School Start Scrambles: The Interplay of Sociotemporal Factors on Women's Labor Force Participation

Abstract

This study shows that K-12 school start times along with contextual school and area-level sociodemographic factors are significant predictors of women's labor force participation. We draw on nationally representative survey data from three publicly available 2019 datasets: the American Community Survey, the National Historical Geographical Information Systems, and the Unlocking Time Survey. Analyses involve two stages. First, ordinary least squares regressions evaluate statistically significant relationships. The second stage uses Monte Carlo cross-validation and parametric bootstrap analyses tests to assess the predictive accuracy of the full model. Our results show that later school start times have important ramifications, extending beyond the mental and physical well-being of children. Women's labor force participation is nearly 5 percentage points higher in areas where schools start at or after the legally recommended time of 8:30am. We find that contextual economic and demographic factors are also significant when it comes to the relationship between school start times and in women's ability to participate in the labor force. Our work represents an important contribution to the ongoing school start time policy debate sweeping the United States. Considering the temporal needs of women and children, this work has important policy implications for sociotemporal disparities in well-being.

Keywords

gender, education, school schedules, women's labor force participation

Hypotheses

Considering work showing that most American women start work between 7:45am and 8am (Blum 2017), we expect that schools starting late – after 8:30am – will correspond to zip code level decreases in the percentage of women participating in the labor force. We hypothesize that area and household-level sociodemographic characteristics shape women's ability to participate in the labor force considering children's school scheduling needs. Specifically, we expect that women's labor force participation will be higher in urban areas, lower in more rural areas, and lower in zip codes where the Gini index of income inequality is higher. We postulate that women's labor force participation will be lower in zip codes in which more children receive need-based free and reduced lunches at school. Building on previous research on racial disparities in labor force participation, we hypothesize that race will be predictive of women's ability to join the labor market considering school scheduling constraints.

Design and Methods

Data

The analyses rest on three publicly available data sources. The first consists of the 2019 Unlocking Time Survey (UTS).[1] UTS is a cross sectional, nationally representative probability sample of public schools in the United States (US). Funded by the Bill and Melinda Gates Foundation, the

[1] https://unlockingtime.org/

UTS contains a comprehensive overview of how K-12 schools in the US manage student and teacher scheduling. The UTS was collected via an online questionnaire, developed in consultation with K-12 school leaders, survey methodologists, and educators. The response rate for the UTS ranges between 52 percent to 80 percent, depending on the school's postal code. An important aspect of this dataset is the ability to geographically assess the distribution of school day start times, along with school, student, and staff demographic characteristics. As the UTS does not contain precise neighborhood-based socioeconomic measures, we supplement this dataset with an additional data source directly mitigating the limitations of the UTS. This allows us to also consider contextual factors that may shape the relationship between school start times and women's ability to participate in the labor force.

In order to allow for the consideration of localized demographic, social, and economic characteristics, we link the UTS dataset with two data sources from the 2019 U.S. Census Bureau: the American Community Survey (ACS) and the National Historical Geographical Information Systems (NHGIS). The ACS is conducted annually by the United States Census Bureau since 2000,[2] representing a cross sectional, nationally representative sample of US households. This is the nation's largest annual household survey. The ACS captures the lived-experiences of more than 2 million households per year, with an 86 percent response rate for 2019. The publicly available ACS dataset anonymizes the individual household surveys by aggregating up to postal code-level responses. Data representing Zip Code Tabulation Areas (postal codes) containing detailed postal code-level race measures were obtained via the U.S. Census Bureau's National Historical Geographic Information System (NHGIS).[3] This is a comprehensive U.S. database

[2] https://www.census.gov/programs-surveys/acs/guidance/subjects.html
[3] https://www.nhgis.org/about-ipums-nhgis

providing publicly available U.S. Census geographic information system mapping files, covering all areas of the U.S. These files contain anonymized geographic distributions of population characteristics, encoding this spatial data into a format analyzable via statistical software (Manson et al. 2022).

Measures

To assess women's labor force participation, we use a continuous variable provided by the ACS representing the percentage of female population over the age of 16 employed in the civilian labor force. We follow the lead of the California Senate Bill 328[4] in classifying schools starting before 8:30am as starting early. The predictor for school start times is coded 0 for early starting schools and 1 for later starting schools. We rely on the Census Bureau's classification for each postal code to classify schools based on locale (rural, town, suburban, city). We assess the socioeconomic context characterizing the postal codes our schools are located in through two measures. The percentage of students in each school receiving free or reduced priced meals serves as a proxy for school-level low student socioeconomic background. We classify the schools that offer free lunches by quantiles to ensure even distribution across the sample and for more meaningful incremental interpretation of area socioeconomic disadvantage. This measure is provided by the UTS dataset. We also consider a summary measure of income inequality through each postal code's Gini Index, provided by the Census Bureau. Given that no zip code approaches the extreme theoretical values of 0 or 1, we transform the Gini Index into quintiles to aid interpretability in relative terms.

