

# **Thriving or Surviving? Examining the Effects of Self-Employment on Mental Health During the COVID-19 Pandemic\***

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**ABSTRACT:** The COVID-19 pandemic brought turbulent changes in both the labor market and individuals' mental well-being. This study investigates how self-employment affects workers' mental health by analyzing pandemic-period data, with a special focus on the ending of the Pandemic Unemployment Assistance (PUA). One major finding is self-employed individuals experienced slightly more mental distress during the COVID-19 pandemic in comparison to employees, controlling for various factors. Furthermore, married self-employed individuals exhibited lower psychological distress compared to their unmarried counterparts. By utilizing triple difference models, we find the ending of PUA had negative impacts on the mental health of both self-employed workers and employees, but the negative impact was unexpectedly more pronounced among employees.

**KEYWORDS:** self-employment, mental health, COVID-19, Pandemic Unemployment Assistance (PUA)

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## **I. Introduction**

Mention of the COVID-19 pandemic may evoke memories of a time marked by lockdowns, business closures, and numerous uncertainties. Constant concerns about infection, lack of social activities, and financial instability collectively contribute to pervasive mental distress and anxiety. The COVID-19 pandemic has brought the critical issue of mental health to the forefront. The World Health Organization reported an increase of 25% in the global prevalence of anxiety and depression in the first year of the COVID-19 pandemic (World Health Organization, 2022). The pervasive mental health challenges may be interconnected with significant employment crises induced by the COVID-19 pandemic (de Miquel et al., 2022; Edwards et al., 2022). To reduce financial stress, a growing number of individuals sought alternative ways of earning a living and shifted to self-employment during the pandemic. In the US, the share of self-employed workers in the labor force had an increase of approximately 0.4 percentage points from February 2020 to August 2020 (Gregory et al., 2023).

In light of the COVID-19 pandemic, which has witnessed an upsurge in self-employment and concurrent mental health challenges, there exists a compelling need to explore the nature and extent of their correlation. Therefore, this paper contributes to the investigation of the impacts of self-employment on mental health during the COVID-19 pandemic. Our approach to this research question builds upon previous research that utilizes the difference-in-difference model to examine the impact of self-employment and pandemic unemployment insurance on individuals' mental health. Taking a step further, we analyze the issue by utilizing a simple OLS model, an OLS model with a moderating variable, an unweighted triple difference model, and a triple difference model with inverse propensity weighting (IPW). Especially, by introducing IPW to the triple difference model, our study balances observed characteristics between self-employed

and employee groups and thus meets the parallel trend assumption, a facet that has been previously overlooked in the literature.

Existing literature on the mental health outcomes of self-employment has yielded diverse and inconsistent conclusions. For example, Zhou et al. (2023) suggest that self-employment significantly decreases the tendency of depression among the younger elderly aged 60–69, whereas Parslow et al. (2004) argue that self-employment has no positive impact on mental health for either females or males. Furthermore, most of the relevant past research was conducted before the COVID-19 pandemic. We believe the COVID-19 pandemic presents a distinctive context for this issue considering its impacts on self-employment and mental health. Therefore, given the inconsistency of previous studies, our study uses the more recent 2021 Household Pulse Survey dataset from the pandemic period in an attempt to get up-to-date insights and reconcile the existing conflicts.

By utilizing econometrics models and techniques, we find statistically significant evidence that self-employed workers tend to experience slightly more mental distress than employees during the pandemic. Additionally, our OLS model with marital status as a moderating variable offers deeper insights into group differences. We discover that the negative impact on the mental well-being of married individuals is smaller compared to their unmarried counterparts. In addition, we get unexpected results from analyzing the impact of ending Pandemic Unemployment Assistance (PUA) on workers' mental health. Both weighted and unweighted triple difference models show that mental distress increases among both self-employed workers and employees after the end of PUA, but the increase is unexpectedly greater among employees, who were not the primary target of the PUA.

Our research paper is organized as follows. Section II reviews past literature on mental health outcomes of self-employment and provides background about the COVID-19 pandemic and the Pandemic Unemployment Assistance (PUA). Section III provides an overview of our dataset, key variables of interest, the termination of the PUA policy, and summary statistics. Section IV exhibits four empirical models and corresponding results: a simple OLS model, an OLS model with a moderating variable, and triple difference models with and without inverse propensity weighting. Section V presents the conclusion of the research and outlines possible insights for researchers and policymakers.

## **II. Literature Review and Background**

### **Self-Employment and Mental Health**

In the past decades, the rise of self-employment has shifted the structure of the economy from the traditional sectors to new industries (Audretsch & Thurik, 2000). A self-employed person, unlike an employee who works for someone else, independently takes control of his/her own business and is fully responsible for all decisions made by the organizational unit (Bjuggren et al., 2012). Due to the differences in the underlying characteristics of job control and job demands between self-employment and traditional employment, these two forms of employment are expected to lead to different health outcomes. Past research suggests that compared to employees, the self-employed usually have better physical health outcomes, such as lower blood pressure, lower somatic morbidity, and lower prevalence rates of hypertension (Stephan & Roesler, 2010). The differences in mental health outcomes, however, have received less attention in the literature compared with physical health, and the existing literature presents conflicting findings.

Research evidence from various countries and region reveal significant positive effects of self-employment on mental health. In China, Zhou et al. (2023) discover that self-employment significantly decreases depression tendencies among the younger elderly aged 60–69 through mechanisms of income growth effect and self-worth realization effect. In Germany, Nikolova (2019) finds the health effects of self-employment vary by the type of entrepreneurship. Relying on the Job Demand-Control model, Nikolova investigates the physical and mental health consequences of two types of self-employment: necessity entrepreneurship and opportunity entrepreneurship. He uses the difference-in-differences (DID) method after entropy balancing and finds that the necessity entrepreneurs experience improvements in their mental health but not in their physical health, while opportunity entrepreneurs experience gains in both physical and mental health. However, this study fails to take unobservable time-variant variables into account, and we adapt time-fixed effects in our model to deal with the problem.

Meanwhile, research by Stephan et al. (2020) in the United Kingdom finds that the impact on mental health changes over the course of self-employment. Using the Stressor-Strain Outcome model as their theoretical model, they apply pooled OLS regression, fixed effects regression, and the difference-in-difference models to investigate the physical and mental health effects of self-employment and test whether these health effects are due to enhanced stress and whether they differ between men and women. The results suggest that those with poorer mental health are more likely to self-select into self-employment. Compared to those who stay in paid employment, self-employed males but not self-employed women experience an initial boost in mental health at the early stage of self-employment due to reduced work-related strain, but the positive effects revert to pre-self-employment levels over the long term (four years). However, they find no relationship between self-employment and physical health.

Other research, however, displays little or no effects of self-employment on mental health. Tuttle and Garr (2009) in their analysis, point out that self-employment has no direct influence on the mental health of female workers. Parslow et al. (2004) even conclude that self-employment has no positive associations with mental health for men and women. Given the contradicted evidence and lingering debate in the literature, our study aims to reconcile the conflicting points of view and add evidence in the context of the United States during the pandemic.

### **COVID-19 and PUA**

As a result of the COVID-19 pandemic, the working mode, mental health, and unemployment insurance have undergone significant changes, making the problem of self-employment and mental health even more complicated. During the pandemic, the US federal government implemented unprecedented unemployment benefits, including Pandemic Emergency Unemployment Compensation (PEUC), Pandemic Unemployment Assistance (PUA), FPUC (Federal Pandemic Unemployment Compensation), and Mixed Earner Unemployment Compensation (MEUC). The policy our research focuses on is the Pandemic Unemployment Assistance (PUA), enacted in March 2020 by President Trump signing into law the Coronavirus Aid, Relief, and Economic Security (CARES) Act. It targeted people who were unable to work as a direct result of COVID-19 and were not eligible for regular state unemployment benefits, such as independent contractors or self-employed workers (*PUA Tip Sheet 20-0424.Pdf*, n.d.). PUA provided up to 39 weeks of retroactive payments to qualifying individuals for weeks of unemployment, partial employment, or inability to work due to COVID-19 reasons starting on or after January 27, 2020, till December 31, 2020 (*U.S. Department Of*

*Labor Publishes Guidance on Pandemic Unemployment Assistance*, n.d.). In December 2020, President Trump signed the Consolidated Appropriations Act of 2021 to revive PUA through March 2021, and President Biden subsequently signed the American Rescue Plan in March 2021 to further extend PUA through September 6, 2021 (Holzer et al., 2021). However, during the validity period of PUA, many states opted out successively due to the strengthening labor markets and concern by businesses about “worker shortages.” For instance, eight states opted out of PUA in June 2021 and two other states opted out of PUA in July 2021. Indiana and Maryland attempted to opt out but were forced by the court to continue paying PUA benefits. Twenty-four states and the District of Columbia did not terminate PUA until September 2021 (Congressional Research Service, 2021).

Recent research demonstrates the ambiguous effects of early termination of unemployment benefit programs like PUA and FDUC on employment and mental health. Coombs et al. (2022) suggest that the early termination of pandemic unemployment insurance leads to more job opportunities and increased earnings for beneficiaries. However, these additional job opportunities would have materialized a few months later even without the premature termination. Berkowitz and Basu (2021) find that the termination of FDUC leads to an increased risk for food insufficiency, depressive symptoms, and anxiety symptoms. Thus, given the contradicted evidence from the literature about self-employment and mental illness and the complications of the labor market and mental health resulting from the COVID-19 pandemic, it is worthwhile to use the up-to-date dataset and reliable methods to investigate what are the impacts of self-employment on mental health during the pandemic.

