fiscal Relief Measures Mattered Most?

Table 1 shows how Covid public policies reduced the share of workers with large income declines across different years (annual and two-year changes) and between those with and without dependents. Panel A considers annual earnings declines in the 2020 recession. Relief reduced the share with large (10 percent or more) annual declines by 14 percentage points, from 33 percent for earnings without relief to 19 percent with relief. Unemployment insurance benefits explain two-thirds of this distribution-wide stabilization effect and stimulus checks explain one-third. Among the bottom quintile, the share with large declines fell much more from fiscal relief—by 27 percentage points (from 53 to 26 percent)—where unemployment insurance and stimulus checks each explain half of the change.

Unemployment insurance was generally more progressive than stimulus payments in recessions. In both 2009 and 2020, the bottom quintile of adults received about one-third of unemployment benefits, while the middle received about one-fifth and the top quintile less than one-tenth (Larrimore, Mortenson, and Splinter forthcoming). Stimulus payment amounts, in contrast, were about the same across the distribution except for a phase out for top income groups.

[12] This 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.

Unemployment benefits also target workers with earnings declines, whereas stimulus payments are largely insensitive to earnings declines.

Panel B considers two-year earnings changes between 2019 and 2021. Relief reduced the share with large two-year declines by 9 percentage points, from 35 percent for earnings without relief to 26 percent with relief. Unemployment insurance benefits explain 39 percent, stimulus checks 53 percent, and advance child tax credits 8 percent of the stabilization effect.[13] Among the bottom quintile, the share with large declines fell by 22 percentage points due to fiscal relief (from 50 to 29 percent).

Fiscal relief disproportionately benefitted adults with dependents, especially in the bottom quintile. For those without dependents, relief reduced the share with large two-year declines by 8 percentage points (Panel C). For those with dependents, relief reduced it by 12 percentage points (Panel D). Among the bottom quintile, relief reduced the share with large decrease for those without and with dependents by 19 and 28 percentage points, respectively. This difference is largely because each tax unit usually received an additional $1,400 of stimulus checks for each dependent and at least $1,500 per child of advance child tax credits.

Table 1. Share of workers with at least a 10 percent real earnings decline

	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)**		
Earnings	33.4	52.6	22.0	34.6	50.3	26.9
+ Unemployment Ins.	24.2	38.4	20.8	31.1	41.7	26.6
+ Stimulus checks	19.3	25.5	19.7	26.3	30.0	25.6
+ Advanced CTC (earnings + relief)	19.3	25.5	19.7	25.6	28.8	25.3
	C: 2019–2021 (2-year): No dependents			**D: 2019–2021 (2-year): With dependents**		
Earnings	36.9	52.2	30.0	29.8	45.2	21.9
+ Unemployment Ins.	33.5	44.4	29.7	26.0	34.4	21.6
+ Stimulus checks	29.3	33.4	29.0	20.1	20.9	20.1
+ Advanced CTC (earnings + relief)	29.2	33.2	29.0	18.2	16.9	19.3

Note: Among workers ages 25 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 plus unemployment benefits in the initial year. Children include dependents younger than 17 years old claimed on tax returns. Earnings are indexed with the chained CPI-U.
Source: Authors' calculations using tax data.

[13] When averaging these estimates with the reverse-order of adding types of relief (i.e., unemployment insurance added last), unemployment insurance benefits explain a similar 37 percent, stimulus checks 52 percent, and advance child tax credits 11 percent of the stabilization effect.

F. Indirect Fiscal Relief Effects

Our estimates focus on *direct* relief going to individuals. *Indirect* fiscal relief, such as aid to state and local governments and the Paycheck Protection Plan (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 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 (forthcoming) estimated a PPP cost per job-year saved of $141,000—in the mid-range of prior estimates—implying it was far more effective at increasing employment per dollar spent than was aid to state and local governments.[14] 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 forthcoming). Consequently, PPP effects on *wage earnings* were likely progressive. But only about half of PPP relief flowed through to earnings.[15] The rest was used for other business expenses, distributed as profits, or retained in the businesses—suggesting PPP effects on *non-wage income* were likely regressive.

We use population-level tax data to estimate non-wage PPP effects. First, based on the number of employees and total employee compensation, we estimate all 2020 PPP loans to eligible businesses.[16] 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 six percent of non-wage PPP, which was much more than prior assumptions. Ranking by wages, this implies top-quintile and bottom-quintile incomes increased by only three percent while middle-quintile incomes increased by an even smaller one percent. Overall, indirect PPP relief caused relatively small percentage changes to income and had a U-shaped distribution. This suggests indirect PPP relief had little effect on the larger sources of strongly progressive direct relief, and post-relief trends remain strongly progressive.

[14] Dalton's (forthcoming) estimate of average PPP cost per annual job of $141,000 is in the mid-range of prior estimates: $32,000–67,000 (Bartik et al. 2021), $150,000 (Doniger and Kay 2022), and $169,000–258,000 (Autor et al. 2022b). Higher estimates resulted from analyses focusing only on larger employers. Dalton's (forthcoming) estimate suggests PPP increased employment by approximately 6 million job years.

[15] 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 forthcoming)

[16] Since the 2021 PPP loans were more targeted, limited to businesses with fewer employees and with revenue losses, its effects on progressivity are likely similar to or more progressive than the 2020 PPP loans discussed here.

