

Covid Effects on the Returns to Schooling in Pennsylvania Industries

YANAN CHEN

*West Chester University **

KYLE A. KELLY

West Chester University

EBRU ISGIN

West Chester University

This paper analyzes the effects of the COVID-19 recession on the rate of return to schooling for twenty industries in Pennsylvania. Using data from the American Community Survey 2011-2021, we find the rate of return to schooling declined by 0.3 percentage points during COVID years from its pre-COVID level, and COVID effects on the rate of return differed among industries in Pennsylvania. COVID increased the returns to schooling for three industries, decreased the returns to schooling for six industries, and had no effect on the returns to schooling for the remaining eleven industries. The changes in the rate of return to schooling reflect shifts in the wage premium between high- and low-wage workers.

Keywords: Rate of Return to Schooling; COVID-19; Wage Gap; Pennsylvania

JEL Classifications: J24; J31

1 Introduction

Pennsylvania experienced a sharp decline in output and an unprecedented rise in unemployment during the COVID-19 recession. The real GDP of Pennsylvania decreased by 8.1% in the first quarter of 2020 from the fourth quarter of 2019, then declined by 34.4% in the second quarter of 2020. The unemployment rate in Pennsylvania surged from 4.9% in March 2020 to 16.1% in April 2020. By December 2020, the unemployment rate declined to 7.6% but remained well above the pre-pandemic levels. Additionally, the labor force participation rate in the state dropped to 60.8% during April 2020, two percentage points lower than its March level.

* Corresponding author, Department of Economics, ychen@wcupa.edu

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This paper analyzes changes in the rate of return to schooling for Pennsylvania workers during the COVID-19 recession. Pennsylvania has a strong working-class population and a unionization rate of 11.7%, one of the highest in the U.S. as of 2024 (U.S. Bureau of Labor Statistics, 2025). Its urban centers are home to diverse populations, with significant demographic, political, and economic differences in urban and rural areas. For example, Philadelphia and Pittsburgh have larger black and Hispanic populations relative to the rest of the state, and noticeable socioeconomic equity gaps. These gaps worsened with COVID due to poverty and limited access to healthcare and technology (Schafft et al., 2022), with people from diverse backgrounds experiencing more adverse effects than the majority (Yilmaz and Hermene, 2022). Additionally, Pennsylvania implemented some of the earliest and longest-lasting school and business closures and restrictive policies during COVID, with urban areas maintaining longer restrictions than rural ones. We focus on Pennsylvania due to its political, economic and demographic variations, equity gaps, strong union presence, and relatively strict policies during COVID.

The rate of return to schooling measures the percentage change in earnings resulting from an additional year of education (Mincer, 1974). It reflects the earnings gap between lower- and higher-educated workers. The COVID-19 pandemic created disproportionate job losses across wage levels. In 2020, approximately 80% of job losses were among the lowest wage earners, while relatively few high-paid workers lost jobs (Gould and Kandra, 2021). Similar findings are found in Gambau et al. (2022) and Chetty et al. (2023). This imbalance may have affected the rate of return to schooling in Pennsylvania. First, it likely increased the wage gap between low- and high-wage workers, potentially altering the returns to schooling. Second, the average hourly earnings rose rapidly for Pennsylvania workers, fueled by rapid loss of low-wage jobs. In April 2020, the year-over-year growth in average hourly earnings in Pennsylvania reached nearly 8% - the highest since 2006. This increase in average hourly wages may have also changed the wage gap and affected the returns to schooling.