### **III. Data Description**

#### **Dataset Overview**

The primary data source for this study is the Household Pulse Survey (HPS), which is a collaborative effort between the National Center for Health Statistics (NCHS) and the U.S. Census Bureau. This partnership of multiple federal agencies ensures the reliability of the data. The HPS contains data on participants' employment statuses, psychological distress levels, genders, ages, educational levels, races, information related to participants' households, etc. Data collection took place during the coronavirus pandemic, commencing on April 23, 2020. The purpose of the survey was to offer relevant information about the influence of COVID-19 in the U.S. and the impact of the government's COVID-19-related programs, hence appropriate for the purpose of our study. This survey recruited participants from different household units and diverse demographic groups, including different age groups, races, and educational levels, and thus national representative.

Our dataset has originally 781,861 observations. We constrain our sample to workers only, which includes self-employed workers and employees while excluding unemployed individuals. After applying the constraint, the number of observations in our dataset is reduced to 569,531. As a result, our dataset specifically focuses on workers with normal working age, spanning from age 18 to 64. Note that our dataset covers a one-year period from January to December 2021, with the exception of November for which data originally is missing.

It is essential to acknowledge a few limitations of our dataset. The dataset is based on self-reported questionnaires and the questionnaire was designed relatively quickly compared to other federal statistical surveys, which could lead to potential weaknesses in reliability and



validity (Centers for Disease Control and Prevention, 2023). Also, bias can arise due to the misunderstanding of the questions or the inaccurate responses by participants, and some individuals who did not provide identifiable contact information are not included in the dataset. Additionally, respondents who chose not to disclose their mental health status or failed to answer all questions were excluded.

### **Construction and Interpretation of Primary Variables**

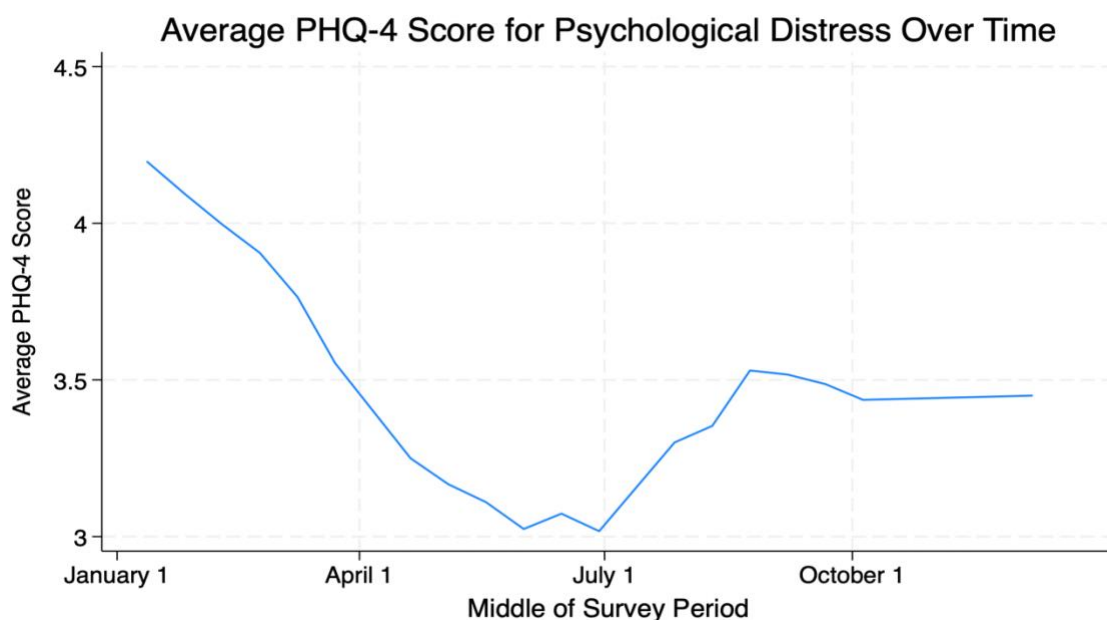
The treatment variable of this study is self-employment, which equals 1 if the individual is self-employed and equals 0 if the individual is an employee. This binary indicator is generated based on the original variable, the sector of employment, in our dataset. The sector of employment is categorized into 6 groups: government, private company, non-profit organization, self-employed, family business, and not employed. As mentioned, we first exclude the unemployed individuals since they are not subjects of this study. We label self-employment as 0 when the individual's employment sector is in government, private firms, nonprofit organizations, and family businesses, and as 1 when the employment sector is self-employment.

The continuous dependent variable is the PHQ-4 score for psychological distress, which is measured with the four-item patient health questionnaire for anxiety and depression. Each of the four items takes a score from 0 to 3, from least to most mental distress. By adding up the scores of the four items corresponding to participants' responses, we get a total PHQ-4 score, which has a maximum of 12 with a higher score representing more severe psychological distress. Getting a total score of 0-2 is viewed as normal, 3-5 as mildly depressed/anxious, 6-8 as moderately depressed/anxious, and 9-12 as severely depressed/anxious.

## Trends in the Dependent Variable PHQ-4 Score

The following figure shows the average PHQ-4 score of workers over time in 2021. The average PHQ-4 score exhibits a notable decline from January to June, decreasing from approximately 4.2 to 3. Then, it shows a somewhat fluctuating pattern with a minor initial increase and a subsequent decrease until July. Thereafter, a distinct rise in the average PHQ-4 score is observed. The average PHQ-4 score increases from 3 to 3.5 between July and late August, which aligns with the time some states ended PUA. Although a slight drop occurs afterward, the average PHQ-4 score stabilizes after October.

Figure 1: Average PHQ-4 Score for Psychological Distress Over Time

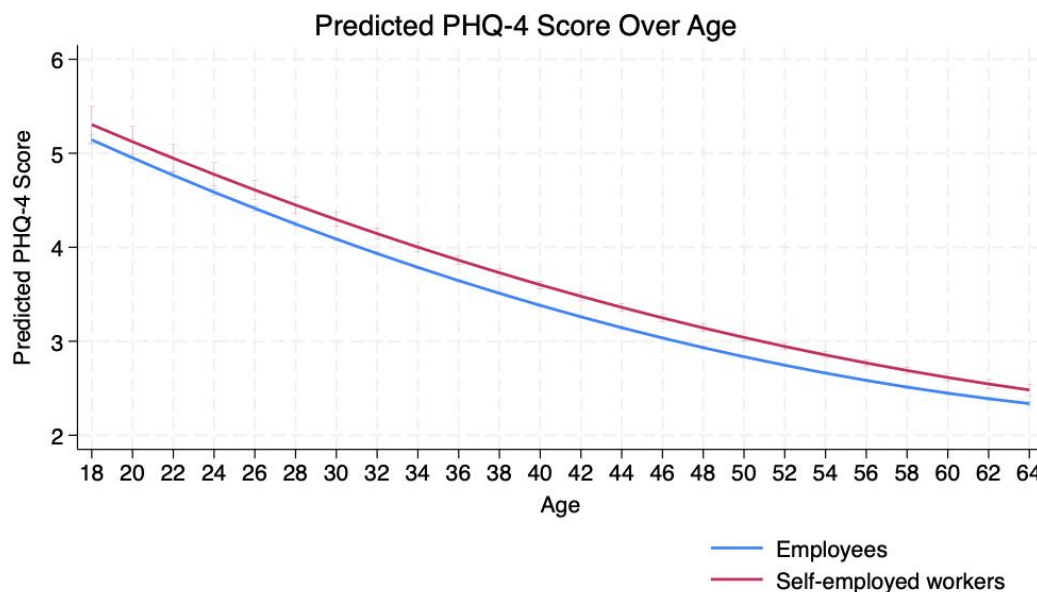


**Notes:** The figure illustrates the average PHQ-4 score among all workers over time in 2021. The horizontal axis represents the middle of the survey period, which are the dates in 2021. The calculation is made by getting the average PHQ-4 score at each midpoint of a survey period.

Figure 2 below shows the downward trend of predicted PHQ-4 scores for both self-employed workers and employees over the working age range of 18 to 64, which suggests a decrease in depressive and anxiety symptoms as age increases. Both groups exhibit similar trends with a gradual flattening effect as age increases, which suggests the rates of change of predicted

PHQ-4 scores decrease when age increases for self-employed individuals and employees. Notably, the curve for self-employed workers is always above the curve for employees, indicating self-employed individuals' higher mental distress than employees throughout the working age range. Also, as age progresses, the disparity in predicted PHQ-4 scores between groups widens slightly first but begins to narrow after around the age of 52.

Figure 2: Predicted PHQ-4 Score Over Age



*Notes:* The figure illustrates the predicted PHQ-4 score over the working age range of 18 to 64 for employees and self-employed workers. The prediction is made by regressing the PHQ-4 score over age and age squared. The horizontal axis represents the age of the individual.