5. Summary

With a panel of tax data, we follow individuals over recent business cycles. Reflecting the rapid pace of the economic recovery, since 2019 about half of workers had higher real earnings (after adjusting for inflation) in both 2020 and 2021. Yet, this overall stability masks trends for low-income workers who experienced substantial earnings declines in 2020.

However, earnings gains have been progressive in the recovery, partially offsetting the regressive earnings losses in the 2020 downturn. Among workers in the bottom quintile before the Covid recession, real median earnings fell 31 percent in 2020 and then increased slightly in 2021, making it 26 percent lower than real pre-Covid earnings. The earnings increases in 2021 for this lowest-earning group greatly exceeded that in higher earnings quintiles, although the two-year earnings change still lags behind those who entered the recession with higher earnings.

Progressive policy responses, especially from expanded unemployment benefits and stimulus checks, also offset initial market earnings losses. When including fiscal relief, bottom-quintile workers saw their earnings increase substantially in 2020 and then stabilize in 2021 as market earnings gains offset the withdrawal of fiscal relief. We contrast these findings with the 2001 and 2008 recessions. In these earlier recessions, earnings changes were more proportional over the distribution and fiscal relief had only modest effects. Consequently, the distributional impacts of the Covid recovery and policy response have been far more progressive than in prior recessions.

References

Autor, David, David Cho, Leland D. Crane, Mita Goldar, Byron Lutz, Joshua Montes, William B. Peterman, David Ratner, Daniel Villar, and Ahu Yildirmaz. 2022a. "The $800 Billion Paycheck Protection Program: Where Did the Money Go and Why Did It Go There?" *Journal of Economic Perspectives* 36 (2): 55–80.

Autor, David, David Cho, Leland D Crane, Mita Goldar, Byron Lutz, Joshua Montes, William B Peterman, David Ratner, Daniel Villar, and Ahu Yildirmaz. 2022b. "An Evaluation of the Paycheck Protection Program using Administrative Payroll Microdata." *Journal of Public Economics* 211, 104664.

Bartik, Alexander, Marianne Bertrand, Feng Lin, Jesse Rothstein, and Matt Unrath. 2020. "Measuring the Labor Market at the Onset of the COVID-19 Crisis." *Brookings Papers on Economic Activity* 2020(2): 239–268.

Bartik, Alexander, Zoe B. Cullen, Edward L. Glaeser, Michael Luca, Christopher T. Stanton, and Adi Sunderam. 2021. "The targeting and impact of paycheck protection program loans to small businesses." NBER Working Paper 27623.

Berman, Yonatan. 2020. "The Distributional Short-Term Impact of the COVID-19 Crisis on Wages in the United States." Working Paper.

Berman, Yonatan. 2022. "Absolute Intragenerational Mobility in the United States, 1962–2014." *Journal of Economic Inequality* 20: 587–609.

Blanchet, Thomas, Emmanuel Saez, and Gabriel Zucman. 2022. "Real-Time Inequality." NBER Working Paper 30229.

Busch, Christopher, David Domeij, Fatih Guvenen, and Rocio Madera. 2021. "Skewed Idiosyncratic Income Risk over the Business Cycle: Sources and Insurance." *American Economic Journal: Macroeconomics* 14(2): 207–242.

Cajner, Tomaz, Leland D. Crane, Ryan A. Decker, John Grigsby, Adrian Hamins-Puertolas, Erik Hurst, Christopher Kurz, and Ahu Yildirmaz. 2020. "The US Labor Market during the Beginning of the Pandemic Recession." *Brookings Papers on Economic Activity* 2020(2): 3–33.

Chetty, Raj, John N. Friedman, Nathanial Hendren, Michael Stepner, and the Opportunity Insights Team. 2022. "The Economic Impacts of COVID-19: Evidence from a New Public Database Built Using Private Sector Data." NBER Working Paper no. 27431.

Clemens, Jeffrey, Philip G. Hoxie, and Stan Veuger. 2022. "Was Pandemic Relief Effective Fiscal Stimulus? Evidence from Aid to State and Local Governments." NBER Working Paper 30168.

Cortes, Guido Matias, and Eliza C. Forsythe. 2021. "Impacts of the Covid-19 Pandemic and the CARES Act on Earnings and Inequality." Working Paper.

Cortes, Guido Matias, and Eliza Forsythe. 2022. "The Heterogeneous Labor Market Impacts of the COVID-19 Pandemic." *ILR Review*. https://doi.org/10.1177/00197939221076856

Dalton, Michael. Forthcoming. "Putting the Paycheck Protection Program into Perspective: An Analysis Using Administrative and Survey Data." *National Tax Journal.*

Doniger, Cynthia and Benjamin Kay. 2022. "Long Lived Employment Effects of Delays in Emergency Financing for Small Businesses" Working paper. http://dx.doi.org/10.2139/ssrn.3747223.

Fitzgerald, John, Peter Gottschalk, and Robert Moffitt. 1998. "An Analysis of Sample Attrition in Panel Data: The PSID." *Journal of Human Resources* 33(2): 251–299.