[4] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB328

We control for available sociodemographic characteristics that have been shown by previous research to influence women's labor force participation. These include the weighted means by population size per zip code of race (Asian, Black, Latino, Other, White); being a single parent (dichotomous); and having children under the age of 18 in the household (dichotomous). We perform a square root transformation on our single parent variable to fit the OLS assumption of normality.

Analytic Models

Analyses begin descriptively, providing sample descriptive characteristics and an overview of zero-order correlations between school start times, women's labor force participation, school-level factors and area-level sociodemographic variables. Next, the results of ordinary least squares linear equations are presented, predicting the influence of school start times on women's labor force participation. This is appropriate, as our dependent variable is continuous, the exact values of our independent variable are known, and the assumptions of independence, normality and homogeneity have not been violated (Freedman 2009). Separate models are used to account for the school and area-level control variables described above. These analyses are conducted in Stata 18.

Robustness

To test the predictive power of our full regression model, estimating its accuracy when it comes to public schools not included in our data, we use Monte Carlo cross-validation tests. This method

involves partitioning the full sample of 3709 schools into complementary subsets via 1000 random splits. The analysis is then performed on one subset (training set), while the other subset is used for the validation of the models (validation set). Considering the overall sample size, this method is an appropriate extension of the ordinary least squares linear models, as it allows for testing how accurately the models would predict U.S. women's labor force participation in practice (Dubitzky 2007; Geisser 1993; Kohavi 1995). Parametric bootstrap analyses are then used to estimate the amount of unknown bias in the sample (Moore 2009). These cross-validation tests were conducted in Python 3.11.0.

Results

Table 1 shows sample descriptive characteristics. The average percentage of women in the labor force across all postal codes is 58 percent. Slightly over 23 percent of the schools in our sample can be classified as starting at or after the recommended time of 8:30am, the rest start too early. Over 30 percent of our schools are located in rural postal codes and nearly 35 percent are in cities. 46.6 percent of students in our sample receive free or reduced priced meals while in school. The most prevalent racial group in our schools by postal code is non-Hispanic White (70.71 percent), followed by Hispanic (11.07 percent), Black (9.97 percent), other (4.9 percent), and Asian (3.34 percent). Nearly 28 percent of households in our school's postal codes have children under the age of 18 years old. Of these, over 30 percent are single parents.

[Table 1]

Table 2 presents the results of the two-tailed differences in means tests between school start time categories across women's labor force participation as well as the school and area-level

sociodemographic variables. We find that the marginal difference in women's labor force participation by school start time is statistically significant. Similarly, we find that significant associations exist between the control variables of school locale, Gini index of income inequality and the percentage of students receiving free and reduced priced lunches in schools and zip code level differences when it comes to the percentage of women in the labor force. School locale appears to be a determining factor for the differences in women's labor force participation, conditional on the school start times. Rural areas with early school start times appear to be associated with increased women's labor force participation relative to rural areas with late school start times (about 1.5 times more prevalent). The reverse is true for city areas with late school start times, relative to city areas with early school start times.

[Table 2]

Regression results are presented in Table 3, with a p-value threshold of $p<0.05$ representing statistical significance. Equations predict percentage point increases in women's labor force participation, considering the effects of the covariates. We estimate four sets of models: Model 1 predicts the percentage of women in the labor force, considering whether a school starts after 8:30am (late start) or before 8:30am (early start). Model 2 builds on Model 1 by also controlling for contextual characteristics. These control variables include school locale, racial composition, and the percentage of students receiving free or reduced priced meals. Model 3 considers the joint influence of contextual and socioeconomic characteristics by also controlling for zip code level Gini index of income inequality, the proportion of children in the household, and the percentage of single parents by zip code. Our full model, Model 4, also considers the influence of interaction effects.

[Table 3]

School start time is statistically significant in all models. However, contrary to our original hypothesis, starting school late (after 8:30am) is not adversely associated with the overall area-level employment among women. As a matter of fact, late start boosts women's labor force participation by anywhere from 1 to 4.6 percentage points, depending on the model. Models 2 - 4 illustrate a persistent gradient pattern in women's labor force participation whereby it increases with the degree of urban development of the school locale. Specifically, areas inside cities and suburbs feature 4.3 to 6.9 percentage points higher female involvement in labor force, relative to the rural areas.