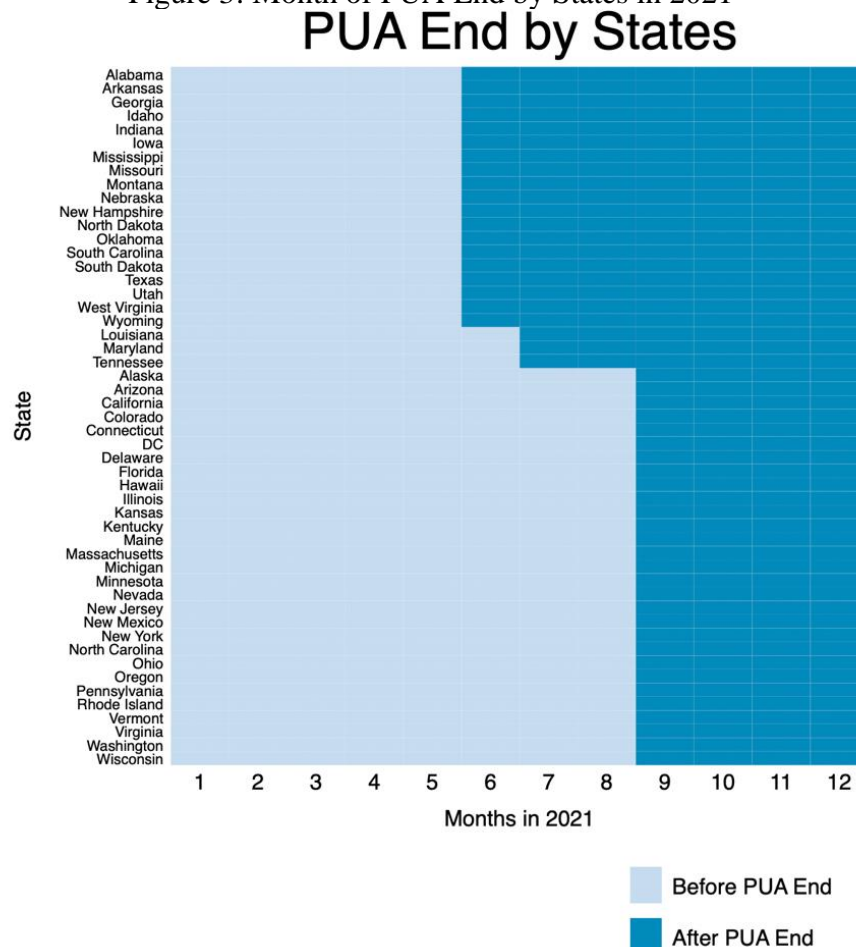
## Overview of PUA Termination

As mentioned in the literature review, the policy of interest in this study is the Pandemic Unemployment Assistance (PUA), which expanded the eligibility for unemployment benefits to self-employed workers. All states enacted the PUA in March 2020 according to the Coronavirus Aid, Relief, and Economic Security (CARES) Act, and it was extended twice by President Trump and President Biden to September 6, 2021. However, many states terminated the PUA prior to its expiration due to economic concerns. Iowa, Mississippi, and Missouri ended their

PUA on June 12, 2021; Alabama, Idaho, and Indiana ended their PUA on June 19; Arkansas, Georgia, and Montana ended their PUA on June 26; Maryland and Tennessee ended their PUA on July 3; Louisiana ended its PUA on July 31. Other states such as Alaska and Arizona, continued the PUA until its expiration in September 2021.

Figure 3 shows the timeline of PUA programs across states. From the beginning of 2021 to May 2021, all states were implementing PUA. In June 2021, the first batch of nearly 20 states terminated PUA programs. Subsequently, in July, three more states opted out. The rest of the states continued implementing PUA until its expiration in September 2021.

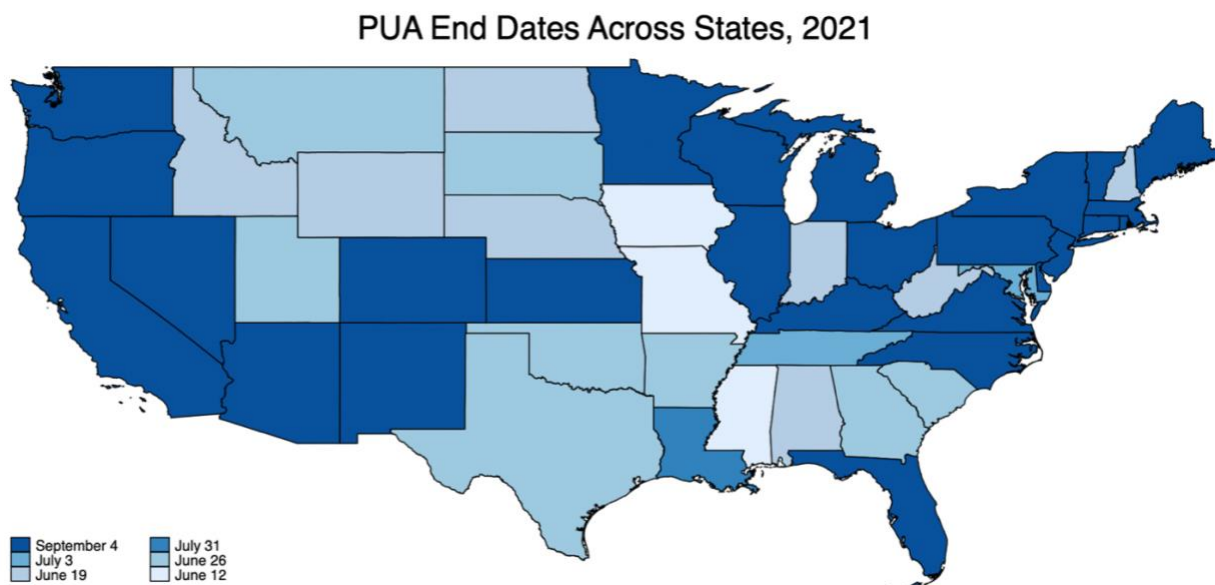
Figure 3: Month of PUA End by States in 2021



**Notes:** The figure illustrates the month of PUA end for each state in 2021. The horizontal axis represents months in 2021 (i.e.: 1 indicates the first month in 2021, which is January). The figure is created based on PUA end months, rather than exact dates. Therefore, if the program ended on any day in June, June and months after June are considered “After PUA Ends” while May and months before May are considered “Before PUA Ends.”

Figure 4 shows the distribution of PUA (Pandemic Unemployment Assistance) ending dates across states in the mainland U.S. There are six distinct PUA ending dates: June 12, 2021; June 19, 2021; June 26, 2021; July 3, 2021; July 31, 2021; and September 4, 2021. The shading on the map corresponds to the end dates of the PUA program, with darker shades indicating later end dates and paler shades representing earlier end dates. Overall, the map reveals that most states ended their PUA programs either in June or September, with only a few choosing to end their PUA programs in July. Although some exceptions exist, most states near the eastern and western coasts of the U.S. such as California and North Carolina tended to stick to PUA until its expiration in September. States in the central region like South Dakota, however, generally early terminated PUA in July or June. Another noteworthy observation is the tendency of neighboring or adjacent states to end their PUA programs on similar or closely aligned dates. For instance, both Iowa and Missouri ended their PUA programs on June 12, 2021, while both Idaho and Wyoming ended theirs on June 19.

Figure 4: PUA End Dates Across States in 2021



**Notes:** The figure illustrates PUA end dates across different states in the U.S. mainland in 2021.

## Summary Statistics

Table 1 shows the summary statistics of all continuous variables used in our estimations. We observe that workers in our sample have an average age of 45.437 and an average distress score of 3.185, which reflects mild depression and anxiety. Also, the average new daily confirmed COVID cases per 100,000 is 185.057. Table 2 shows summary statistics of all categorical variables. Especially, we observe that 89.49% of our sample are self-employed and 10.51% of the sample are employees.

Table 1: Summary Statistics of Continuous Variables

VARIABLES	Mean	SD
PHQ-4 score	3.185	3.463
Age	45.437	11.191
New Daily Confirmed COVID Cases	185.057	157.596

**Notes:** The table shows summary statistics for all continuous variables used in the estimation. Number of observations for each variable is 569,531. New daily confirmed COVID cases refers to new cases per 100,000 people over the past 7 days. Table 5 for variable description is attached in the Appendix.

Table 2: Summary Statistics of Categorical Variables

VARIABLES	Categories	%
Self-employment	Self-employed	89.49
	Employee	10.51
End of PUA	PUA not end	73.24
	PUA end	26.76
Married	no	39.78
	yes	60.22
Gender	Male	41.24
	Female	58.76
Race	White	81.64
	Black	7.39
	Asian	6.16
	Other/mixed	4.8
Hispanic	Non-Hispanic	90.29
	Hispanic	9.71
Aggregated educational attainment	Less than high school	1.11
	High school degree	36.88

	Bachelor's degree	32.81
	Graduate degree	29.2
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Total household income		
	Less than \$25,000	5.14
	\$25,000 - \$34,999	5.79
	\$35,000 - \$49,999	8.2
	\$50,000 - \$74,999	14.87
	\$75,000 - \$99,999	13.69
	\$100,000 - \$149,999	19.76
	\$150,000 - \$199,999	10.39
	\$200,000 and above	12.86
	Not reported	9.29
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HH has children under 18		
	No	57.29
	Yes	42.71
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**Notes:** The table shows summary statistics for all categorical variables used in the estimation. Number of observations for each variable is 569,531. Total household income refers to the income in the previous year before tax deductions. Table 5 for variable description is attached in the Appendix.

Table 3 and Table 4 present the summary statistics of categorical and continuous variables categorized by employment groups before and after the end of PUA, respectively.

Table 3 shows that self-employed workers are slightly elder than employees on average.

According to the trend of the PHQ-4 score shown in Figure 2, elder people tend to experience less mental distress than younger people. However, the mean of the PHQ-4 scores for self-employed workers is higher than that for employees before the end of PUA, but the mean for self-employed workers becomes lower than that for employees after the end of PUA. This contradiction to our expectation that PUA alleviates the mental distress of the self-employed might be explained by the changes in other policies that happened at the same time, like the ending of the Federal Pandemic Unemployment Compensation (FPUC). Table 4 shows that our sample contains more married than unmarried, more female than male, and more white than other races among all self-employed workers and employees surveyed both before and after the end of PUA.

