Are There Human Capital Externalities in U.S. States?

Evidence from the Current Population Survey

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Abstract

This paper estimates human capital externalities across U.S. states. We combine repeated cross-sections of the Current Population Survey (CPS) with state-level data to produce a rich and comprehensive panel data set. By directly controlling for individual job characteristics and state labor market conditions, we can identify the human capital externality in an augmented Mincerian model. We find that an extra year of average schooling at the state-level increases individual wages by five percent above and beyond the private return to education. Subsequent analysis finds that the estimated externality is greater for poorly-educated workers and larger in highly-educated, highly-innovative states. These results imply that the positive coefficient for state-level schooling is in fact an externality and that differences in human capital externalities can help explain "The Great Divergence" in wages between geographic areas with highly-skilled workers versus those with low-skilled areas.

Keywords: education, externality, Mincerian, human capital, spillovers

1. Introduction

Economists have long recognized the possibility of human capital externalities arising as individual workers learn from each other, raising productivity in skilled labor markets without additional compensation (Marshall, 1890). At the individual level, these uncompensated externalities imply that the private return to human capital paid to each worker is less than the total return provided to society. At an aggregate level, these uncompensated externalities can provide an important source of economic growth across cities (Black and Henderson, 1999 and Moretti, 2011); regions (Yamarik, 2010 and Crespo-Cuaresma *et al*., 2012); and nations (Lucas, 1988 and Mankiw *et al*., 1992).

Rauch (1993), Acemoglu and Angrist (2001), Moretti (2004a) and others use a Mincerian wage equation augmented with average (city or state) education to directly estimate human capital externalities. The basic Mincerian wage equation posits that individual productivity and thus the wage rate depends positively upon education, experience and experience-squared. By adding average eduation, the augmented Mincerian wage equation therefore estimates the externality by comparing the wages of otherwise similar individuals who work in locales with different average education levels. Their estimates of the human capital externality (in terms of one more year of average education) range from zero (Rudd, 2000 and Acemoglu and Angrist, 2001) to 3-5 percent (Rauch, 1993) to 25 percent (Moretti, 2004a).[1]

One of the main empirical issues confronting the augmented Mincerian wage approach is the possibility of confounding factors between individual wages and average education. There are many unobserved individual and regional characteristics that impact individual wages and are

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[1] Moretti (2004a) used the share of college graduates to measure average education and estimated that a one percent increase in that group raised wages by 1 percent. In his 1990 sample, the average share of college graduates was about 20 percent. Assuming that the average years of schooling in the other 80 percent is 12 years, it takes a change in the college share of 0.25 to increase average years of schooling by one. See Lange and Topel (2006) for details.

correlated with aggregate education. In the regional labor market demand shocks that impact the relative productivity of highly-educated workers and supply shocks that change the relative attractiveness of a region for a highly-educated worker will produce a spurious correlation between wages and average education. At the individual level, unobserved worker characteristics may make workers in regions with high education averages more productive than workers with the same observables in regions with low education averages.

The most common strategy to control for this omitted variable bias and enable measurement of the human capital externality is to instrument for average education. Acemoglu and Angrist (2001) use compulsory schooling to instrument for state-level years of schooling, while Moretti (2004a) uses age structure and the presence of a land grant college as instruments for the percentage of college-educated workers in a city. Similarly, Dalmazzo and de Blasio (2007), Liu (2007) and Kirby and Riley (2008) use compulsory schooling and demographic variables to instrument for average schooling in Italian and Chinese regions and English firms, respectively.

However, Lange and Topel (2006) and section 2 of this paper show that these instruments, if not all potential instruments, are likely to be invalid. Building upon a spatial equilibrium model, Lange and Topel demonstrate that an instrument for average education must be orthogonal to productivity differences across regions, unobservable regional human capital, *and* the valuation of local amenities. We derive similar conditions in section 2 starting from a Mincerian wage equation. For compulsory schooling and land grant college instruments to be valid, labor supplies of all skill types must be perfectly mobile so that the characteristics of a location where human capital is *produced* has no relation to the factors of a locale where that human capital is *employed*. However, the fact that these instruments are correlated with current schooling means that labor supplies are not elastic and these predetermined instruments are correlated with current amenities and their valuation.

