# To What Extent did the COVID-19 Pandemic Affect the Relationship Between Salary Income and Travel Time to Work?

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## Introduction

In March 2020, the COVID-19 pandemic began to impact broad swaths of the global economy. In the United States, concerns surrounding the spread of the airborne virus led to nationwide stay-at-home orders that contributed to trillions of dollars of economic losses (Chen et al., 2021). As a result of these orders, many companies implemented remote work policies that enabled employees to attend work without being physically present at the workplace. Despite this, a portion of the workforce was designated as "essential workers" due to the importance of their jobs in maintaining society. Essential workers such as grocery clerks, healthcare workers, and childcare providers were exempted from stay-at-home orders and expected to travel to work throughout the pandemic (Blau et al., 2021

Research before the pandemic found that a 1-minute increase in mean travel time to work is correlated with an $817.73 increase in mean household income (Johnston, 2019). This relationship exists to a lesser extent among young adults, with 10 additional minutes of one-way commute time associated with a 2.9% increase in annual income (French et al., 2020). These findings are attributed to the changing amenity preferences as younger individuals age into the labor force. Specifically, younger workers are more likely to live closer to their workplace and receive lower wages than more experienced workers (French et al., 2020). Furthermore, salary income and commute times tend to peak for workers around age 50 before declining as individuals begin to retire (Newbold, 2022; Guvenen et al., 2019). While age, income, and commute time are correlated, the large number of personal and economic factors that determine an individual's desired and actual commute time makes it difficult to discern a specific causal mechanism driving the relationship.

Work-from-home orders implemented in response to the pandemic meaningfully altered typical commuting patterns, with more than 33% of American employers increasing remote work for some or all of their employees (U.S. Bureau of Labor Statistics, 2022). Additionally, more remote work opportunities were concentrated around higher-paying jobs, both within and between industries (U.S. Bureau of Labor Statistics, 2022). Many of these policies remained following the easing of COVID-19 restrictions in large part due to the substantial time savings, averaging upwards of two hours a week, associated with remote and hybrid work modalities (Aksoy et al., 2023). This would suggest that individuals with higher-income jobs are more likely to work from home and thus experience shorter average commute times than lower-income individuals.

This widespread shift in work modalities has substantial implications for employees, employers, and governments (Althoff et al., 2022; Battisti

et al., 2022). First, workers with remote work opportunities will experience greater time savings and residence flexibility compared to their in-person counterparts. Second, employers will need to balance the increased demand for remote work with potential efficiency and operational concerns. Third, governments may have to alter road development and resource allocation strategies as traditional commuting and housing density trends change in response to remote work opportunities. Additionally, there are potential equity concerns stemming from the exacerbated commute times of lower-income individuals who are less likely to be offered opportunities for remote work and more likely to live further from urban employment centers due to a lack of affordable housing (Blumenberg & Wander, 2022).

This paper seeks to answer the question: How did the COVID-19 pandemic affect the relationship between salary income and travel time to work? We expect our analysis will find that the COVID-19 pandemic caused a reversal in the relationship between commute time and salary income. This would mean that, following the pandemic, individuals with higher incomes would, on average, experience shorter commute times than individuals with lower incomes. We anticipate this outcome because lower-income individuals were more likely to be classified as "essential workers" and expected to commute during the pandemic. Conversely, individuals with higher-paying jobs were less likely to be "essential workers" and, as a result, more frequently operated under hybrid or work-from-home modalities that resulted in a substantial reduction or elimination of commute times for these individuals (U.S. Bureau of Labor Statistics, 2022).