Most empirical studies find that recessions have positive effects on the rate of return to schooling since wages of unskilled workers tend to decline by more than that of skilled workers during economic downturns (Welch, 1979). Higher unemployment is also associated with a wider college-high school wage gap (Genda, et al., 2010). Studies by Kniesner, Padilla and Polachek (1978, 1980), King (1980), and Chen and Kelly (2020) find that higher unemployment rates lead to higher returns to schooling. Belfield (2015) finds the returns to schooling for young workers in Arkansas increased in the quarters following the Great Recession. Likewise, Chen and Kelly (2025a) find the rate of return to schooling for Kentucky workers increased during the Great Recession. However, some studies report negative effects or no significant effects of recessions on the rate of return to schooling. For example, Psacharopoulos, et al. (1996) show that the returns to schooling in Mexico declined during a recession and rose during the recovery. Liu et al. (2014) find consistent returns to community college before and after the Great

Recession for both associate and bachelor's degrees in North Carolina community college for cohorts who entered college in 2002-2003. Chen and Kelly (2025b) estimate the rate of return to schooling for U.S. workers from 2011 to 2021 and find no significance difference in the returns to schooling between the pre-COVID years and COVID years.

We examine the effects of the COVID recession on the rate of return to schooling across industries in Pennsylvania. Although all industries in the state experienced output declines and job losses during the COVID recession, the extent of the impact varied. According to the U.S. Bureau of Economic Analysis (2021), industries, such as manufacturing, transportation, health care and social assistance, arts, entertainment, and recreation, accommodation and food services, saw the largest drop in real GDP. In contrast, some industries, such as agriculture, forestry, fishing, and hunting, mining, professional, scientific, and technical services, management of companies and enterprises, received relatively small effects from COVID. Given these differences, we expect the changes in the rate of return to schooling to be different across industries in Pennsylvania.

This paper is structured as follows. Section 2 presents our regression model and describes our sample selection process. Section 3 reports the empirical results. Finally, Section 4 concludes with a summary and discussion of the key findings.

2 Regression Model and Data

2.1 Modeling the COVID Effect on the Rate of Return to Schooling

The main purpose of this study is to test for a difference in the rate of return to schooling between COVID and non-COVID years. We capture the potential effects of the COVID recession on the rate of return to schooling in an extended Mincer wage equation setup. Following the framework developed in Chen and Kelly (2025b), we generate a dummy variable for COVID years and include it in our wage equation. Our regression model takes the following form:

$$\ln Y_{it} = \beta_0 + \beta_1 S_{it} + \beta_2 S_{it} COVID + \beta_3 COVID + \gamma X_{it} + \delta T + \varepsilon_{it} \quad (1)$$

where Y_{it} is the wage income for individual i at time t . $\ln Y$ is the logarithmic term of the wage income. S is the individual's years of schooling completed. $COVID$ is the dummy variable for COVID years. X_{it} is a vector of control variables that could influence wage income. T is a set of year dummies to control for the time trend in the regression. ε_{it} is the error term with its normal properties.

Taking the expected value of log wages, Equation (1) becomes:

$$E[\ln Y_{it} | S_{it}, S_{it}COVID, COVID, X_{it}, T] = \beta_0 + \beta_1 S_{it} + \beta_2 S_{it}COVID + \beta_3 COVID + \gamma X_{it} + \delta T \quad (1a)$$

The rate of return to schooling can be measured by taking the partial derivative of the expected value of log wages with respect to years of schooling, S , as shown in Equation (2):

$$\partial E[\ln Y_{it} | S_{it}, S_{it}COVID, COVID, X_{it}, T] / \partial S = \beta_1 + \beta_2 COVID \quad (2)$$

In non-COVID years, the rate of return to schooling is given by the coefficient β_1 , while the sum of the coefficients of β_1 and β_2 , measures the rate of return to schooling in COVID years. The coefficient on $COVID$, β_2 , shows the difference in the rate of return to schooling between COVID and non-COVID years.

2.2 Data

Our data comes from the American Community Survey (ACS), which is a U.S. census microdata accessed through the Integrated Public Use Microdata Series (IPUMS) database (Ruggles, et al., 2025). The ACS gathers detailed demographic and economic information on U.S. households and individuals across all states, including wage and salary income, education background, employment status, and work history. It also provides industry classification information on individuals which allows us to examine the COVID effects on the rate of return to schooling across different industries in Pennsylvania.