Table 3: Summary Statistics for Continuous Variables by Employment Groups, Before and After the End of PUA

Variables	Before PUA End						After PUA End					
	Self-employed			Employee			Self-employed			Employee		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
PHQ-4 score	43,139	3.211	3.512	372,998	3.187	3.463	16,705	3.125	3.487	136,689	3.179	3.445
Age	43,139	48.734	10.505	372,998	45.251	11.121	16,705	48.178	10.733	136,689	44.568	11.412
New Daily Cases	43,139	152.686	144.481	372,998	154.16	143.812	16,705	269.717	162.325	136,689	269.239	162.301

**Notes:** The table shows summary statistics for all continuous variables used in the estimation for both self-employed workers and employees surveyed before and after the end of PUA. N refers to the number of observations in each category. SD refers to standard deviation. New daily confirmed COVID cases refers to new cases per 100,000 people over the past 7 days.

Table 4: Summary Statistics for Categorical Variables by Employment Groups, Before and After the End of PUA

Variables	Categories	Before PUA End				After PUA End			
		Self-employed		Employee		Self-employed		Employee	
		N	%	N	%	N	%	N	%
Married	No	42,918	34.79	371,655	40.3	16,635	34.08	136,305	40.64
	Yes		65.21		59.7		65.92		59.36
Gender	Male	43,139	42.22	371,998	40.94	16,705	42.95	136,689	41.54
	Female		57.78		59.06		57.05		58.46
Race	White	43,139	84.37	372,998	81.12	16,705	84.93	136,689	81.81
	Black		5.22		7.43		6.11		8.14
	Asian		5.58		6.55		4.35		5.51
	Other/mixed		4.83		4.91		4.62		4.54
Hispanic	Non-Hispanic	43,139	89.54	372,998	90.03	16,705	90.44	136,689	91.23
	Hispanic		10.46		9.97		9.56		8.77
Aggregated educational attainment	Less than high school	43,139	2.1	372,998	1.01	16,705	2.02	136,689	0.96
	High school degree		38.68		36.08		41.19		37.97
	Bachelor's degree		30.9		33.17		29.93		32.78
	Graduate degree		28.32		29.74		26.86		28.3
Total household income	Less than \$25,000	43,139	8.97	372,998	4.51	16,705	10.72	136,689	4.98
	\$25,000 - \$34,999		7.24		5.45		7.85		5.99
	\$35,000 - \$49,999		8.58		8.09		8.39		8.38
	\$50,000 - \$74,999		13.99		14.89		14.07		15.2
	\$75,000 - \$99,999		11.65		13.92		11.56		13.98
	\$100,000 - \$149,999		15.84		20.34		14.87		20.01
	\$150,000 - \$199,999		8.52		10.76		7.85		10.3
	\$200,000 and above		15.22		12.96		14.03		11.72
	Not reported		9.99		9.08		10.67		9.46



HH has children under 18									
	No								
	Yes	43,139	56.61	372,998	57.13	16,705	57.36	136,689	57.93
			43.39		42.87		42.64		42.07

**Notes:** The table shows summary statistics for all categorical variables used in the estimation for both self-employed workers and employees surveyed before and after the end of PUA. N refers to the number of observations in each category. % refers to the percentage of workers in each category. Total household income refers to the income in the previous year before tax deductions.

## IV. Empirical Models

In this section, we investigate the relationship between self-employment and mental health through several empirical models. We first start with a simple OLS regression model, then an OLS model with a moderating variable, and finally present triple difference models without and with inverse propensity weighting (IPW).

### Simple OLS Model

Our simple OLS model aims to predict the direct linear relationship between mental health score (PHQ-4 score) and self-employment. Compared with employees, self-employed workers enjoy more flexibility and autonomy over their work but also face financial and job insecurity and shoulder all responsibilities and risks. Given the challenging and unstable economic environment during the COVID-19 pandemic, we hypothesize the negative impact of self-employment on mental health exceeds the positive impact, thus resulting in an overall negative impact. The following is the equation for our Simple OLS Model:

$$MHScore_{it} = \beta_0 + \gamma_1 SelfEmp_{it} + \beta_1 Z_{it} + u_s + \theta_t + \varepsilon_{it} \quad (1)$$

- The dependent variable  $MHScore_{it}$  is the PHQ-4 score for psychological distress, with a higher score representing more severe distress.

- The treatment variable  $SelfEmp_{it}$  is a binary variable for self-employment. It equals 1 if the worker is self-employed and 0 if the worker is an employee.
- The control variables  $Z_{it}$  include continuous variables age,  $age^2$ , and new daily confirmed COVID-19 cases, categorical variables education level, household income, and race, and binary variables for being female, having a Hispanic origin, having any children under age 18, and being married (marital status). These variables are employed to control for factors affecting the dependent variable PHQ-4 score.
- $u_s$  represents the state-fixed effect.
- $\theta_t$  represents the time-fixed effect for the middle of the survey period.
- $\varepsilon_{it}$  is the error term.

Our simple OLS model has a binary variable of self-employment as a treatment variable and a continuous variable of mental distress score, PHQ-4 score, as a dependent variable. The coefficient  $\gamma_1$ , which is the coefficient of the self-employment variable, represents the difference in predicted PHQ-4 scores for self-employed people and employees when holding other variables constant. A positive  $\gamma_1$  means self-employed people have greater mental distress than employees, whereas negative  $\gamma_1$  means employees have more mental distress, all else equal. Thus, given our hypothesis, we expect a positive  $\gamma_1$ .

A series of control variables are introduced to manage the impacts of several factors on the dependent variable. Age is included as people of different ages face different kinds of pressure and anxiety. The variable  $age^2$  can capture possible non-linear relationship between age and the PHQ4-score. Variables for race, female, and Hispanic origin are included because of the potential discrimination they create in the workplace and life. Education level, household income, whether having any children under age 18, and whether being married are expected to

create either emotional reassurance or stress for workers. More new cases of COVID-19 are expected to bring additional stress and anxiety about the infection. It is important to include state fixed effect  $u_s$  because workers' mental health scores can differ across states due to factors like weather, state policies, and local culture. We also include a time-fixed effect  $\theta_t$  since workers' mental health might vary across time possibly caused by factors like policy change and seasonal shifts.  $\varepsilon_{it}$  represents all unobserved factors that are not captured by the model but influence the dependent variable, like time spent on social media, sports, with friends or families each week. We also make a heteroskedasticity assumption that  $\varepsilon_{it}$  is uncorrelated to the control variables and the dependent variable.

Table 5: Results of Simple OLS Model

Dependent Variable: PHQ-4 score	
VARIABLES	Simple OLS Model
Self-employment=1	0.102*** (0.015)
Observations	567,513
R-squared	0.097
State fixed effect	YES
Time fixed effect	YES
Control variables	YES

**Notes:** The table shows the results of the simple OLS model. It is estimated based on Equation 1. The complete version is attached as Table 1 in the Appendix. The dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 5 above shows the results of our simple OLS model. The estimated coefficient for self-employment is 0.102, indicating the predicted PHQ-4 score of self-employed workers is 0.102 points higher than that of employees on average, ceteris paribus. This outcome aligns with our expectations and supports our hypothesis, underscoring the mental strain experienced by self-employed workers probably due to stressful workloads, financial uncertainty, and the lack of

social benefits. It is important to note although this estimated coefficient is statistically significant, the magnitude is quite small considering the scale of the score from 0 to 12.

### OLS Model with Moderating Variable

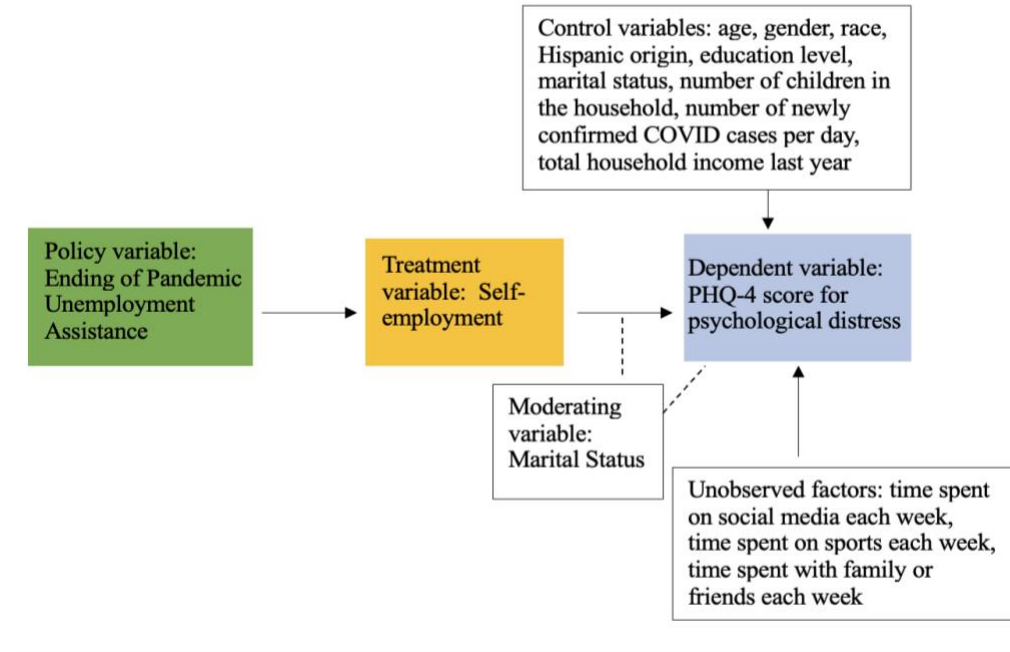
Based on the results of simple OLS regression and daily life experience, we hypothesize the impact of self-employment on mental health might vary across married workers and unmarried workers because marriage potentially provides more financial stability and emotional support. Therefore, we introduce the variable of being married as a moderating variable and add an interaction term of marital status and self-employment. The following is the equation for our OLS Model with a moderating variable:

$$MHScore_{it} = \beta_0 + \gamma_1 SelfEmp_{it} + \gamma_2 Married_{it} + \gamma_3 (Married_{it} \times SelfEmp_{it}) + \beta_1 Z_{it} + u_s + \theta_t + \varepsilon_{it} \quad (2)$$

- The moderating variable  $Married_{it}$  is a binary variable for marital status. It equals 1 if the worker is married and equals 0 if unmarried.
- $Married_{it} \times SelfEmp_{it}$  is the interaction term of marital status and self-employment. It equals 1 only if the worker is self-employed and married.
- The control variables  $Z_{it}$  include age,  $age^2$ , new daily confirmed COVID-19 cases, education level, household income, race, being female, having a Hispanic origin, and having any children under age 18.