In this paper, we measure how commute times are affected by income before and following the COVID-19 pandemic. To determine this relationship, we examined the commute time and wage income of working individuals aged 18 to 65 using data gathered from the American Community Survey in 2016 and 2021. We chose these years because 2016 was a reasonable baseline before the COVID-19 pandemic, and 2021 was the first full year following the onset of the pandemic. Our dependent variable will be average commute time, and our independent variable will be annual wage and salary income. Both are continuous individual variables. We will estimate the same regression model on data from 2016 and 2021 to determine if the COVID-19 pandemic caused a change in the relationship between salary income and commute time. Further, we will control for confounding factors including race, migration status, age, gender, employment industry, education level, family status, and urban-rural classification.

Consistent with previous studies on the transition to remote work, our research found that the relationship between income and commute times changed following the COVID-19 pandemic. In addition, we found a reversal in the relationship between working from home and annual income, with higher-income individuals being more likely to work from home in 2021 following the pandemic.

## Data

Data from the American Community Survey, conducted by the United States Census Bureau, was used to investigate the relationship between income and travel time to work. The sample includes individuals living in the United States during the 2016 and 2021 survey years. Further, the dataset was restricted to employed individuals aged 18 to 65. From this data, we generated variables on wage and salary income, work commute times, age, gender, race, number of children, urban-rural status, marital status, education, self-employment, migration, and work industry for our analysis. These variables are suitable to answer our research question as they measure income and work travel time alongside other pertinent control variables for employed

individuals before and after work modality shifts due to the COVID-19 pandemic.

We used average travel time to work from this data set as our dependent variable. A new inflation-adjusted wage and salary income was generated to control for potential wage gains due to inflation. This inflation-adjusted annual wage and salary income variable is used as our independent variable. This allows us to compare wages, which change across years, with commute times, which have remained relatively constant outside of their interaction with stay-at-home and remote work policies that originated during the COVID-19 pandemic. New variables representing the natural log of the dependent and independent variables were used in the final regression as the log functional form yielded the largest adjusted R-squared value.

Additional dummy variables were constructed for categorical variables to distinguish between different genders, races, education levels, marital status, migration status, employment industries, and urban-rural locations. Continuous variables, including age, number of children, and average weekly hours worked, were used in the regression. In concert, these variables control for other factors that could impact the relationship between income and commute time.

***Table 1: Summary Statistics for Discrete Variables from 2016 and 2021***

| Variable | Average (2016) | Average (2021) |
|---|---|---|
| Urban | 0.893 | 0.895 |
| Rural | 0.107 | 0.105 |
| Male | 0.519 | 0.520 |
| Female | 0.481 | 0.480 |
| White | 0.776 | 0.665 |
| Black | 0.092 | 0.083 |
| All Other Races | 0.132 | 0.252 |
| Moved in Last Year | 0.856 | 0.866 |
| Did Not Move in Last Year | 0.144 | 0.134 |
| Less Than High School | 0.060 | 0.052 |
| High School | 0.325 | 0.315 |
| Some College | 0.255 | 0.231 |
| College Degree | 0.225 | 0.245 |
| Postgraduate | 0.135 | 0.156 |
| Married | 0.567 | 0.554 |
| Formerly Married | 0.138 | 0.128 |
| Never Married | 0.296 | 0.318 |
| Self Employed | 0.092 | 0.097 |
| Agriculture, Forestry, Fishing, Hunting, and Mining Services | 0.020 | 0.018 |
| Construction | 0.001 | 0.001 |
| Manufacturing | 0.107 | 0.105 |
| Wholesale Trade | 0.027 | 0.023 |
| Retail Trade | 0.106 | 0.104 |
| Transportation, Warehousing and Utility Services | 0.052 | 0.056 |
| Information | 0.021 | 0.019 |
| Finance, Insurance, and Real Estate Services | 0.048 | 0.051 |
| Professional, Scientific, Management, Administrative, and Waste Management Services | 0.112 | 0.123 |
| Education, Health Care and Social Assistance Services | 0.241 | 0.243 |
| Arts, Entertainment, Recreation, Accommodation and Food Services | 0.079 | 0.072 |
| Other Industries/Services | 0.047 | 0.044 |
| Public Administration | 0.049 | 0.051 |
| Serving in the Military | 0.009 | 0.010 |
| | | |
| Number of Observations | 1,358,184 | |