Our sample is drawn from the ACS 2010 – 2021. Based on the COVID timeline established by CDC and American Journal of Managed Care (AJMC Staff, 2021), we define our COVID years as 2020 and 2021. The timespan allows us to compare the pre-COVID and COVID-era outcomes while excluding the Great Recession and its recovery period from 2007 to 2010, allowing us to isolate the effects of the COVID pandemic.

In Equation (1), wage income Y is measured as the hourly wage and is calculated as the annual wage and salary income divided by annual work hours. All wages are converted to 2021 dollars using the Consumer Price Index (CPI) for all urban consumers. We select the following variables as the control variables X_{it} in Equation (1): *Exp* (potential years of work experience; calculated as age-5, assuming the person goes to school at age 5 and starts working right after school), Exp^2 (the square term of the potential years of work experience), *Female* (whether the person is female), *Black* (whether the person is black), and *Married* (whether the person is married). The summary statistics of the main variables are reported in Table 1.

We restrict our sample to individuals between ages 18 and 60 in Pennsylvania for each survey year. We further drop the individuals who report as unemployed, with unclassified industry category, or serve on active-duty military. Our restricted sample is a pooled cross-section dataset that contains 642,889 observations.

Table 1. Definition and Summary Statistics of the Main Variables

	Definition	Mean	Std.Dev
Wage	Annual wage and salary income	28.161	124.185
S	Total years of schooling	13.701	2.498
Exp	Potential years of work experience; =age-s-6	20.007	12.864
Female	=1 if respondent is female; 0 for male	0.488	0.500
Black	=1 if respondent is black; 0 otherwise	0.062	0.242
Married	=1 if respondent is married or permanently cohabiting; 0 otherwise	0.549	0.498

Date source: American Community Survey 2011-2021

The twenty industries are as follows. The primary and resource-based industries include agriculture, forestry, fishing and hunting (AGRI); mining, quarrying, and oil and gas extraction (MINI); and utilities (UTIL). The goods-producing industries include construction (CONS) and manufacturing (MANU). The trade and transportation industries include wholesale trade (WHOL), retail trade (RETA), and transportation and warehousing (TRAN). Information and financial services industries include information (INFO), finance and insurance (FINA), and real estate and rental and leasing (REAL). The professional and business services industries include professional, scientific, and technical services (PROF), management of companies and enterprises (MANG), and administrative and support and waste management and remediation services (ADMI). The education and health services industries include educational services (EDUC) and healthcare and social assistance (HEAL). Finally, leisure, hospitality, and other services industries include arts, entertainment, and recreation (ARTS), accommodation and food services (FOOD), other services except public administration (SERV), and public administration (PUBL).

Table 2 provides the description and distribution of all industry categories. Overall, Pennsylvania has a relatively large proportion of workers in the industries of manufacturing (0.129), retail trade (0.113), educational services (0.104), and health care and social assistance (0.161). In manufacturing and in health care and social assistance, the shares of workers are much greater than the national averages (Chen and Kelly, 2025b). A small proportion of workers are employed in agriculture, forestry, fishing and hunting (0.008), mining, quarrying, and oil and gas extraction (0.007), utilities (0.011), real estate and rental and leasing (0.011), management of companies and enterprises (0.001).