The following flow chart provides a visualization of the variables and their interrelationships in our OLS Model with a moderating variable.

Figure 5: Flow Chart of Variables



**Notes:** The figure is a flow chart of variables used in our OLS model with a moderating variable (Equation 2). Several possible unobserved factors are listed. Actual unobserved factors include but are not limited to those listed above.

Table 6: Coefficient Interpretation for OLS Model with a Moderating Variable

	Married	Unmarried	Marriage Premium
Self-employed workers	$\gamma_2 + \gamma_1 + \gamma_3$	$\gamma_1$	$\gamma_2 + \gamma_3$
Employee	$\gamma_2$	0	$\gamma_2$
Employment Group Difference	$\gamma_1 + \gamma_3$	$\gamma_1$	$\gamma_3$

**Notes:** The table presents the coefficient interpretation for our OLS model with a moderating variable (Equation 2). Employment Group Difference = coefficient for self-employed – coefficient for employee. Marriage premium = coefficient for married - coefficient for unmarried.

Table 6 above shows the coefficient interpretation for our OLS model with a moderating variable. This model allows us to get deeper insights into group differences. In Equation 2,  $\gamma_1$  measures the impact of self-employment on predicted PHQ4-score among unmarried workers,

and  $\gamma_1 + \gamma_3$  measures the impact of self-employment on predicted PHQ4-score among married workers. Therefore,  $\gamma_3$  indicates how the impact differs across married and unmarried groups.

Table 7: Results of OLS Model with Moderating Variable

Dependent Variable: PHQ-4 score	
VARIABLES	OLS Model with Moderating Variable
Self-employment=1	0.262*** (0.027)
Married =1	-0.399*** (0.011)
Self-employment $\times$ Married	-0.245*** (0.031)
Observations	567,513
R-squared	0.097
State fixed effect	YES
Time fixed effect	YES
Control variables	YES

**Notes:** The table presents the results of our OLS model with a moderating variable. It is estimated based on Equation 2. The complete version is attached as Table 2 in the Appendix. The dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 7 above presents the regression results of our OLS model with a moderating variable. The predicted PHQ-4 score for self-employed workers is statistically significant 0.017 points higher than that for employees among married workers while it is statistically significant 0.262 points higher among unmarried workers. Therefore, such difference in predicted PHQ-4 score for self-employed workers and employees is statistically significant 0.245 points higher among married workers compared to unmarried workers. Overall, this result is consistent with the results of our simple OLS regression model as self-employed workers are predicted to have more stress and anxiety than employees among both married and unmarried groups. The smaller

impacts of self-employment on mental health among married workers might be explained by the potential financial and emotional support offered by marriage.

### Triple Difference Model

To further investigate the relationship between self-employment and mental health, it is important to consider socioeconomic factors. Therefore, we take a policy change, the end of Pandemic Unemployment Assistance (PUA), into account. The dates of ending PUA vary across states as mentioned previously, ranging from June 2021 to September 2021. The termination of PUA represents the cessation of providing unemployment benefits for the self-employed. Intuitively, PUA offers a form of emotional reassurance to self-employed workers as it assures them of financial support if they become unemployed, so ending PUA possibly removed such emotional security from self-employed workers. Therefore, we hypothesize ending PUA would have negative impacts on the mental health of self-employed workers while not influencing the mental health of employees as they are not the targets of PUA.

To further examine the differential impacts of ending PUA on mental health between employees and self-employed workers, we employed a triple difference model. It is important to note that all states are treated states and are switchers in our model since all of them implemented PUA in March 2020 and ended it by early September 2021. The following is the equation for our triple difference model:

$$MHScore_{it} = \beta_0 + \gamma_1 SelfEmp_{it} + \gamma_2 Post_{st} + \gamma_3 (Post_{st} \times SelfEmp_{it}) + \beta_1 Z_{it} + u_s + \theta_t + \varepsilon_{it} \quad (3)$$

- The post-policy variable  $Post_{st}$  equals 1 if the observation is after the end of PUA and 0 if the observation is before the end of PUA for switchers (all states in our case).

- $Post_{st} \times SelfEmp_{it}$  is the interaction term of the post-policy indicator and the treatment indicator. It equals 1 only if the worker is self-employed, from switcher states, and surveyed after the end of PUA.

Table 8: Coefficient Interpretation for Triple Difference Model

	Before PUA End	After PUA End	Pre and Post Difference
Self-employed workers	$\gamma_1$	$\gamma_2 + \gamma_1 + \gamma_3$	$\gamma_2 + \gamma_3$
Employee	0	$\gamma_2$	$\gamma_2$
Group Difference	$\gamma_1$	$\gamma_1 + \gamma_3$	$\gamma_3$

**Notes:** The table presents the coefficient interpretation for our triple difference model (Equation 3). Pre and Post Difference = coefficient for After PUA End – coefficient for Before PUA End. Marriage premium = coefficient for self-employed workers - coefficient for employees

Table 8 above shows the coefficient interpretation for our triple difference model (Equation 3).  $\gamma_2 + \gamma_3$  measures the difference in the PHQ-4 score of self-employed workers before and after the ending PUA, which shows the effect of ending PUA on the PHQ-4 score of self-employed workers.  $\gamma_2$  measures the effect of ending PUA on the PHQ-4 score of employees.  $\gamma_3$ , the coefficient of the interaction term, indicates the difference of such effects between self-employed workers and employees. We anticipate  $\gamma_3$  to be positive as we expect a greater positive increase in the PHQ-4 score among self-employed workers than employees after the ending of PUA.

Table 9: Results of Triple Difference Model

Dependent Variable: PHQ-4 score	
VARIABLES	Triple Difference Model
Post-policy = 1, After PUA End	0.117*** (0.022)
Self-employment = 1	0.129***

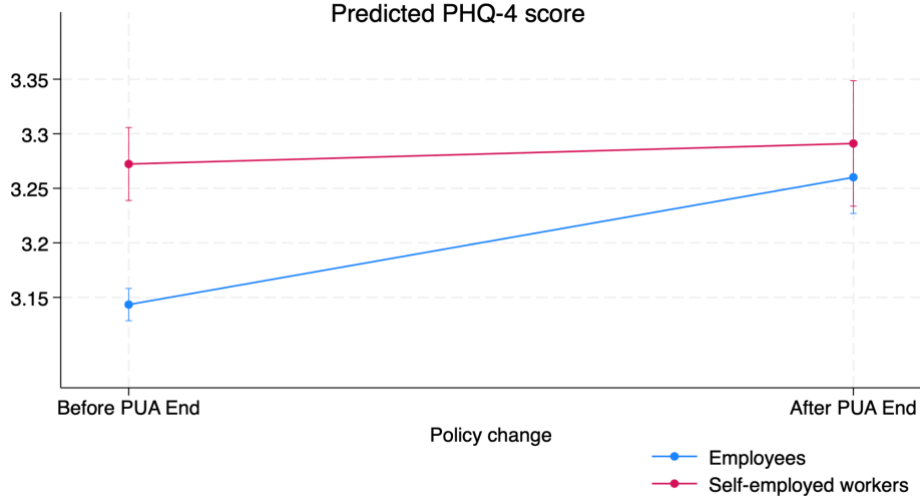


	(0.017)
Post-policy × Self-employment	-0.098***
	(0.032)
Observations	567,513
R-squared	0.097
State-fixed effect	YES
Time-fixed effect	YES
Control variables	YES

**Notes:** The table presents the results of our triple difference model. It is estimated based on Equation 3. The complete version is attached as Table 3 in the Appendix. The dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 9 above presents the results of our triple difference model. For self-employed workers, their predicted PHQ-4 score is 0.019 points higher after ending PUA than before, which shows the predicted effect of ending PUA on self-employed workers. PHQ-4 scores for self-employed workers are predicted to be very similar before and after the end of PUA. Also, the PHQ-4 score of employees is predicted to have a 0.117 points increase after ending PUA. Therefore, ending PUA is predicted to have negative impacts on the mental health of both employees and self-employed workers as predicted PHQ-4 scores increase in both groups after PUA ends although the magnitudes of impacts are small for both. It is important to point out that the predicted increase in PHQ-4 score is 0.098 points lower for self-employed people than that for employees. Therefore, ending PUA has a more pronounced adverse effect on the mental health of employees compared to self-employed workers, which differs from our initial hypothesis. This difference can be clearly illustrated and supported by Figure 6. The red line representing self-employed workers is flatter while the blue line representing employees is steeper and the gap between predicted PHQ-4 scores of both employees and self-employed workers shrinks after the end of PUA.

Figure 6: Predicted PHQ-4 score of Employees and Self-employed Workers



**Notes:** The figure shows the predicted PHQ-4 score for employees and self-employed workers before and after the end of PUA. Calculations are based on Equation 3. The horizontal axis indicates before or after the PUA end.