***Table 2: Summary Statistics for Continuous Variables in 2016***

| Variable | Average | Minimum | Maximum |
|---|---|---|---|
| Age | 42.09 years | 18 | 65 |
| Wage & Salary Income (In 2016 Dollars) | $50,158.91 | $0 | $714,000 |
| Usual Work Hours per Week | 39.77 hours | 1 | 99 |
| Usual Commute Time | 27.09 minutes | 0 | 160 |
| Number of Children | 0.813 | 0 | 9 |
| | | | |
| Number of Observations | 1,358,184 | | |

***Table 3: Summary Statistics for Continuous Variables in 2021***

| Variable | Average | Minimum | Maximum |
|---|---|---|---|
| Age | 41.98 years | 18 | 65 |
| Wage & Salary Income (In 2021 Dollars) | $59,252.63 | $0 | $787,000 |
| Wage & Salary Income (Inflation Adjusted to 2016 Dollars) | $52,497.83 | $0 | $697,282 |
| Usual Work Hours per Week | 39.58 hours | 1 | 99 |
| Usual Commute Time | 22.87 minutes | 0 | 163 |
| Number of Children | 0.802 | 0 | 9 |
| | | | |
| Number of Observations | 1,359,556 | | |

Tables 1, 2, and 3 show summary statistics for variables generated from the 2016 and 2021 editions of the American Community Survey. Respondents were primarily white (78% in 2016 and 67% in 2021), married (57% in 2016 and 55% in 2021), and living in urban areas (89% in both 2016 and 2022). Respondents were split between genders (52% males in both 2016 and 2021) and worked across a variety of industries, with education, health care, and social assistance services being the most common (24% in both 2016 and 2021). The inflation-adjusted average wage and salary income of respondents in the sample ranged from $0 to $787,000, with average incomes of $50,158.91 in 2016 and $52,497.83 in 2021. The average travel time to work ranged from 0 to 163 minutes, with an average of 27 minutes in 2016 and 23 minutes in 2021.

***Figure 1: 2016 Scatterplot of Salary Income and Travel Time to Work***

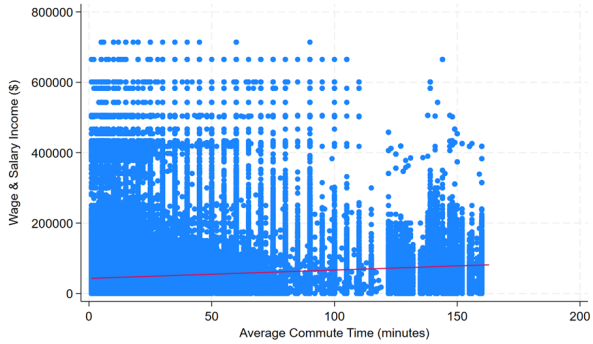



***Figure 2: 2021 Scatterplot of Inflation Adjusted Salary Income and Travel Time to Work***

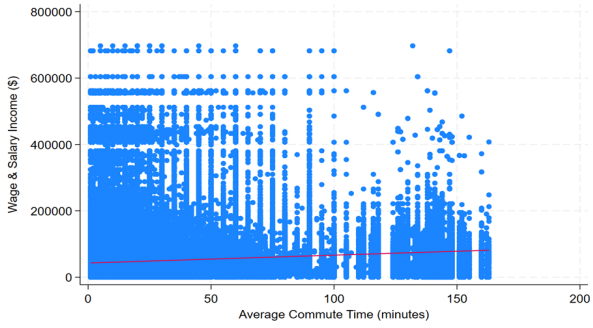
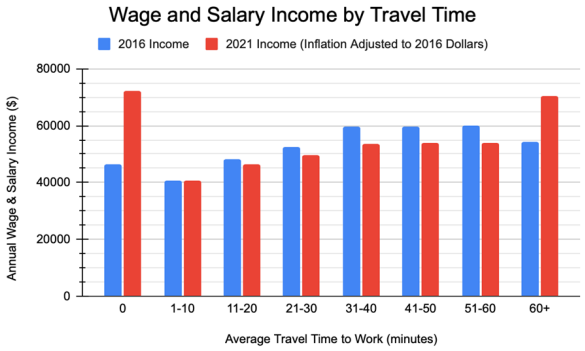