Table 2. Description and Distribution of Industry Categories in Pennsylvania

Industry	Description	Mean	Std.Dev
AGRI	Agriculture, Forestry, Fishing and Hunting	0.008	0.091
MINI	Mining, Quarrying, and Oil and Gas Extraction	0.007	0.083
UTIL	Utilities	0.011	0.102
CONS	Construction	0.059	0.236
MANU	Manufacturing	0.129	0.335
WHOL	Wholesale Trade	0.025	0.157
RETA	Retail Trade	0.113	0.316
TRAN	Transportation and Warehousing	0.043	0.203
INFO	Information	0.016	0.125
FINA	Finance and Insurance	0.047	0.211
REAL	Real Estate and Rental and Leasing	0.011	0.106
PROF	Professional, Scientific, and Technical Services	0.059	0.235
MANG	Management of Companies and Enterprises	0.001	0.033
ADMI	Administrative and Support and Waste Management and Remediation Services	0.034	0.182
EDUC	Educational Services	0.104	0.306
HEAL	Health Care and Social Assistance	0.161	0.368
ARTS	Arts, Entertainment, and Recreation	0.020	0.141
FOOD	Accommodation and Food Services	0.068	0.251
SERV	Other Services (Except Public Administration)	0.040	0.195
PUBL	Public Administration	0.044	0.205

Date source: American Community Survey 2011-2021.

Industry categories are coded using North American Industrial Classification System (NAICS)

3 Empirical Results

Table 3 presents the regression results. We begin by estimating the COVID effects on the rate of return to schooling for the entire sample in Pennsylvania. To address potential selection bias, we use Heckman two-stage model to estimate Equation (1) (Heckman, 1976). The first stage probit model is the decision to participate in the labor market (with annual work hours greater than zero). The explanatory variables in the probit model include years of schooling, age, and dummy variables for COVID, female, black, and married.

Column 1 of Table 3 reports the regression results for the entire sample. The estimated coefficient on years of schooling, S , is 0.126 and is statistically significant at the 1% level. It indicates that one more year of schooling increases hourly wage by an average of 12.6% in pre-COVID years (2011 – 2019) for Pennsylvania workers. The estimated coefficient on $S \cdot COVID$ is -0.003 and is statistically significant at the 1% level, suggesting COVID has negative, but small effects on the rate of return to schooling in Pennsylvania. On average, each additional

year of schooling increases hourly wage by 12.3% for Pennsylvania workers during the COVID-era (2020 – 2021). The rate of return to schooling decreases by an average of 0.3 percentage points during COVID.

We then use Heckman two-stage estimation to estimate Equation (1) separately for each industry in Pennsylvania. Our regression results are presented in Table 3 from Column 2 to Column 21. All the estimated coefficients on schooling years, S , are positive and statistically significant at the 1% level, indicating schooling significantly increases workers' hourly wage in all Pennsylvania industries in pre-COVID years. The estimated rate of return to schooling ranges from 3.8% to 17.8% among industries. In Pennsylvania, workers receive the highest rate of return to schooling in the industries of management of companies and enterprises (MANG), 0.178, health care and social assistance (HEAL), 0.149, professional, scientific, and technical services (PROF), 0.143, educational services (EDUC), 0.142, and finance and insurance (FINA), 0.139. In pre-COVID years of 2011 – 2019, each additional year of schooling increases workers' hourly wage by an average of 17.8%, 14.9%, 14.3%, 14.2% and 13.9% for those five industries, respectively. The five industries with the lowest rate of return to schooling are agriculture, forestry, fishing and hunting (AGRI), 0.038, accommodation and food services (FOOD), 0.064, and construction (CONS), 0.064, other services except public administration (SERV), 0.069, and transportation and warehousing (TRAN), 0.076. Before COVID, each additional year of schooling increases workers' hourly wage by an average of 3.8%, 6.4%, 6.4%, 6.9% and 7.6% in those industries, respectively.