In this paper, we identify the human capital externality by directly controlling for individual job characteristics and state labor market conditions. We combine the pseudo-panel nature of the Current Population Survey (CPS) with state-level data to produce a rich and comprehensive data set. By using the CPS, we can control for individual job characteristics such as unionization status, occupation, and industry that both vary across individuals and through time. Furthermore, the inclusion of cohort effects can control for unobserved individual differences across birth years. As opposed to city data, state-level data provide a much broader array of *time-varying* controls for labor demand and supply shocks. In particular, state-level capital-to-labor ratios, industry shares, industry composition and population density provide good proxies for labor demand shocks, while labor force participation, unionization, minimum wage and public assistance benefits provide decent measures for labor supply shocks.

Although not the first to use this identification strategy, our paper nevertheless does represent an important advance in the human capital externalities literature. Rauch (1993) uses population and geographic characteristics to control for labor market conditions and thus identifies externalities across U.S. cities. His lack of city-level characteristics, especially *time-varying* ones, calls into question whether he is identifying why some cities have more educated workers than others. Rudd (2000) and Lang and Topel (2006) use individual industry and fixed birth-state/cohort effects plus fixed state effects to identify the human capital externality. Rudd includes these factors directly, while Lange and Topel follow a two-step procedure. Although the fixed state effects will control for permanent differences in state labor market, the lack of time-varying state characteristics raises concerns over identification.

We first estimate our augmented Mincerian model for all individuals. Using a basic Mincerian specification (individual education, age, age-squared and demographics), we find that an extra year of average state-level schooling increases the individual wage by 2.4 percent. We then control for additional individual controls and time-varying state-level factors and find that the value of the externality rises to 5.5 percent. We find similar results using the share of college-educated workers in each state to measure the externality.

However, the positive link between individual wages and state-level education does not necessarily imply an externality. If workers of different education levels are imperfect substitutes, then the positive coefficient for average education could reflect an increase in the wages of unskilled workers that more than offset the decrease in the wages of skilled workers (Ciccone and Peri, 2006). We therefore estimate our augmented Mincerian model for different levels of education. We find that the effect of average education is greater for lower-educated workers. For the lower-educated groups, a ten percentage point increase in the share of college-educated workers raises the wages of high school drop-outs by 3.7 percent and high-school graduates by 4.2 percent. For the higher-educated groups, a ten percentage point increase in the share of college-educated workers raises the wages of workers with some college education by 1.9 percent and 4-year college graduates by 3.0 percent. Therefore, the positive coefficient for state-level education is indicative of a human-capital externality.

We next examine whether differences in educational externalities could be a source of regional divergence across U.S. states. City-level analysis by Moretti (2004b), Shapiro (2006) and Diamond (2012); and state-level research by Ciccone and Peri (2006) and Lindley and Machin (2012) have documented that geographic areas with highly-skilled workers experience higher wage and housing price growth than those with low-skilled workers. We therefore partition the data along two state-level dimensions: initial average education levels and initial innovation rankings. We find that the effect of average education is greater for highly-educated, highly-innovative states. In the low-education, low-innovation states; an extra year of average state-level schooling increases the individual wage by 1.5 percent. However, in high-education, high innovation states an extra year of average state-level schooling raises the individual wage by 5.6 percent - nearly a four-fold increase in the magnitude of the externality.

The remainder of the paper proceeds as follows. Section 2 describes the empirical design. Data and estimation techniques are presented in Section 3. Section 4 provides the estimation results and section 5 presents the conclusion.

2. Empirical Design

The augmented Mincerian equation posits that the wage of individual *i* living in state *s* in period *t* is determined by:

$$\ln w_{ist} = \beta_0 + \beta_1 ed_{ist} + \alpha ED_{st} + \beta_2 exp_{ist} + \beta_3 exp_{ist}^2 + x_{is}\gamma + \nu_s + t_t + u_{ist} \qquad (1)$$

where ed_{ist} is individual education, ED_{st} is average state education, exp_{ist} is individual experience, x_{is} are observed demographic characteristics of individual *i* in state *s*; ν_s are fixed state effects, and t_t are fixed time effects. The coefficient β_1 is the private return to schooling, while the coefficient α represents the human capital externality. The sum of β_1 and α is the social return to schooling.