Greig, Fiona, Erica Deadman, and Tanya Sonthalia. 2022. "Household Pulse: The State of Cash Balances at Year End." www.jpmorganchase.com/institute/research/household-income-spending/household-pulse-cash-balances-at-year-end#finding-1

Guvenen, Fatih, Serdar Ozkan, and Jae Song. 2014. "The Nature of Countercyclical Income Risk." *Journal of Public Economics* 122(3): 621–660.

Internal Revenue Service and Joint Committee on Taxation. 2022. "5-Percent Individual Sample from IRS tax document population." Last updated August 18, 2022. (accessed October 5, 2022).

Kaplan Greg, and Giovanni L. Violante. 2014. "A Tale of Two Stimulus Payments: 2001 versus 2008." *American Economic Review* 104(5): 116–121.

Larrimore, Jeff, Jacob Mortenson, and David Splinter. 2020. "Presence and Persistence of Poverty in US Tax Data." NBER Working Paper 26966.

Larrimore, Jeff, Jacob Mortenson, and David Splinter. 2022a. "Earnings Shocks and Stabilization During COVID-19." *Journal of Public Economics* 206: 104597.

Larrimore, Jeff, Jacob Mortenson, and David Splinter. 2022b. "Income Declines During COVID-19." *AEA Papers & Proceedings* 112: 340–344.

Larrimore, Jeff, Jacob Mortenson, and David Splinter. Forthcoming. "Unemployment Insurance in Survey and Administrative Data." *Journal of Policy Analysis and Management*.

McKinney, Kevin L., John M. Abowd, and Hubert P. Janicki. 2022. "U.S. Long-Term Earnings Outcomes by Sex, Race, Ethnicity, and Place of Birth," *Quantitative Economics* 13(4): 1879–1945.

Meyer, Bruce D., Connacher Murphy, and James X. Sullivan. 2022. "Changes in the Distribution of Economic Well-Being During the COVID-19 Pandemic: Evidence from Nationally Representative Consumption Data." NBER Working Paper 29878.

Meyer, Bruce D., Derek Wu, Grace Finley, Patrick Langetieg, Carla Medalia, Mark Payne, and Alan Plumley. 2020. "The Accuracy of Tax Imputations: Estimating Tax liabilities and Credits Using linked Survey and Administrative Data." NBER Working Paper 28229.

Moffitt, Robert A. and James P. Ziliak. 2020. "COVID-19 and the US Safety Net." *Fiscal Studies* 41(3): 515–548.

Montenovo, Laura, Xuan Jiang, Felipe Lozano Rojas, Ian M. Schmutte, Kosali I. Simon, Bruce A. Weinberg, and Coady Wing. 2020. "Determinants of Disparities in Covid-19 Job Losses." NBER Working Paper 27132.

Parker, Jonathan A., Nicholas S. Souleles, David S. Johnson, and Robert McClelland. 2013. "Consumer Spending and the Economic Stimulus Payments of 2008." *American Economic Review* 103(6): 2530–2553.

Rothbaum, Jonathan and Adam Bee. 2021. "Coronavirus Infects Surveys, Too: Nonresponse Bias During the Pandemic." Census Bureau Working Paper SEHSD WP2020-10.

Semega, Jessica and Melissa Kollar. 2022. "Income in the United States: 2021." Census Bureau Report P60-276.

Splinter, David Splinter. Forthcoming. "Stimulus Checks: True-Up and Safe Harbor Costs." *National Tax Journal*.

ONLINE APPENDIX

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

Jeff Larrimore, Jacob Mortenson, David Splinter

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	41.0	53.8	56.7	71.7	73.3	61.3	30.8	19.5	4.6
2019 to 2021	44.5	52.7	50.5	68.5	64.8	54.5	24.0	12.1	4.1

Note: Among workers aged 25 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	66.0	8.8	1.8	96.5	8.9	1.5
2019 to 2021	-25.8	0.9	-0.8	61.6	7.7	0.6	87.4	6.8	1.5