The changes in the rate of return to schooling during COVID vary across industries in Pennsylvania. The estimated coefficient on the schooling interactive term, $S \cdot COVID$, is positive and statistically significant for the following three industries: information (INFO), 0.023, real estate and rental and leasing (REAL), 0.032, and health care and social assistance (HEAL), 0.011. This indicates positive effects of COVID on the rate of return to schooling for those industries. The rate of return to schooling for the three industries increases by an average of 2.3 percentage points, 3.2 percentage points, and 1.1 percentage points during the COVID years of 2020 – 2021, respectively. In contrast, the estimated coefficient on the interactive term, $S \cdot COVID$, is negative and statistically significant for the following six industries: mining, quarrying, and oil and gas extraction (MINI), -0.039, utilities (UTIL), -0.020, transportation and warehousing (TRAN), -0.011, educational services (EDUC), -0.010, accommodation and food services (FOOD), -0.012, and other services except public administration (SERV), -0.016. It indicates negative COVID effects on the rate of return to schooling for those six industries. During COVID, the rate of return decreases by an average of 3.9 percentage points, 2.0 percentage points, 1.1 percentage points, 1.0 percentage points, 1.2 percentage points, and 1.6 percentage points for those industries, respectively. For the remaining eleven industries, agriculture, forestry, fishing and hunting (AGRI), construction (CONS), manufacturing (MANG), wholesale trade (WHOL), retail trade (RETA), finance and insurance (FINA),

professional, scientific, and technical services (PROF), management of companies and enterprises (MANA), administrative and support and waste management and remediation services (ADMI), arts, entertainment, and recreation (ARTS), and public administration (PUBL), the rate of return to schooling remains the same throughout the entire sample, given by the insignificant estimated coefficients on $S \cdot COVID$.

Table 3. The COVID Effect on the Rate of Return to Schooling Among Industries in Pennsylvania

	Total (1)	AGRI (2)	MINI (3)	UTIL (4)	CONS (5)	MANU (6)	WHOL (7)
S	0.126*** (0.001)	0.038*** (0.004)	0.091*** (0.007)	0.112*** (0.005)	0.064*** (0.002)	0.132*** (0.002)	0.127*** (0.004)
S · COVID	-0.003** (0.001)	0.004 (0.014)	-0.039* (0.022)	-0.020* (0.012)	-0.002 (0.006)	0.000 (0.004)	-0.006 (0.008)
COVID	0.171*** (0.018)	0.110 (0.184)	0.675** (0.291)	0.385** (0.171)	0.204*** (0.075)	0.101** (0.050)	0.229** (0.113)
Exp	0.043*** (0.000)	0.025*** (0.003)	0.028*** (0.004)	0.040*** (0.003)	0.041*** (0.001)	0.032*** (0.001)	0.040*** (0.002)
Exp ²	-0.001*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)
Female	-0.237*** (0.002)	-0.104*** (0.031)	-0.211*** (0.032)	-0.272*** (0.018)	-0.200*** (0.012)	-0.190*** (0.005)	-0.186*** (0.012)
Black	-0.125*** (0.004)	-0.198* (0.102)	-0.142 (0.126)	-0.163*** (0.039)	-0.267*** (0.029)	-0.191*** (0.015)	-0.238*** (0.035)
Married	0.187*** (0.002)	0.150*** (0.031)	0.190*** (0.021)	0.139*** (0.017)	0.189*** (0.008)	0.197*** (0.005)	0.181*** (0.012)
Year Dummies	0.126*** Yes	0.038*** Yes	0.091*** Yes	0.112*** Yes	0.064*** Yes	0.132*** Yes	0.127*** Yes
Inverse Mills Ratio	0.088 (0.001)	-0.676 (0.048)	0.075 (0.034)	0.048 (0.010)	0.031 (0.005)	0.082 (0.005)	0.189 (0.027)
Obvs	642,889	5,389	4,322	6,514	38,376	81,571	16,066

Table 3. The COVID Effect on the Rate of Return to Schooling Among Industries in Pennsylvania-Continued