This triple difference model has several assumptions. Firstly, we assume the absence of spillover effects between two groups that the response of one group to the ending of PUA does not have a ripple effect on another group. Second, we assume the exogeneity of control variables that control variables  $Z_{it}$  and error terms are uncorrelated ( $\text{Cov}(Z_{it}, \varepsilon_{it}) = 0$ ). However, this assumption might be violated. For example, unobservable factors like time spent with families are likely to be affected by personal characteristics like gender and age. We also assume the exogeneity of the post-policy variable  $Post_{st}$  ( $\text{Cov}(Post_{st}, \varepsilon_{it}) = 0$ ). However, this assumption is likely to be violated in our case. When states decide on PUA withdrawal dates, they might take labor factors into account. For example, states that worry more about labor shortages might withdraw from PUA early. Furthermore, we hold the conditional independence that the selection into the self-employed group is random conditional on control variables, the post-policy variable, and fixed effects. This assumption is likely to be violated because individuals' decision to be self-employed is largely determined by personal and social factors. Moreover, we assume a

parallel trend that both self-employed workers and employees have the same PHQ-4 score before the end of PUA. This assumption is clearly violated. Other socioeconomic and policy changes that occurred simultaneously with the ending of PUA, like the ending of the Federal Pandemic Unemployment Compensation (FPUC), are likely to diverge the PHQ-4 score trend between self-employed workers and employees. To address the violation of assumptions, we introduce inverse propensity weight to the triple difference model to balance self-employed and employee groups.

### **Triple Difference Model with IPW**

Before introducing inverse propensity weight, we conduct a t-test on the observable characteristics of self-employed and employee groups. The result is shown in the second column of Table 10. Notice the two groups are significantly different in characteristics of female, age, age squared, race, Hispanic, education category, household income category, and married at the 1% significance level, and significantly different in having a kid younger than 18 years old at the 5% significance level. Thus, the control and treatment groups are significantly different in most observable characteristics.

To counterbalance the potential violations to the assumptions and remove the confounding, we create balancing groups based on observable characteristics and implement inverse propensity weighting (IPW). In the context of our research, the inverse propensity weight balances observed characteristics between two groups by placing more weight on workers who are predicted to have a higher likelihood of being employees while giving less weight to workers who are predicted to have more likelihood of being self-employed. The estimated propensity score is

$$\hat{p} = Prob(G_{i,t_0} = 1) = \alpha Z_{i,t_0} + \mu_{i,t_0}, \text{ where } G_{i,t_0} = \begin{cases} 1 & \text{if self-employed individual} \\ 0 & \text{if employee} \end{cases} \quad (4)$$

The estimated inverse propensity weight is

$$IPW = \begin{cases} 1/\hat{p}, & \text{if } G_{i,t_0} = 1 \\ 1/(1 - \hat{p}), & \text{if } G_{i,t_0} = 0 \end{cases} \quad (5)$$

After applying IPW to adjust the group differences, we conduct a t-test again to check the differences in the observable characteristics between groups. The third column of Table 10 shows that after applying IPW, characteristics such as female, Hispanic, having kids younger than 18 years old, and household income categories are not significantly different between the control and treatment groups at any significance level; marital status is significantly different at 10% level between groups; age squared ( $age^2$ ) is significantly different at 5% level; and age, race, and education category are still significantly different at 1% level. The t-test results after applying IPW indicate that we partially eliminate the differences in observable characteristics between groups, and we are more confident about the assumption of a parallel trend between the two groups.

Table 10: T-test for Observable Characteristics before and after IPW Adjustment

VARIABLES	(2) Before IPW	(3) After IPW
Married = 1	0.055*** (0.002)	-0.005* (0.003)
Female =1	-0.013*** (0.003)	0.003 (0.003)
Age of HH head	3.483*** (0.056)	-0.193*** (0.071)
Age squared	314.028*** (5.048)	-14.003** (5.993)
Race categories = 2, [2] Black	-0.022*** (0.001)	0.005*** (0.002)
Race categories = 3, [3] Asian	-0.010*** (0.001)	-0.001 (0.001)

Race categories = 4, [4] Other/mixed	-0.001 (0.001)	0.003* (0.001)
Hispanic =1	0.005*** (0.002)	0.001 (0.002)
HH has children under 18 = 1	0.005** (0.003)	0.004 (0.003)
Aggregated educational attainment = 2, [2] HS degree	0.026*** (0.002)	0.017*** (0.003)
Aggregated educational attainment = 3, [3] Bachelor's degree	-0.023*** (0.002)	-0.008*** (0.003)
Aggregated educational attainment = 4, [4] Graduate degree	-0.014*** (0.002)	-0.010*** (0.003)
Categories for total HH income = 2, [2] \$25,000 - \$34,999	0.018*** (0.001)	-0.001 (0.001)
Categories for total HH income = 3, [3] \$35,000 - \$49,999	0.005*** (0.001)	-0.001 (0.001)
Categories for total HH income = 4, [4] \$50,000 - \$74,999	-0.009*** (0.002)	-0.001 (0.002)
Categories for total HH income = 5, [5] \$75,000 - \$99,999	-0.023*** (0.002)	-0.001 (0.002)
Categories for total HH income = 6, [6] \$100,000 - \$149,999	-0.045*** (0.002)	0.002 (0.002)
Categories for total HH income = 7, [7] \$150,000 - \$199,999	-0.022*** (0.002)	0.000 (0.002)
Categories for total HH income = 8, [8] \$200,000 and above	0.023*** (0.002)	-0.001 (0.002)
Categories for total HH income = 13, [13] Not reported	0.009*** (0.001)	0.004** (0.002)

**Notes:** The table shows the results of the t-test for observable characteristics before and after applying IPW. Two groups of the t-test are self-employed workers and employees. Total number of observations  $N_1 = 416,137$  before applying IPW, and  $N_2 = 414,537$  after applying IPW. Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Total household income refers to the income in the previous year before tax deductions.

After introducing IPW into our previously proposed triple difference model, estimate coefficients for the main group effect, main policy effect, and interaction term remain statistically significant, which implies ending PUA still has different effects across the two

groups. The predicted PHQ-4 score is increased by 0.056 points for self-employed workers after the ending of PUA while it is increased by 0.178 points for employees following the end of PUA. The increase in predicted PHQ-4 score is 0.122 points lower among self-employed workers than among employees. It is important to note the increase in predicted PHQ-4 score for both groups and the difference in increase are all more pronounced in the weighted model than in the unweighted model. Overall, the triple difference model with IPW shows negative impacts of ending PUA on both groups in terms of mental health and the impact is more adverse for employees than for self-employed workers, which is consistent with the unweighted triple difference model but differs from our initial hypothesis. The unexpected result might be attributed to policy and socioeconomic changes that occurred simultaneously with the ending of PUA, like the ending of the Federal Pandemic Unemployment Compensation (FPUC) and gradual macroeconomic recovery from the impact of COVID-19.

Table 11: Triple Difference Model with IPW vs Triple Difference Model Estimates

Dependent Variable: PHQ-4 score		
VARIABLES	Triple Difference Model with IPW	Triple Difference Model
Post policy = 1, After PUA End	0.178*** (0.039)	0.117*** (0.022)
Self-employment=1	0.149*** (0.019)	0.129*** (0.017)
Post-policy $\times$ Self-employment	-0.122*** (0.037)	-0.098*** (0.032)
Observations	567,513	567,513
R-squared	0.098	0.097
State fixed effect	YES	YES
Time fixed effect	YES	YES
Control variables	YES	YES

**Notes:** The table presents the results of our triple difference model with IPW. It is estimated based on Equation 3. The results of our triple difference model without IPW are also attached for comparison. The complete version is attached as Table 4 in the Appendix. The dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust standard errors are in parentheses.

## V. Conclusion

This paper explores the impacts of self-employment on mental health during the COVID-19 pandemic. By utilizing econometrics models, this study approaches the question progressively and incorporates different factors to get a comprehensive understanding.

Our simple OLS model and OLS model with marriage status as a moderating variable predict that self-employed workers face more mental distress than employees although the difference is small in magnitude. This result can be explained by the inherent financial uncertainties, the lack of social benefits, and the all-encompassing responsibility of managing their own business, which self-employed individuals typically face. Our unweighted and weighted triple difference models incorporate a policy change, the termination of PUA. Both models predict the negative effect of ending PUA on the mental health of self-employed workers and employees but the negative impact would be more pronounced among employees. This result deviates from our initial hypothesis that ending PUA is likely to induce anxiety and emotional insecurity among self-employed workers without significantly affecting employees. This unexpected result might be due to socioeconomic changes that coincided with the termination of the PUA, such as the end of the Federal Pandemic Unemployment Compensation and the gradual recovery of the macroeconomy.

This paper offers valuable insights for policymakers to consider the mental health factors of self-employed workers when planning for future crises. Possible approaches include enhancing the accessibility of mental health services, offering additional support for self-employed businesses, and tailoring financial relief programs specifically for self-employed individuals. Furthermore, the unanticipated findings in this study point to potential directions for future research. We encourage future researchers to explore and analyze alternative policy

measures and socioeconomic shocks when investigating the issue of mental health and self-employment.