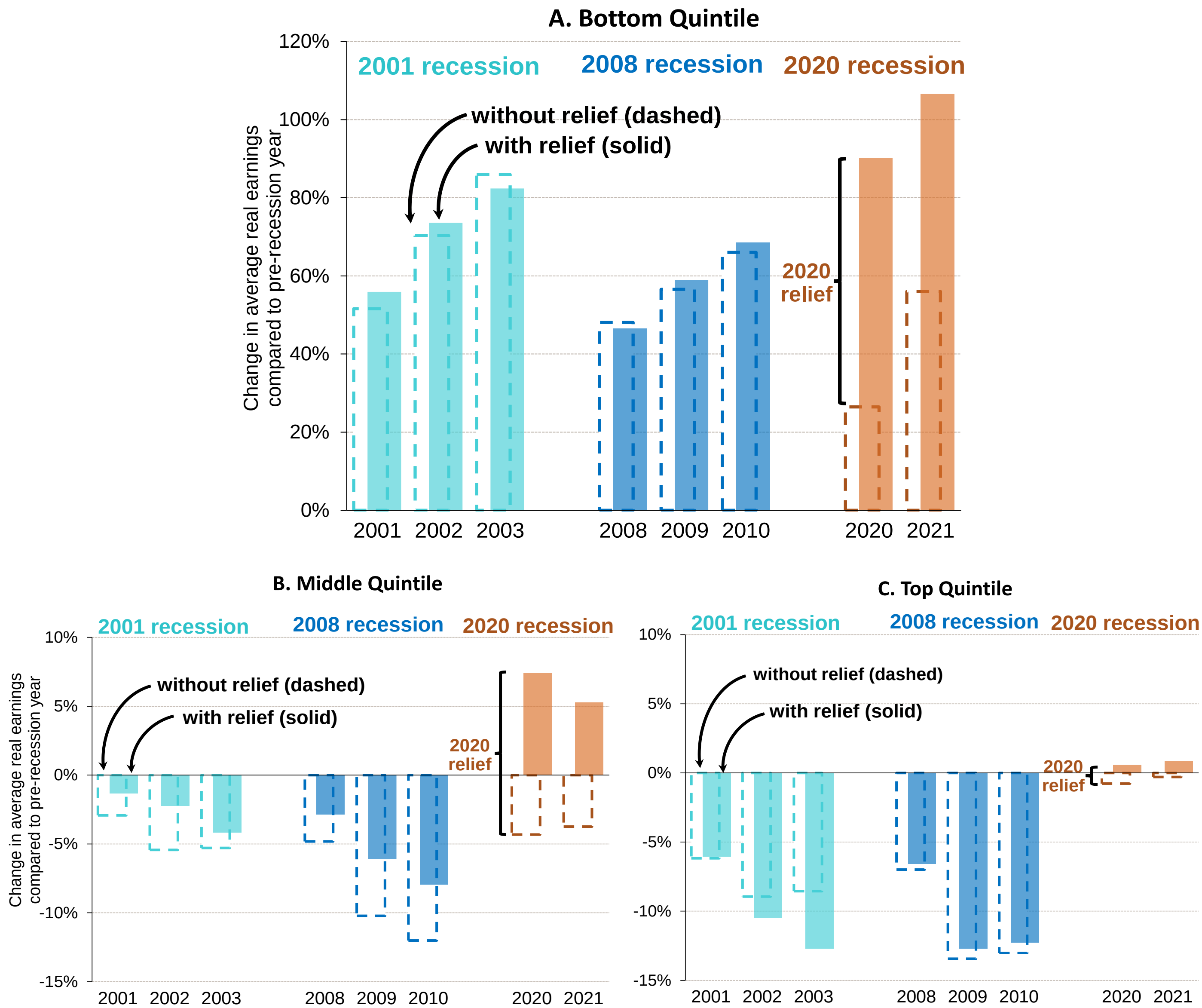
Note: Among workers aged 25 to 99 with earnings or unemployment benefits in the pre-recession year and alive at end of specific year. Earnings are indexed with the chained CPI-U. *Source*: Authors' calculations using tax data.

Table A3. Decomposition of share of workers with at least a 10% real earnings decline

		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)		-14.1	-27.0	-2.2	-9.0	-21.6	-1.7
Share of change	Unemployment Ins.	65%	52%	53%	39%	40%	17%
	Stimulus checks	35%	48%	47%	53%	55%	62%
	Advanced CTC	---	---	---	8%	6%	21%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
		C: 2019–2021 (2-year): No dependents			**D: 2019–2021 (2-year): With dependents**		
Total Change (pp)		-7.7	-19.0	-1.0	-11.6	-28.2	-2.6
Share of change	Unemployment Ins.	44%	41%	30%	33%	38%	12%
	Stimulus checks	55%	58%	70%	50%	48%	58%
	Advanced CTC	1%	1%	0%	17%	14%	31%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Note: Among workers ages 25 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 plus unemployment benefits in the initial year. Children include dependents younger than 17 years old claimed on tax returns.
Source: Authors' calculations using tax data.

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



Note: Among workers aged 25 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