	RETA (8)	TRAN (9)	INFO (10)	FINA (11)	REAL (12)	PROF (13)	MANG (14)
S	0.094*** (0.002)	0.076*** (0.003)	0.107*** (0.004)	0.139*** (0.003)	0.104*** (0.006)	0.143*** (0.003)	0.178*** (0.014)
S · COVID	0.006 (0.004)	-0.011* (0.007)	0.023* (0.012)	-0.007 (0.006)	0.032** (0.013)	-0.001 (0.005)	0.041 (0.029)
COVID	0.049 (0.056)	0.221** (0.090)	-0.180 (0.186)	0.189** (0.090)	-0.289 (0.180)	0.171** (0.081)	-0.503 (0.460)

Exp	0.042*** (0.001)	0.032*** (0.002)	0.059*** (0.003)	0.053*** (0.001)	0.041*** (0.003)	0.048*** (0.001)	0.060*** (0.008)
Exp ²	-0.001*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Female	-0.218*** (0.006)	-0.187*** (0.009)	-0.296*** (0.015)	-0.312*** (0.009)	-0.217*** (0.018)	-0.267*** (0.007)	-0.305*** (0.045)
Black	-0.095*** (0.013)	-0.125*** (0.016)	-0.115*** (0.034)	-0.109*** (0.016)	-0.109*** (0.032)	-0.065*** (0.023)	-0.297 (0.203)
Married	0.168*** (0.006)	0.143*** (0.009)	0.210*** (0.017)	0.118*** (0.008)	0.203*** (0.020)	0.166*** (0.008)	0.045 (0.054)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inverse Mills Ratio	0.184 (0.022)	0.068 (0.010)	0.120 (0.017)	0.144 (0.018)	0.111 (0.028)	0.054 (0.005)	-0.046 (0.109)
Obvs	74,772	27,872	10,223	28,941	7,298	36,670	681

Table 3. The COVID Effect on the Rate of Return to Schooling Among Industries in Pennsylvania-Continued

	ADMI (15)	EDUC (16)	HEAL (17)	ARTS (18)	FOOD (19)	SERV (20)	PUBL (21)
S	0.090*** (0.003)	0.142*** (0.002)	0.149*** (0.002)	0.079*** (0.005)	0.064*** (0.002)	0.069*** (0.002)	0.113*** (0.003)
S· COVID	-0.005 (0.007)	-0.010*** (0.003)	0.011*** (0.003)	0.011 (0.011)	-0.012** (0.006)	-0.016*** (0.006)	0.009 (0.007)
COVID	0.208** (0.098)	0.269*** (0.055)	-0.071 (0.048)	-0.042 (0.152)	0.384*** (0.079)	0.362*** (0.082)	-0.114 (0.110)
Exp	0.028*** (0.002)	0.040*** (0.001)	0.034*** (0.001)	0.045*** (0.002)	0.029*** (0.001)	0.028*** (0.002)	0.041*** (0.002)
Exp ²	-0.000*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)
Female	-0.112*** (0.011)	-0.178*** (0.006)	-0.174*** (0.006)	-0.142*** (0.015)	-0.110*** (0.008)	-0.206*** (0.009)	-0.119*** (0.008)
Black	-0.197*** (0.018)	-0.005 (0.015)	-0.097*** (0.008)	-0.014 (0.035)	-0.043*** (0.016)	-0.076*** (0.024)	-0.212*** (0.022)
Married	0.241*** (0.012)	0.069*** (0.006)	0.144*** (0.005)	0.119*** (0.020)	0.112*** (0.010)	0.170*** (0.011)	0.205*** (0.010)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inverse Mills Ratio	0.089 (0.010)	0.055 (0.006)	0.165 (0.010)	0.143 (0.063)	0.117 (0.032)	0.034 (0.005)	0.019 (0.002)
Obvs	23,375	65,315	102,453	13,369	46,244	25,818	27,620

Date source and notes: American Community Survey 2011-2021.

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4 Conclusion and Discussion

This study examines the effects of the COVID recession on the rate of return to schooling for twenty industries in Pennsylvania. Our sample is drawn from the American Community Survey 2011 – 2021. It provides us with enough information on Pennsylvania workers' demographics and industry classification for both periods before COVID (2011 – 2019) and during COVID (2020 – 2021). Our main findings are as follows.