***Figure 3: Wage and Salary Income by Travel Time to Work in 2016 and 2021***




Figures 1 and 2 show a scatterplot of income and commute time with a best-fit line in 2016 and 2021. From these figures, we can see that the general distribution of income and travel times remained fairly consistent between the two years with a minor decrease in the slope of the best fit line. Figure 3 shows the inflation-adjusted average wage and salary income for individuals with different commute times in 2016 and 2021. Between these years, there was a nearly $25,000 increase in income for those working remotely or commuting zero minutes to work. The incomes associated with other travel time bands remained flat or decreased between 2016 and 2021 except for those with more than 60 minutes of travel time to work. The increase in this category could be attributed to an increase in hybrid work arrangements where individuals are willing to commute farther distances fewer times a week.

## Results

An ordinary least squares regression (OLS) was used to evaluate the effect of wage and salary income (independent variable) on average travel time to work (dependent variable). There will be separate regressions run for data collected in 2016 and 2021 to determine the change in this relationship between the two time periods. Additional control variables were included to prevent the influence of omitted variable bias on the

coefficients estimated by the regression. This yields the following regression equation:

$$\begin{aligned} log(commute)_i &= \alpha + \beta_1 log(income)_i + \beta_2 nchild_i + \beta_3 age_i + \beta_4 uhrswork_i \\ &+ \beta_5 female_i \\ &+ \beta_6 wasmarried_i + \beta_7 nevermarried_i + \beta_8 lessthanhs_i + \beta_9 hs_i + \beta_{10} somecoll_i \\ &+ \beta_{11} coll_i \\ &+ \beta_{12} rural_i + \beta_{13} black_i + \beta_{14} otherrace_i + \beta_{15} notmoved_i + \beta_{16} self employed_i \\ &+ \beta_{17} agriculture_i + \beta_{18} construction_i + \beta_{19} manufacturing_i \\ &+ \beta_{20} wholesaletrade_i \\ &+ \beta_{21} retailtrade_i + \beta_{22} transportation_i + \beta_{23} information_i + \beta_{24} professional_i \\ &+ \beta_{25} education_i + \beta_{26} arts_i + \beta_{27} other_i + \beta_{28} public_i + \beta_{29} military_i + \varepsilon_i \end{aligned}$$

The regression will exclude male, married, postgraduate, urban, white, moved, and finance as the comparison categories for the dummy variables.