## VI. Bibliography

- Abreu, M., Oner, O., Brouwer, A., & van Leeuwen, E. (2019). Well-being effects of self-employment: A spatial inquiry. *Journal of Business Venturing*, 34(4), 589–607. <https://doi.org/10.1016/j.jbusvent.2018.11.001>
- Adams, P., Hurd, M. D., McFadden, D., Merrill, A., & Ribeiro, T. (2003). Healthy, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status. *Journal of Econometrics*, 112(1), 3–56. [https://doi.org/10.1016/S0304-4076\(02\)00145-8](https://doi.org/10.1016/S0304-4076(02)00145-8)
- Ahn, T. (2020). Employment and health among older people: Self-employment vs. wage employment. *Applied Economics Letters*, 27(19), 1574–1580. <https://doi.org/10.1080/13504851.2019.1697795>
- Audretsch, D. B., & Thurik, A. R. (2000). Capitalism and democracy in the 21st Century: From the managed to the entrepreneurial economy\*. *Journal of Evolutionary Economics*, 10(1), 17–34. <https://doi.org/10.1007/s001910050003>
- Berkowitz, S. A., & Basu, S. (2021). Unmet Social Needs And Worse Mental Health After Expiration Of COVID-19 Federal Pandemic Unemployment Compensation. *Health Affairs*, 40(3), 426–434. <https://doi.org/10.1377/hlthaff.2020.01990>
- Bjuggren, C. M., Johansson, D., & Stenkula, M. (2012). Using self-employment as proxy for entrepreneurship: Some empirical caveats. *International Journal of Entrepreneurship and Small Business*, 17(3), 290–303. <https://doi.org/10.1504/IJESB.2012.049578>
- Bogan, V. L., Fertig, A. R., & Just, D. R. (2022). Self-employment and mental health. *Review of Economics of the Household*, 20(3), 855–886. <https://doi.org/10.1007/s11150-021-09578-3>
- Cabib, I., Azar, A., Biehl, A., & Budnevich-Portales, C. (2023). Socially stratified associations between self-employment and health among Chilean older people. *Sociology of Health & Illness*, 45(3), 580–604. <https://doi.org/10.1111/1467-9566.13609>
- Centers for Disease Control and Prevention. (2023, October 11). *Mental health - household pulse survey - covid-19*. Centers for Disease Control and Prevention. <https://www.cdc.gov/nchs/covid19/pulse/mental-health.htm>
- Congressional Research Service (2021) States Opting Out of COVID-19 Unemployment Insurance (UI) Agreements IN11679. Last updated August 20, 2021.
- Coombs, K., Dube, A., Jahnke, C., Kluender, R., Naidu, S., & Stepner, M. (2022). Early Withdrawal of Pandemic Unemployment Insurance: Effects on Employment and Earnings. *AEA Papers and Proceedings*, 112, 85–90. <https://doi.org/10.1257/pandp.20221009>

- COVID-19 pandemic triggers 25% increase in prevalence of anxiety and depression worldwide.* (n.d.). Retrieved September 20, 2023, from <https://www.who.int/news/item/02-03-2022-covid-19-pandemic-triggers-25-increase-in-prevalence-of-anxiety-and-depression-worldwide>
- Daniel, E., Roxanna;Essien, Lawrence S. ;Levinstein, Michael. (n.d.). *U.S. labor market shows improvement in 2021, but the COVID-19 pandemic continues to weigh on the economy: Monthly Labor Review: U.S. Bureau of Labor Statistics*. Retrieved September 20, 2023, from <https://www.bls.gov/opub/mlr/2022/article/us-labor-market-shows-improvement-in-2021-but-the-covid-19-pandemic-continues-to-weigh-on-the-economy.htm>
- de Miquel, C., Domènech-Abella, J., Felez-Nobrega, M., Cristóbal-Narváez, P., Mortier, P., Vilagut, G., Alonso, J., Olaya, B., & Haro, J. M. (2022). The mental health of employees with job loss and income loss during the COVID-19 pandemic: The mediating role of perceived financial stress. *International Journal of Environmental Research and Public Health*, 19(6), 3158. <https://doi.org/10.3390/ijerph19063158>
- Gregory, V., Harding, E., & Steinberg, J. (2023, July 5). *Self-employment grows during COVID-19 pandemic*. Federal Reserve Bank of St. Louis. <https://www.stlouisfed.org/on-the-economy/2022/jul/self-employment-returns-growth-path-pandemic>
- Hamilton, V. H., Merrigan, P., & Dufresne, É. (1997). Down and out: Estimating the relationship between mental health and unemployment. *Health Economics*, 6(4), 397–406. [https://doi.org/10.1002/\(SICI\)1099-1050\(199707\)6:4<397::AID-HEC283>3.0.CO;2-M](https://doi.org/10.1002/(SICI)1099-1050(199707)6:4<397::AID-HEC283>3.0.CO;2-M)
- Holzer, H. J., Hubbard, R. G., & Strain, M. R. (2021). Did Pandemic Unemployment Benefits Reduce Employment? Evidence from Early State-Level Expirations in June 2021. *NBER Working Paper Series*. <https://doi.org/10.3386/w29575>
- Nikolova, M. (2019). Switching to self-employment can be good for your health. *Journal of Business Venturing*, 34(4), 664–691. <https://doi.org/10.1016/j.jbusvent.2018.09.001>
- Parslow, R. A., Jorm, A. F., Christensen, H., Rodgers, B., Strazdins, L., & D’Souza, R. M. (2004). The associations between work stress and mental health: A comparison of organizationally employed and self-employed workers. *Work & Stress*, 18(3), 231–244. <https://doi.org/10.1080/14749730412331318649>
- Rietveld, C. A., van Kippersluis, H., & Thurik, A. R. (2015). Self-Employment and Health: Barriers or Benefits? *Health Economics*, 24(10), 1302–1313. <https://doi.org/10.1002/hec.3087>
- Smith, S. M., & Edwards, R. (2021). Unemployment rises in 2020, as the country battles the covid-19 pandemic. *Monthly Labor Review*. <https://doi.org/10.21916/mlr.2021.12>

Stephan, U., & Roesler, U. (2010). Health of entrepreneurs versus employees in a national representative sample. *Journal of Occupational and Organizational Psychology*, 83(3), 717–738. <https://doi.org/10.1348/096317909X472067>

Stephan, U., Li, J., & Qu, J. (2020a). A fresh look at self-employment, stress and health: Accounting for self-selection, time and gender. *International Journal of Entrepreneurial Behaviour & Research*, 26(5), 1133–1177. <https://doi.org/10.1108/IJEBr-06-2019-0362>

Tuttle, R., & Garr, M. (2009). Self-Employment, Work–Family Fit and Mental Health Among Female Workers. *Journal of Family and Economic Issues*, 30(3), 282–292. <https://doi.org/10.1007/s10834-009-9154-y>

U.S. Department of Labor publishes guidance on Pandemic unemployment assistance. DOL. (n.d.). <https://www.dol.gov/newsroom/releases/eta/eta20200405>

What is pandemic unemployment assistance? how do I qualify? (n.d.). [https://oui.doleta.gov/unemploy/pdf/PUA\\_FactSheet.pdf](https://oui.doleta.gov/unemploy/pdf/PUA_FactSheet.pdf)

World Health Organization. (2022, March 2). *Covid-19 pandemic triggers 25% increase in prevalence of anxiety and depression worldwide*. World Health Organization. [https://www.who.int/news/item/02-03-2022-covid-19-pandemic-triggers-25-increase-in-prevalence-of-anxiety-and-depression-worldwide#:~:text=Wake%20Dup%20call%20to%20all,mental%20health%20services%20and%20support&text=In%20the%20first%20year%20of,Health%20Organization%20\(WHO\)%20today.](https://www.who.int/news/item/02-03-2022-covid-19-pandemic-triggers-25-increase-in-prevalence-of-anxiety-and-depression-worldwide#:~:text=Wake%20Dup%20call%20to%20all,mental%20health%20services%20and%20support&text=In%20the%20first%20year%20of,Health%20Organization%20(WHO)%20today.)

Zhou, D., Zhan, Q., & Lele, L. (2023). The impact of self-employment on mental health of the younger elderly in China. *BMC Geriatrics*, 23, 1–14. <https://doi.org/10.1186/s12877-023-03948-5>

## VII. Appendix

Table 1: Results of Simple OLS Model

Dependent Variable: PHQ-4 score	
VARIABLES	Simple OLS Model
Self-employment=1	0.102*** (0.015)
Married = 1	-0.423*** (0.011)
Female =1	0.599*** (0.009)
Age of HH head	-0.021*** (0.003)
Race categories = 2, [2] Black	-0.318*** (0.018)
Race categories = 3, [3] Asian	-0.437*** (0.018)
Race categories = 4, [4] Other/mixed	0.305*** (0.023)
Hispanic =1	-0.072*** (0.016)
HH has children under 18 = 1	-0.040*** (0.010)
Aggregated educational attainment = 2, [2] HS degree	0.042 (0.048)
Aggregated educational attainment = 3, [3] Bachelor's degree	-0.185*** (0.048)
Aggregated educational attainment = 4, [4] Graduate degree	-0.162*** (0.049)
Categories for total HH income = 2, [2] \$25,000 - \$34,999	-0.334*** (0.031)
Categories for total HH income = 3, [3] \$35,000 - \$49,999	-0.611*** (0.029)
Categories for total HH income = 4, [4] \$50,000 - \$74,999	-0.957*** (0.026)
Categories for total HH income = 5, [5] \$75,000 - \$99,999	-1.264*** (0.027)

Categories for total HH income = 6, [6] \$100,000 - \$149,999	-1.573*** (0.026)
Categories for total HH income = 7, [7] \$150,000 - \$199,999	-1.788*** (0.028)
Categories for total HH income = 8, [8] \$200,000 and above	-2.032*** (0.027)
Categories for total HH income = 13, [13] Not reported	-1.494*** (0.028)
Constant	6.442*** (0.101)
Observations	567,513
R-squared	0.097
State fixed effect	YES
Time fixed effect	YES

**Notes:** The table shows the complete results of the simple OLS regression model. It is estimated based on Equation 1. Dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Total household income refers to the income in the previous year before tax deductions. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Variables  $age^2$  and new daily confirmed cases are omitted because their estimate coefficients are 0.