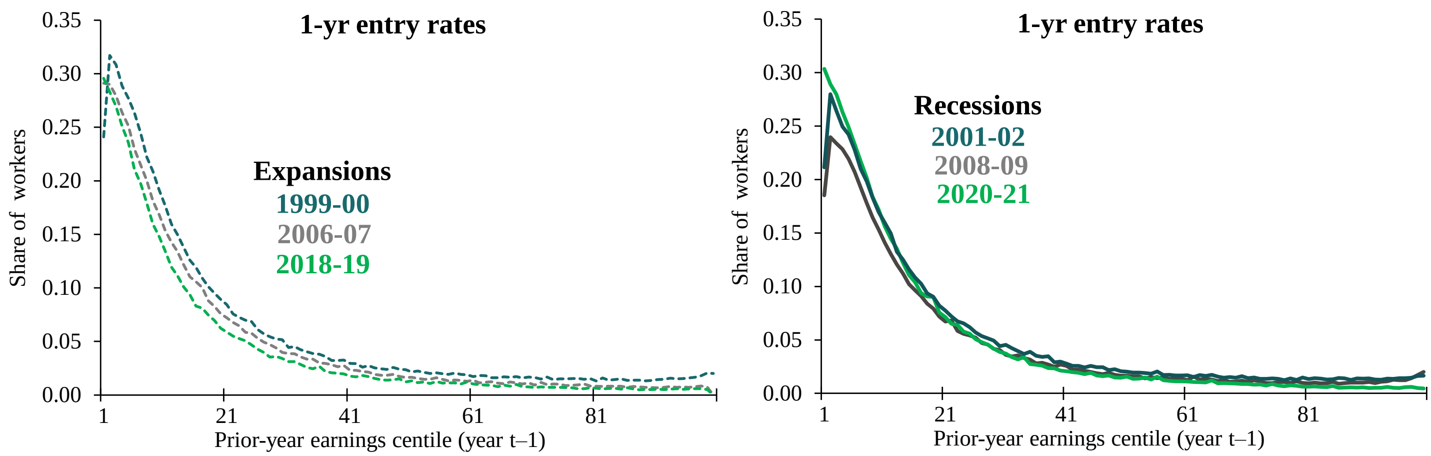
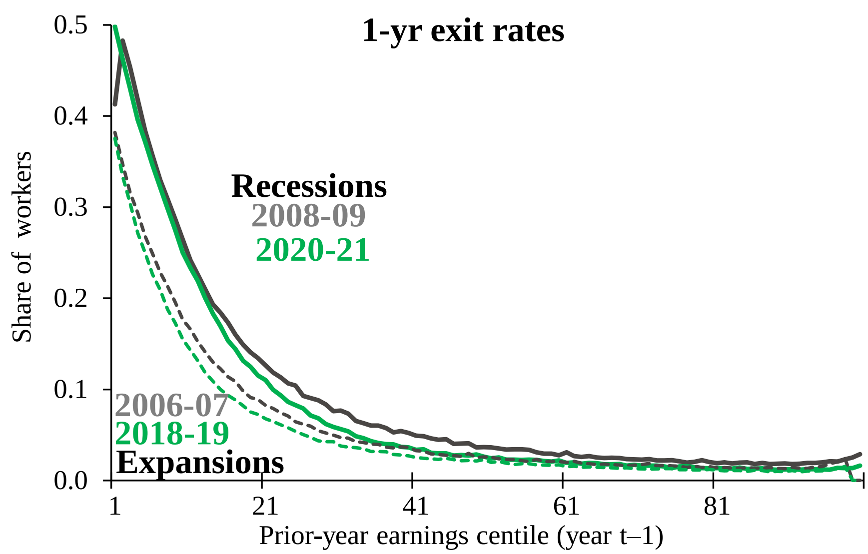
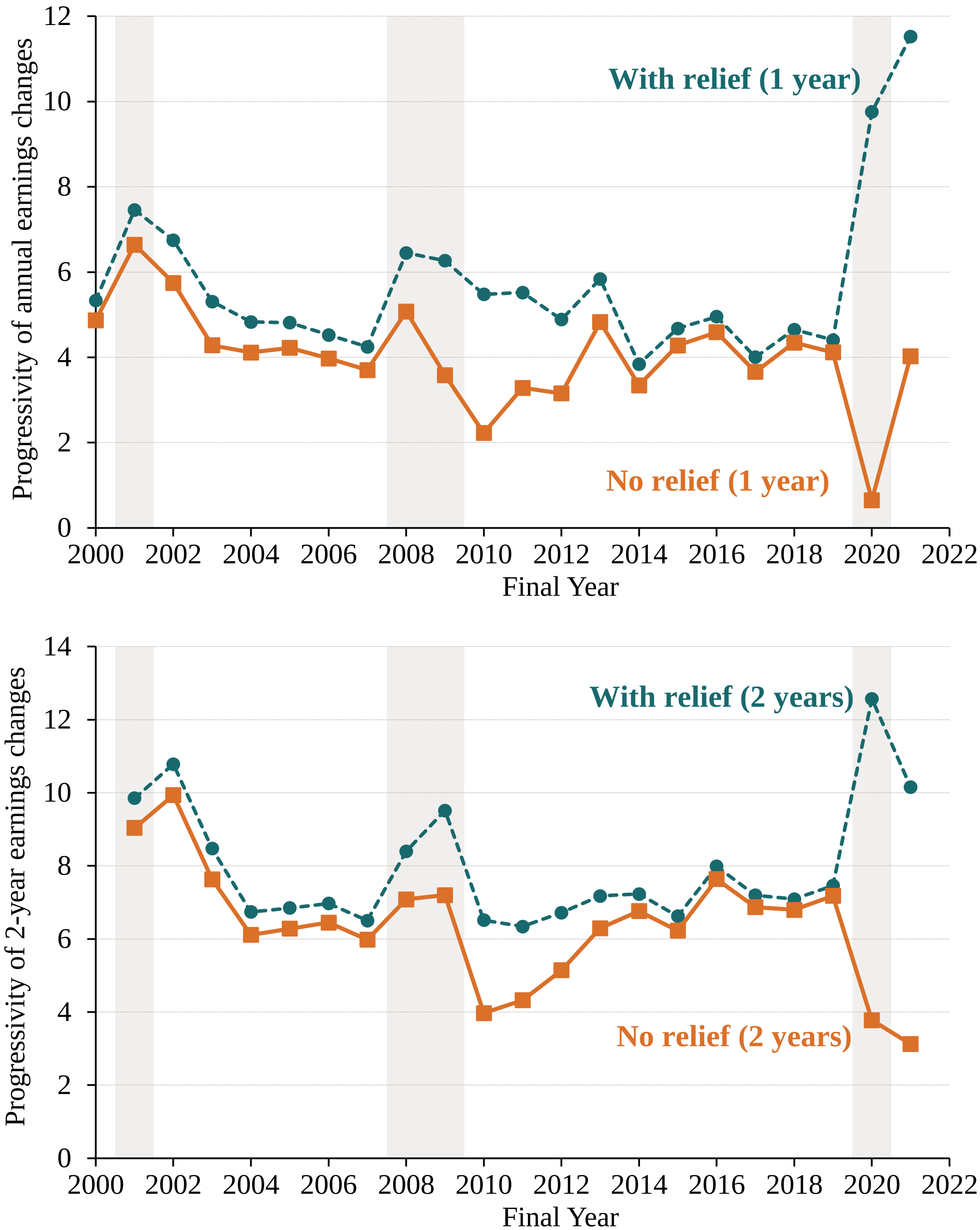