***Table 4: OLS Regression for Log of Commute Time***

| Variable | Coefficient 2016 | P-Value 2016 | Coefficient 2021 | P-Value 2021 |
|---|---|---|---|---|
| Log of Wage & Salary Income (Inflation Adjusted to 2016) | 0.088*** | 0.000 | 0.062*** | 0.000 |
| Number of Children | 0.006*** | 0.000 | 0.004*** | 0.000 |
| Age | 0.000*** | 0.000 | 0.000*** | 0.000 |
| Usual Work Hours per Week | 0.001*** | 0.000 | 0.001*** | 0.000 |
| Female | -0.038*** | 0.000 | -0.073*** | 0.000 |
| Formerly Married | -0.128*** | 0.000 | -0.013*** | 0.000 |
| Never Married | -0.017*** | 0.000 | -0.035*** | 0.000 |
| Less Than High School | 0.006 | 0.161 | 0.030*** | 0.000 |
| High School | -0.028*** | 0.000 | 0.008*** | 0.006 |
| Some College | -0.022*** | 0.000 | 0.007** | 0.021 |
| College Degree | 0.014*** | 0.000 | 0.018*** | 0.000 |
| Rural | -0.250*** | 0.000 | -0.194*** | 0.000 |
| Black | 0.150*** | 0.000 | 0.127*** | 0.000 |
| All Other Races | 0.110*** | 0.000 | 0.091*** | 0.000 |
| Did Not Move in Last Year | -0.028*** | 0.000 | -0.027*** | 0.000 |
| Self Employed | -0.237*** | 0.000 | -0.152*** | 0.000 |
| Agriculture, Forestry, Fishing, Hunting, and Mining Services | -0.214*** | 0.000 | -0.175*** | 0.000 |
| Construction | -0.110*** | 0.000 | -0.070*** | 0.005 |
| Manufacturing | -0.082*** | 0.000 | -0.054*** | 0.000 |
| Wholesale Trade | -0.044*** | 0.000 | -0.026*** | 0.000 |
| Retail Trade | -0.175*** | 0.000 | -0.161*** | 0.000 |
| Transportation, Warehousing and Utility Services | -0.034*** | 0.000 | -0.027*** | 0.000 |
| Information | -0.035*** | 0.000 | -0.077*** | 0.000 |
| Professional, Scientific, Management, Administrative, and Waste Management Services | -0.005 | 0.105 | -0.045*** | 0.000 |
| Education, Health Care and Social Assistance Services | -0.180*** | 0.000 | -0.127*** | 0.000 |
| Arts, Entertainment, Recreation, Accommodation and Food Services | -0.214*** | 0.000 | -0.180*** | 0.000 |
| Other Industries/Services | -0.191*** | 0.000 | -0.152*** | 0.000 |
| Public Administration | -0.082*** | 0.000 | -0.065*** | 0.000 |
| Serving in the Military | -0.597*** | 0.000 | -0.515*** | 0.000 |
| Number of Observations | | 1,050,701 | | 884,660 |
| R^2 | | 0.061 | | 0.040 |
| Adjusted R^2 | | 0.061 | | 0.040 |

Table 4 shows the results of an OLS regression on the log of average travel time to work. We report our regression analysis in the double-logged form because this form yields the largest adjusted R^2 values for all functional forms tested. As both the dependent and independent variables are logged, coefficients are interpreted as the percent change in average travel time to work. The coefficient of interest, the log of wage and salary income, is highlighted in the table. Prior to COVID in 2016, a 1% increase in annual wage and salary income increased average travel time to work by 0.088%, holding all variables constant. However, following COVID-19 in 2021, a 1% increase in annual wage and salary income increased average travel time to work by 0.062%, holding all variables constant.

To assist in digesting these numbers, if annual wage and salary income increased by 10%, individuals tended to spend 0.88% and 0.62% more time in the car traveling to work in 2016 and 2021, respectively. The 95% confidence intervals for wage and salary income in 2016 [0.087, 0.091] and 2021 [0.060, 0.064] do not overlap, showing a significant difference between the two years. This significant decrease in our coefficient of interest suggests that the relationship between commute time and income became less pronounced following the COVID-19 pandemic. Other essential factors in determining commute time were individuals' urban-rural location and self-employed status. Compared to living in an urban setting, rural residents had lower average commute times both before and after the pandemic, but there was an increase in travel time amongst rural residents after COVID-19. In 2016, living in a rural area reduced commute time by 25% compared to individuals living in urban areas, and in 2021 it reduced commute time by 19.4%. This aligns with the adverse effect observed in our regression, as those living in rural areas usually have cheaper living costs and less income, hence them commuting longer post-pandemic. Similarly, those who were

self-employed, compared to employees working for wages, experienced commute times 23.7% less in 2016 and 15.2% less in 2021.