First, for all Pennsylvania workers, the estimated rate of return to schooling in the pre-COVID years is 0.126. In Pennsylvania, each additional year of schooling increases workers' hourly wage by 12.6%, on average. Compared to the national level of 11.5%¹, Pennsylvania workers experienced a 1.1 percentage point higher rate of return to schooling in the pre-COVID years of 2011 – 2019.

The COVID pandemic reduced the rate of return to schooling. During the COVID years (2020 – 2021), the rate of return to schooling declined to 12.2%, a drop of 0.3 percentage points from the pre-COVID level. Unlike the national average, which showed no significant change², Pennsylvania workers experienced a noticeable decline in returns when compared to the national average.

Second, the effects of COVID on the rate of return to schooling varied across industries in Pennsylvania. During COVID years, the rate of return to schooling significantly increased from 1.1 percentage points to 3.2 percentage points for three industries: health care and social assistance (HEAL), information (INFO), and real estate and rental and leasing (REAL). It decreased from 1.0 percentage points to 3.9 percentage points for six industries: mining, quarrying, and oil and gas extraction (MINI), utilities (UTIL), transportation and warehousing (TRAN), educational services (EDUC), accommodation and food services (FOOD), and other services except public administration (SERV). For the remaining eleven industries, there was no significant change in the rate of return to schooling during COVID years compared to pre-COVID years.

Our empirical results are consistent with the previous studies on the returns to schooling over the business cycles. Changes in the rate of return to schooling reflect shifts in the wage premium between high- and low-wage workers. A greater wage premium leads to a greater wage change as schooling years increase, which results in a higher rate of return to schooling. Traditionally, economic downturns have negative effects on wages. During recessions, higher unemployment rates and limited employment opportunities diminish the bargaining power of workers. This leads to a decrease in wages or a slowdown in the growth rate of wages. The negative effects differ between high- and low-wage workers, which may change the wage premium. The COVID recession shares similar macroeconomic properties as previous

¹ See Chen and Kelly (2025b), Table 3.

² See Chen and Kelly (2025b), Table 3.

recessions and results in similar labor market tightness. In some industries, the negative effects of COVID on wages may be greater for high-wage workers than for low-wage workers, which reduces the wage premium and thus decreases the rate of return to schooling during COVID. In contrast, if the negative effects of COVID on wages are smaller for high-wage workers than for low-wage workers, the wage premium between the two educational groups increases, and therefore increases the rate of return to schooling during COVID.

Our results show that Pennsylvania followed national trends in most cases. The wage premium and rate of return to schooling is relatively low and are affected negatively by COVID in the raw material, resource extraction and service industries, such as agriculture, construction, food and service. In contrast, in the knowledge-based and high-level decision-making industries, such as professional, scientific, technical services, and management of companies, the wage premium and the rate of return to schooling are relatively high and experienced relatively small effects from COVID. The education sector presents an interesting case where the effects of COVID on rates of return to schooling are negative as opposed to a positive U.S. average. This may be due to decreasing student enrollment, funding issues and static teacher salaries.

Our study only focuses on the COVID effects on the rate of return to schooling. Although COVID was the most important event of 2020 that affected the rate of return to schooling, other factors could have contributed to the change in the wage premium and the returns to schooling as well. For example, the percentage of union members to all employed workers in Pennsylvania was below 13% in most years from 2010 – 2019, and it increased to 13.5% in 2020. The increased union membership should lead to less wage inequality among workers, which may decrease wage premium and rate of return for Pennsylvania workers. Another factor is the increase in the supply of skilled workers. The number of college graduates in Pennsylvania increased between 2010 and 2021. Without a corresponding increase in demand for those skills, the increase in the supply of college graduates may also decrease the wage premium and the returns to schooling in Pennsylvania.

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