Figure A3: Exit rates: Share of initial-year workers without any earnings in next year



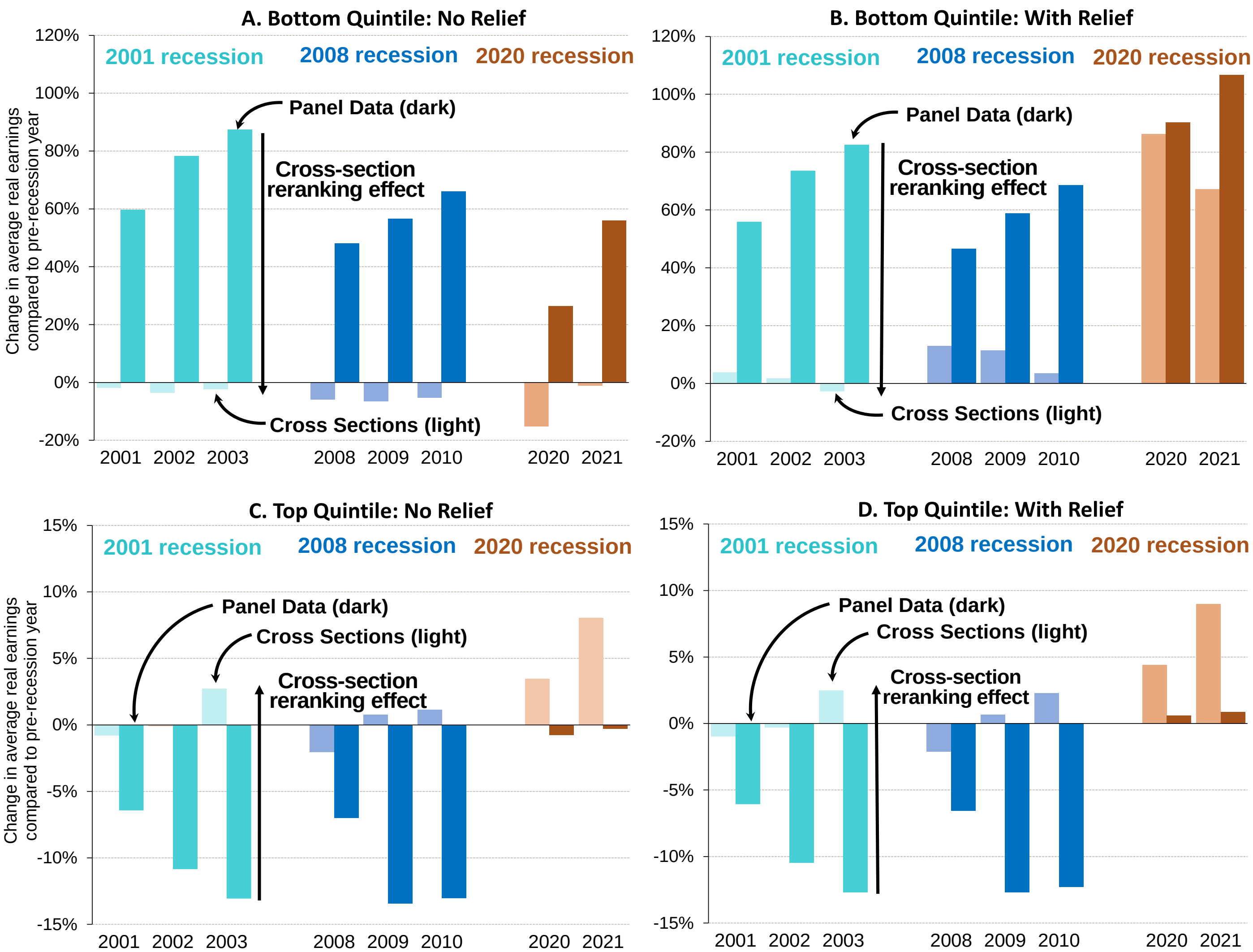
Note: Entry includes adults with no initial-year earnings and any next-year earnings. Exit includes adults with any initial-year earnings and no next-year earnings. Relative to earnings if adults worked the entire year, part-year employment increases the share of entry and exit appearing at the bottom of the earnings distribution. Among those aged 25 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 25 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: Panel vs. Cross-Section Data:
Average real earnings relative to pre-recession year, by earnings quintile