To further evaluate the relationship between the COVID-19 pandemic, income, and commute time, we generated a new variable denoting if an individual works from home (WFH), defined if their average travel time to work was zero. This variable was then used in a new regression to examine how wage and salary income affected the probability of working from home before and after the COVID-19 pandemic. This new regression, displayed below and summarized in Table 5, excluded the same dummy variables as in our initial regression.

$$wfh_i = \alpha + \beta_1 log(income)_i + \beta_2 nchild_i + \beta_3 age_i + \beta_4 uhrswork_i + \beta_5 female_i + \beta_6 wasmarried_i + \beta_7 nevermarried_i + \beta_8 lessthanhs_i + \beta_9 hs_i + \beta_{10} somecoll_i + \beta_{11} coll_i + \beta_{12} rural_i + \beta_{13} black_i + \beta_{14} otherrace_i + \beta_{15} notmoved_i + \beta_{16} selfemployed_i + \beta_{17} agriculture_i + \beta_{18} construction_i + \beta_{19} manufacturing_i + \beta_{20} wholesaletrade_i + \beta_{21} retailtrade_i + \beta_{22} transportation_i + \beta_{23} information_i + \beta_{24} professional_i + \beta_{25} education_i + \beta_{26} arts_i + \beta_{27} other_i + \beta_{28} public_i + \beta_{29} military_i + \varepsilon_i$$

***Table 5: OLS Regression for Work from Home***

| Variable | Coefficient 2016 | P-Value 2016 | Coefficient 2021 | P-Value 2021 |
|---|---|---|---|---|
| Log of Wage & Salary Income (Inflation Adjusted to 2016) | -0.011*** | 0.000 | 0.031*** | 0.000 |
| Number of Children | 0.002*** | 0.000 | -0.005*** | 0.000 |
| Age | 0.001*** | 0.000 | -0.000*** | 0.000 |
| Usual Work Hours per Week | -0.001*** | 0.000 | -0.002*** | 0.000 |
| Female | 0.015*** | 0.000 | 0.058*** | 0.000 |
| Formerly Married | -0.005*** | 0.000 | -0.019*** | 0.000 |
| Never Married | -0.005*** | 0.000 | -0.011*** | 0.000 |
| Less Than High School | -0.028*** | 0.000 | -0.200*** | 0.000 |
| High School | -0.026*** | 0.000 | -0.178*** | 0.000 |
| Some College | -0.016*** | 0.000 | -0.135*** | 0.000 |
| College Degree | -0.000 | 0.740 | -0.027*** | 0.000 |
| Rural | -0.007*** | 0.000 | -0.074*** | 0.000 |
| Black | -0.007*** | 0.000 | 0.002 | 0.122 |
| All Other Races | -0.003*** | 0.000 | -0.003*** | 0.002 |
| Did Not Move in Last Year | 0.011*** | 0.000 | 0.036*** | 0.000 |
| Self Employed | 0.137*** | 0.000 | 0.027*** | 0.000 |
| Agriculture, Forestry, Fishing, Hunting, and Mining Services | 0.019*** | 0.000 | -0.066*** | 0.000 |
| Construction | -0.008 | 0.290 | -0.012 | 0.267 |
| Manufacturing | -0.016*** | 0.000 | -0.080*** | 0.000 |
| Wholesale Trade | 0.004** | 0.015 | -0.062*** | 0.000 |
| Retail Trade | -0.026*** | 0.000 | -0.111*** | 0.000 |
| Transportation, Warehousing and Utility Services | -0.015*** | 0.000 | -0.096*** | 0.000 |
| Information | 0.031*** | 0.000 | 0.133*** | 0.000 |
| Professional, Scientific, Management, Administrative, and Waste Management Services | 0.034*** | 0.000 | 0.084*** | 0.000 |
| Education, Health Care and Social Assistance Services | -0.021*** | 0.000 | -0.162*** | 0.000 |
| Arts, Entertainment, Recreation, Accommodation and Food Services | -0.031*** | 0.000 | -0.123*** | 0.000 |
| Other Industries/Services | -0.016*** | 0.000 | -0.088*** | 0.000 |
| Public Administration | -0.028*** | 0.000 | -0.084*** | 0.000 |
| Serving in the Military | 0.022*** | 0.000 | -0.147*** | 0.000 |
| Number of Observations | | 1,119,413 | | 1,122,056 |
| R^2 | | 0.029 | | 0.110 |
| Adjusted R^2 | | 0.029 | | 0.110 |