The increasing proportion of schools offering free school lunches is consistently associated with decreased women's labor force participation. However, the relationship is not incrementally linear. The strongest decrease occurs for areas falling into the 3rd quintile, relative to the first quintile (i.e., the least subsidized areas in terms of school lunches), where women's labor force participation decreases by 3.3-3.4 percentage points, and further by 1.5 percentage points in the areas most heavily subsidized, relative to the baseline. This suggests that socioeconomic disadvantage is closely associated with women's involvement in market work.

Accounting for the joint influence of contextual demographic and socioeconomic characteristics of the area (Model 3) improves the model fit considerably. Income inequality (Gini index) in a zip code decreases women's labor force participation. Women's labor force participation increases in the presence of a higher proportion of children in households and higher proportion of households headed by single parents (6.7 and 3.8 percentage points higher, respectively). In other words, the presence of children and the financial burden brought about by single parenthood increase the labor force participation of women.

A key distinction demonstrated by Model 4 is that there is a penalty of late school start times on women's labor force participation in zip codes with high proportion of families with children. Specifically, women's involvement in the labor force is 12.4 percentage points lower in the above zip codes. This is consistent with our expectations, particularly since we see that the presence of children in household by itself boosts labor force participation among women. However, late school start time negates this advantage among women in zip codes with higher proportion of children in families.

Tables and Figures

Table 1. Sample Descriptives

		Mean / %	SD
Women in Labor Force (%)		58.00	8.15
Late Start (%)		23.03	0.42
Locale (%)			
	Rural	30.70	0.39
	Town	17.30	0.37
	Suburban	27.50	0.45
	City	24.60	0.43
Free lunch (mean)		46.60	0.25
Racial Composition (mean)			
	Asian	3.34	0.06
	Black	9.97	0.18
	Hispanic	11.07	0.15
	Other	4.90	0.09
	White	70.71	0.25
Gini Index (mean)		43.59	0.05
Children in Household (%)		27.63	0.08
Single Parents (%)		30.42	0.16

N schools = 3,709; N postal codes = 3,474

Table 2. Differences in Means Between School Start Time Categories, Women's Labor Force Participation, School and Area-Level Sociodemographic Variables

	Categorical School Start Time	
	Early Start	*Late Start*
Percentage of Women in the Labor Force	57.63**	59.23**
Locale		
Rural	32.93	23.01
Town	18.23	13.93
Suburban	26.79	29.73
City	22.05	33.33
Chi-square for Locale: 60.76**		
Free lunch	46.07**	48.37**
Gini Index	43.44**	44.08*
Children in the Household	27.67	27.52
Single Parents	30.37	30.67

*p<0.05; **p<0.01; two-tailed test.

Table 3. Ordinary Least Squares Regression Coefficients Predicting Women's Labor Force Participation

Characteristics		Model 1	Model 2	Model 3	Model 4
Reference categories: Early Start, Rural School, First Free Lunch Quintile, White Race, No Children in the Household, Not a Single Parent, First Gini Index Quintile					
Intercept		57.63**	57.27**	56.95**	55.96**
Late Start		1.63**	1.04**	1.21*	4.64**
Locale					
	Town		1.43**	1.88**	1.86**
	Suburban		4.61**	4.30**	4.29**
	City		5.61**	6.87**	6.84**
Free Lunch Quintile					
	2nd quintile		-0.43	-0.91**	-0.91**
	3rd quintile		-3.32**	-3.41**	-3.40**
	4th quintile		-5.38**	-5.02**	-4.99**
	5th quintile		-5.67**	-5.10**	-5.12**
Racial Composition					
	Asian		9.78**	10.75**	10.40**
	Black		1.26*	0.922*	0.90
	Hispanic		-1.30	-3.40**	-3.38**
	Other		4.34**	2.65**	2.74**
Gini Index Quintile					
	2nd quintile			-2.39**	-2.36**
	3rd quintile			-3.81**	-3.81**
	4th quintile			-5.25**	-5.23**
	5th quintile			-6.82**	-6.85**
Children in Household				6.68**	10.04**
Single Parents				3.77**	3.90**
Late Start * Children in Household					-12.37**
Adj R^2		0.0068	0.2025	0.2852	0.2876

*p<0.05; **p<01