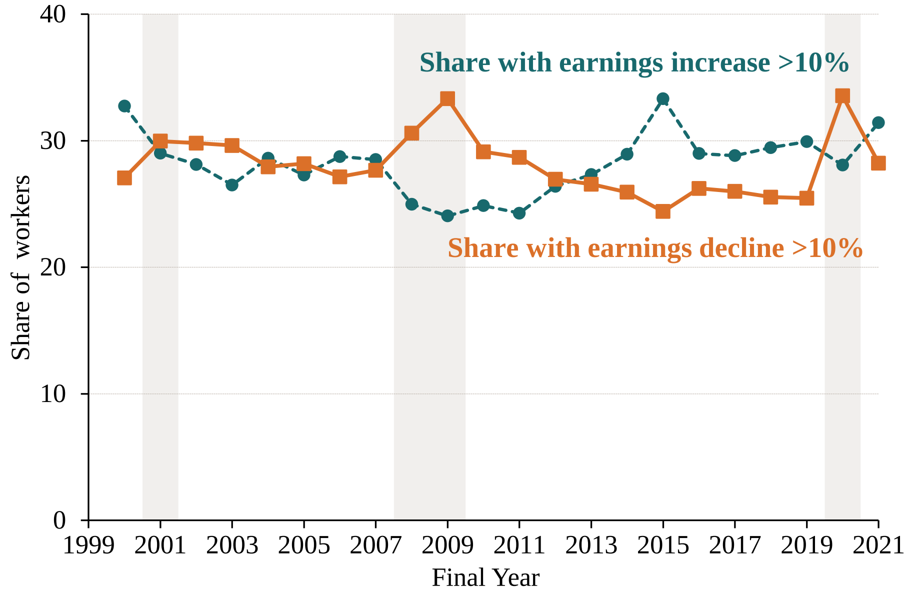


Note: Relative to cross-sectional measures, panel data control for significant re-ranking due to earnings mobility and are valuable for following the trajectory of the same individuals. Relative to cross-sectional earnings changes, panel changes show more progressive changes: higher mobility in the bottom quintile and lower mobility in the top quintile. Cross-section re-ranking effects are the differences between cross-sectional and panel changes relative to pre-recession years (2000, 2007, and 2019). Cross-sectional results are among workers aged 23 and older alive at end of the year who had earnings in the current year, with no restrictions on earnings in prior years. Panel results are among workers aged 25 to 99 with earnings or unemployment benefits in pre-recession year and alive at end of specific year. 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. For other comparisons and literature reviews, see Berman and Bourguignon (2022) and Splinter (2019). *Source*: Authors' calculations using tax data.

Berman, Yonatan, and Francois Bourguignon. 2022. "Anonymous and Non-Anonymous Growth Incidence Curves: United States, 1968–2016." Working paper.

Splinter, David. 2019. "Progressive Growth: Comparing Cross-Sectional and Panel Approaches." Working paper.

Figure A6: Share of workers with real annual earnings changes of at least 10%



Note: Among workers aged 25 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.

APPENDIX B: Imputation Procedure for Late 2021 Form W-2 Data

A. Description of the Imputation Procedure

This appendix describes our procedure to account for yet-to-be-processed Form W-2s for 2021. 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 August 18th, 2022. Form W-2 data currently spans tax years from 1999 to 2021 and includes a processing date. We use patterns in W-2 processing in the two prior years, 2019 and 2020, to impute missing data for individuals that received W-2s in 2021 that have not been processed. As of August 18th, 2022, there were 256.4 million W-2 forms for tax year 2021. At the same point in 2021 (2020), there were 244.9 (257.6) million W-2 forms from tax year 2020 (2019), which was 96.0 (97.2) percent of all W-2 forms for that year. 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 2019 and 2020, and, in the current draft, *D* corresponds to August 18th, 2020 (for the tax year 2019 data), or August 18th, 2021 (for the tax year 2020 data), where all dollar amounts are inflation-adjusted to 2021 price levels using chained-CPI.

The coefficient estimates are then used to generate predicted values for individuals in 2021, 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 39,000 individuals (unweighted in a 5-percent sample, so representing about 780,000 individuals) are assigned late W-2s. This is between the approximately 35,000 individuals that received W-2s processed after August 18th in tax year 2019 and 41,000 in 2020. The following steps determine the amounts of wages corresponding with the assigned late W-2.

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 2019 and 2020, 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 and 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 their random number was in. Table B.1 contains a summary of the assignment produced in this step, as well as the (observed) distribution across bins in tax years 2019 and 2020.

The third step assigns a wage amount to those individuals assigned a late W-2 in the first step. Using tax year 2019 and 2020 late-processed W-2 recipients, late W-2 recipients in 2021 are randomly assigned a wage value drawn from the pooled distribution of 2019 and 2020 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 2019 and 2020. The sampling is done with replacement.

B. Evaluation of the Imputation Procedure

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 count and distribution of late W-2 wages in tax year 2019 and 2020, 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 B.2 contains counts of W-2s processed in 2020, 2021, and 2022 before and after August 18th, for tax years 2019, 2020, and 2021, respectively. The counts after August 18th, 2022, for tax year 2021 are the result of the imputation procedure described above.

2. Distribution. Figure B.1 displays the distribution of W-2 wages for W-2s processed after August 18th, for those with wages below $50,000. The series for tax year 2021 is the result of the imputation procedure.