After generating the work from home variable, table 5 shows that in 2016, before the COVID-19 pandemic, a 1% increase in income was correlated to a 0.011 percentage point decrease in the likelihood of working from home. However, following the COVID-19 pandemic in 2021, the effect flipped, and higher incomes were correlated with a higher likelihood of working from home. In fact, a 1% increase in wage and salary income was correlated to a 0.031 percentage point increase in the likelihood of working from home. In plain text, higher-salary jobs after the pandemic were more likely to involve working from home. Most of our other variables, such as rural reflected similar patterns as in the first regression. This second regression shows that when

compared to living in a densely populated area, individuals after the pandemic were even less likely to work from home than they were before.

However, our R^2 and adjusted R^2 values in the second regression were significantly lower than those values of the first regression. This means that our variable of interest, log of wage, and salary income, as well as all the other predictors in the model, explain much more of the variation in travel time to work than they did in the likelihood of working from home. We can interpret this as saying that our chosen independent variables are more closely related to travel time than they are to working from home. This difference is anticipated as work from home is a binary outcome that inherently has a limited variation that the model can explain.

## Conclusion

Our research found that the COVID-19 pandemic did alter the relationship between wage and salary income and average travel time to work. These findings align with previous research that has found substantial growth in the number of remote and hybrid working modalities, especially among higher-paying professions (U.S. Bureau of Labor Statistics, 2022). Additionally, we see a reversal in the relationship between salary income level and work modality due to the pandemic. We can say that our alternative hypothesis, that the relationship between commute time and salary income would weaken after the pandemic, is true and reject our null hypothesis that there is no change in the relationship between 2016 and 2021.

This pandemic-induced shift in the relationship between commute time and income, with higher-income individuals experiencing shorter commute times than lower-income individuals, can be attributed to the concentration of remote work opportunities in higher-paying jobs and the classification of lower-income workers as "essential", requiring them to continue commuting during the pandemic (Blau et al., 2021). Seeing as over one-third of American employers increased remote work opportunities since the start of the pandemic, there was a substantial increase in income for those with zero commute time who were working from home. The shift towards remote work was more pronounced in higher-paying jobs, both within and across industries (U.S. Bureau of Labor Statistics, 2022). We found that the average income for individuals with no commute time increased by nearly $25,000 between 2016 and 2021. These findings suggest that the pandemic has led to a significant restructuring of work arrangements, with remote work becoming more prevalent among higher-income workers.

While this research found evidence of a change in the relationship, there are ways to answer the research question more comprehensively. The analysis could be improved with the use of panel data, which would allow us to directly compare changes in income and travel time at an individual level before and after the pandemic. Further, a control variable describing if an individual works a typical 9-5 schedule would be valuable, as people working this schedule typically experience longer commute times during rush hour. Additionally, a difference-in-differences model would be more useful in understanding how the relationship between income and commute time changes across different income levels over time.

Further research could investigate if remote or hybrid jobs demand a wage premium over traditional in-person arrangements. Economic theory would suggest that additional flexibility and reduced commute times associated with alternative working modalities should require a lower wage from employers. However, the extent to which this change has been realized in the labor market is unclear. Investigating this question would provide additional insight into the historic and ongoing influence of the pandemic on the labor market.

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