Table 2: Results of OLS Model with Moderating Variable

Dependent Variable: PHQ-4 score	
VARIABLES	OLS with moderating variable
Self-employment = 1	0.262*** (0.027)
Married =1	-0.399*** (0.011)
Self-employment $\times$ Married	-0.245*** (0.031)
Female = 1	0.601*** (0.009)
Age of HH head	-0.021*** (0.003)
Race categories = 2, [2] Black	-0.316*** (0.018)
Race categories = 3, [3] Asian	-0.437*** (0.018)

Race categories = 4, [4] Other/mixed	0.304*** (0.023)
Hispanic = 1	-0.071*** (0.016)
HH has children under 18 = 1	-0.041*** (0.010)
Aggregated educational attainment = 2, [2] HS degree	0.043 (0.048)
Aggregated educational attainment = 3, [3] Bachelor's degree	-0.184*** (0.048)
Aggregated educational attainment = 4, [4] Graduate degree	-0.162*** (0.048)
Categories for total HH income = 2, [2] \$25,000 - \$34,999	-0.324*** (0.031)
Categories for total HH income = 3, [3] \$35,000 - \$49,999	-0.598*** (0.029)
Categories for total HH income = 4, [4] \$50,000 - \$74,999	-0.944*** (0.026)
Categories for total HH income = 5, [5] \$75,000 - \$99,999	-1.252*** (0.027)
Categories for total HH income = 6, [6] \$100,000 - \$149,999	-1.562*** (0.026)
Categories for total HH income = 7, [7] \$150,000 - \$199,999	-1.777*** (0.028)
Categories for total HH income = 8, [8] \$200,000 and above	-2.020*** (0.028)
Categories for total HH income = 13, [13] Not reported	-1.483*** (0.028)
Constant	6.433*** (0.101)
Observations	567,513
R-squared	0.097
State fixed effect	YES
Time fixed effect	YES

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**Notes:** The table shows the complete results of the OLS model with a moderating variable. It is estimated based on Equation 2. Dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Total household income refers to the income in the

previous year before tax deductions. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Variables *age*<sup>2</sup> and new daily confirmed cases are omitted because their estimate coefficients are 0.

Table 3: Results of Triple Difference Model

Dependent Variable: PHQ-4 score	
VARIABLES	Triple Difference Model
Post policy = 1, After PUA End	0.117*** (0.022)
Self-employment = 1	0.129*** (0.017)
Post-policy × Self-employment	-0.098*** (0.032)
Female = 1	0.599*** (0.009)
Age of HH head	-0.020*** (0.003)
Race categories = 2, [2] Black	-0.318*** (0.018)
Race categories = 3, [3] Asian	-0.437*** (0.018)
Race categories = 4, [4] Other/mixed	0.305*** (0.023)
Hispanic = 1	-0.072*** (0.016)
HH has children under 18 =1	-0.040*** (0.010)
Aggregated educational attainment = 2, [2] HS degree	0.043 (0.048)
Aggregated educational attainment = 3, [3] Bachelor's degree	-0.184*** (0.048)
Aggregated educational attainment = 4, [4] Graduate degree	-0.162*** (0.049)
Categories for total HH income = 2, [2] \$25,000 - \$34,999	-0.334*** (0.031)
Categories for total HH income = 3, [3] \$35,000 - \$49,999	-0.611*** (0.029)

Categories for total HH income = 4, [4] \$50,000 - \$74,999	-0.957*** (0.026)
Categories for total HH income = 5, [5] \$75,000 - \$99,999	-1.265*** (0.027)
Categories for total HH income = 6, [6] \$100,000 - \$149,999	-1.574*** (0.026)
Categories for total HH income = 7, [7] \$150,000 - \$199,999	-1.789*** (0.028)
Categories for total HH income = 8, [8] \$200,000 and above	-2.033*** (0.027)
Categories for total HH income = 13, [13] Not reported	-1.494*** (0.028)
Married =1	-0.423*** (0.011)
Observations	567,513
R-squared	0.097
State fixed effect	YES
Time fixed effect	YES

**Notes:** The table presents the complete results of our triple difference model. It is estimated based on Equation 3. Dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Total household income refers to the income in the previous year before tax deductions. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Variables *age*<sup>2</sup> and new daily confirmed cases are omitted because their estimate coefficients are 0.

Table 4: Triple Difference Model with IPW vs. Triple Difference Model Estimates

Dependent Variable: PHQ-4 score		
VARIABLES	Triple Difference Model with IPW	Triple Difference Model
Post-policy = 1, After PUA End	0.178*** (0.039)	0.117*** (0.022)
Self-employment = 1	0.149*** (0.019)	0.129*** (0.017)
Post-policy × Self-employment	-0.122*** (0.037)	-0.098*** (0.032)
Female =1	0.596*** (0.017)	0.599*** (0.009)
Age of HH head	-0.022***	-0.020***



	(0.008)	(0.003)
Race categories = 2, [2] Black	-0.289***	-0.318***
	(0.042)	(0.018)
Race categories = 3, [3] Asian	-0.411***	-0.437***
	(0.037)	(0.018)
Race categories = 4, [4] Other/mixed	0.386***	0.305***
	(0.045)	(0.023)
Hispanic = 1	-0.127***	-0.072***
	(0.032)	(0.016)
HH has children under 18 = 1	-0.075***	-0.040***
	(0.020)	(0.010)
Aggregated educational attainment = 2, [2] HS degree	0.037	0.043
	(0.071)	(0.048)
Aggregated educational attainment = 3, [3] Bachelor's degree	-0.150**	-0.184***
	(0.072)	(0.048)
Aggregated educational attainment = 4, [4] Graduate degree	-0.155**	-0.162***
	(0.072)	(0.049)
Categories for total HH income = 2, [2] \$25,000 - \$34,999	-0.365***	-0.334***
	(0.046)	(0.031)
Categories for total HH income = 3, [3] \$35,000 - \$49,999	-0.618***	-0.611***
	(0.045)	(0.029)
Categories for total HH income = 4, [4] \$50,000 - \$74,999	-1.056***	-0.957***
	(0.040)	(0.026)
Categories for total HH income = 5, [5] \$75,000 - \$99,999	-1.331***	-1.265***
	(0.043)	(0.027)
Categories for total HH income = 6, [6] \$100,000 - \$149,999	-1.583***	-1.574***
	(0.042)	(0.026)
Categories for total HH income = 7, [7] \$150,000 - \$199,999	-1.834***	-1.789***
	(0.046)	(0.028)
Categories for total HH income = 8, [8] \$200,000 and above	-2.082***	-2.033***
	(0.043)	(0.027)
Categories for total HH income = 13, [13] Not reported	-1.494***	-1.494***
	(0.044)	(0.028)
Married =1	-0.517***	-0.423***
	(0.020)	(0.011)
Observations	567,513	567,513
R-squared	0.098	0.097

State Fixed Effect	YES	YES
Time Fixed Effect	YES	YES

**Notes:** The table presents the results of our triple difference model with IPW. It is estimated based on Equation 3. The results of our triple difference model without IPW are also attached for comparison. Dependent variable is the PHQ-4 score, which is indicated in the first row of the table. Self-employment =1 for self-employed, Self-employment =0 for employees. Total household income refers to the income in the previous year before tax deductions. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Variables age squared and new daily confirmed cases are omitted because their estimate coefficients are 0.

Table 5: Variable Description

Variable name	Vector	Variable label	Type	Notes about variable construction
PHQ-4 Score	$Y_{it}$	phq4score	continuous	Higher score means more severe psychological distress
Self-employment	$X_{it}^*$	self_emp	binary	=1 if the individual is self-employed = 0 if the individual is an employee
PUA end date	$P_{st}$	pua_end	date	End date of the Pandemic Unemployment Assistance for each state
Marital status	$M_{it}$	married	binary	=1 if married =0 if not married
Age	$Z_{it}$	age	continuous	Age of the individual
Age squared ( $age^2$ )	$Z_{it}$	age2	continuous	Age of the individual squared
Female	$Z_{it}$	female	binary	=1 if female =0 if male
Race	$Z_{it}$	race	categorical	=1 if White =2 if Black =3 if Asian =4 if Other/mixed
Hispanic	$Z_{it}$	hispanic	binary	=1 if hispanic =0 if not hispanic
Education categories	$Z_{it}$	educag	categorical	=1 if less than High School =2 if High School degree =3 if Bachelor's degree =4 if Graduate degree
Household has kid under 18 years old	$Z_{it}$	hhhaskid18	binary	=1 if household has children under 18 =0 if household not have children under 18

Total household income categories	$Z_{it}$	hhcinccat	categorical	=1 if less than \$25,000 =2 if \$25,000 - \$34,999 =3 if \$35,000 - \$49,999 =4 if \$50,000 - \$74,999 =5 if \$75,000 - \$99,999 =6 if \$100,000 - \$149,999 =7 if \$150,000 - \$199,999 =8 if above \$200,000 =13 if not reported
New COVID-19 cases	$Z_{it}$	sw_cases_new	continuous	New daily confirmed COVID cases per 100,000 people over the past 7 days

**Notes:**  $X_{it}$  is created using the categorical variable emp\_sector in the dataset. Self\_emp = 1 when emp\_sector = 4 (self-employed) and self\_emp = 0 when emp\_sector = 1, 2, 3, and 5 (government, private company, non-profit organization, and family business). Total household income refers to the income in the previous year before tax deductions.