Table B.1: Counts of late W-2 Forms by Prior-year Wage Bin (5% sample)

Prior-year Wage Bin	2019	2020	2021 (imputed)
$1 to $2,000	6,183	6,512	5,433
$2,001 to $20,000	13,854	15,700	16,204
$20,001 to $100,000	13,355	17,924	16,204
$100,001 or more	1,240	1,251	1,023
Total	**34,632**	**41,387**	**38,864**

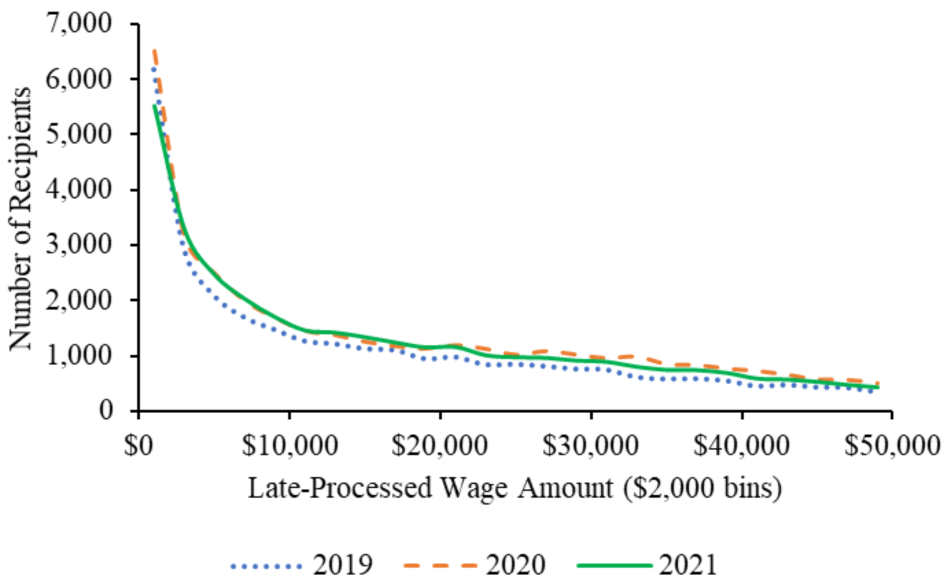
Note: Among workers aged 25 to 99 with earnings or unemployment benefits in the prior year and alive at end of each year. Earnings are indexed with the chained CPI-U. *Source*: Authors' calculations using tax data.

Table B.2: Number of Workers with W-2 Forms Processed Before and After August 18th (5% sample)

Tax Year	Before	After
2019	6,890,297	34,632
2020	6,849,808	41,387
2021	6,824,055	38,864

Note: Among workers aged 25 to 99 with earnings or unemployment benefits in the prior year and alive at end of each year. August 18th is the following calendar year (e.g., tax year 2019 processing before and after is relative to August 18th, 2020). Tax year 2021 after counts are imputed. *Source*: Authors' calculations using tax data.

Figure B.1: Distribution of Late-Processed W-2s Below $50,000 (5% sample)



Note: Among workers aged 25 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 2021 counts are imputed. *Source*: Authors' calculations using tax data.

APPENDIX C: Imputation Procedure for PPP Relief

This appendix describes our procedure to estimate the distribution of Payment Protection Plan (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 (forthcoming) 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 (forthcoming) discusses reasons for differences.

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 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, suggesting a more progressive distribution than the 2020 PPP loans discussed here.

A. Estimating Businesses-Level 2020 PPP Loans: Totals and Distribution

PPP loans totaled about $520 billion in 2020, which includes the first two "tranches." This was out of $670 billion that was allocated (in 2021 an additional $285 billion was allocated). 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 nearly all businesses with fewer than 500 full-time equivalent employees. The 2020 loan amount was up to 10 weeks 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 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.

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 C1. 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."

B. Linking Business-Level PPP Loans to Individual Tax Returns

The business-level estimates of PPP loans are linked to individual tax returns or W-2 forms. 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 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 no linking of loans for C corporations and non-profits and half explained by incomplete links of loans for partnerships and S corporations.

The estimated distributions of PPP loans among tax filers are shown in Table C2. 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 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). Columns 4 shows PPP shares of wages ranked by wages. Results are similar, except percentage changes are larger because wages are smaller than income.

Table C1: 2020 PPP loan counts and amounts by loan size

Loan Size	**PPP loan counts (thousands)**		**PPP loan amounts ($billion)**	
	SBA	**Tax Data**	**SBA**	**Tax Data**
>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 C2: Distribution of 2020 PPP 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

Autor, David, David Cho, Leland D. Crane, Mita Goldar, Byron Lutz, Joshua Montes, William B. Peterman, David Ratner, Daniel Villar, and Ahu Yildirmaz. 2022. "The $800 Billion Paycheck Protection Program: Where Did the Money Go and Why Did It Go There?" *Journal of Economic Perspectives* 36 (2): 55–80.

Dalton, Michael. Forthcoming. "Putting the Paycheck Protection Program into Perspective: An Analysis Using Administrative and Survey Data." *National Tax Journal.*

Small Business Administration. 2021. "Forgiveness Platform Lender Submission Metrics, December 26, 2021." Accessed 1/18/2023. https://www.sba.gov/sites/default/files/2021-12/2021.12.26_Weekly%20Forgiveness%20Report_Public-508.pdf