Following Moretti (2004a, 2004b), we define the error term as a function of three components:

$$u_{ist} = \mu_s \theta_i + v_{st} + \varepsilon_{ist} \quad (2)$$

where θ_i is a permanent unobservable component of human capital (i.e. ability and skill) for individual *i*; μ_s is the return on that unobserved skill in state *s*; v_{st} is time-varying shocks to labor demand and supply in state *s* in time *t*; and ε_{ist} is the transitory component of wages which is assumed to be i.i.d. over individuals, states and time. With the exception of the valuation of local amenities, equations (1) and (2) are very similar to those derived by Lange and Topel (2006) using a spatial equilibrium model.

There are two potential sources of bias in estimating equation (1). First, the presence of time-varying or transitory shocks to state labor market correlated with average education: $E(v_{st}ED_{st}) \neq 0$. For instance, a skill-biased technological progress shock would increase the demand for skilled labor and thus could result in higher state-level education levels. Second, the presence of unobserved worker characteristics that result in more productive workers (with the same observables) in high-education states vs. low-education states: $E(\theta_i ED_{st}) > 0$.

As mentioned earlier, the most common strategy to control for this omitted variable bias is to instrument for average education. These instruments Z_{st} must be both exogenous and relevant to generate consistent estimates of the human capital externality *α*. Relevancy requires that the instruments be correlated with average education. Validity requires that the instruments be orthogonal to the error term u_{ist}. Using (2), validity requires the following three conditions:

$$E(Z_{st}\mu_s) = 0 \quad (3)$$

$$E(Z_{st}\theta_i) = 0 \quad (4)$$

$$E(Z_{st}v_{st}) = 0\,. \quad (5)$$

The first condition requires that the instruments for average education be independent of the return to the unobservable skills. The second condition requires there be no correlation between the instruments and the unobserved skills of the workers in that state. The third condition requires that the instruments for average education be orthogonal to transitory shocks (demand and supply) to the state labor markets.

Our identification strategy is to directly control for observed and unobserved individual job characteristics and *time-varying* state labor market conditions:

$$\ln w_{ist} = \beta_0 + \beta_1 ed_{ist} + \alpha ED_{st} + \beta_2 exp_{ist} + \beta_3 exp_{ist}^2 + x_{ist}\gamma + o_{ist}\kappa + Z_{st}\delta + \mu_c + \nu_s + t_t + \varepsilon_{ist} \quad (6)$$

where o_{ist} are a set of observed job characteristics of individual *i* in state *s* at time *t*; Z_{st} are a set of factors that shift labor demand and supply in state *s* at time *t*; μ_c are fixed cohort effects; ν_s are fixed state effects; and t_t are fixed time effects.

We use CPS data on job characteristics and constructed cohort effects to identify differences in observed and unobserved ability in equation (6). The job characteristics include controls for union membership and coverage by a collective bargaining agreement, 12 broad occupation codes, and 15 broad NAICS industry indicators. The inclusion of cohort-specific effects, μ_c, arises from the pseudo-panel nature of the CPS. In true panel data individuals are observed multiple times and their individual-specific effects can be controlled through either fixed or random effects. The CPS data used does only a single observation per individual (more detail on the CPS data are presented in the next section) so it is not possible to include individual-specific fixed effects. Deaton (1985), Verbeek and Nijman (1993), and Nijman and Verbeek (1990) propose to construct cohorts of individuals who are likely to have similar individual effects and include cohort controls in the regression model. We construct our cohorts by 10 age groups (five-year increments from 16-65 years old), 12 occupation groupings and sex, which generates 240 individual cohort controls.

We use state data to control for *time-varying* labor markets shocks Z_{st} in equation (6) (with the exception of Alaska and Hawaii which are excluded from our study). For labor demand, we include state capital-to-labor ratio, log of population density and the industry share. The capital-to-labor ratio provides the physical capital per average worker. Population density is the ratio of total population to surface area and controls for possible agglomeration effects. The industry share is the percentages of state income generated by the NAICS industry. To control for labor supply shifters, we use state labor force participation rate, unionization rate, effective minimum wage, average public assistance and average workers compensation. The labor force participation and unionization measures are quantity indicators of labor supply, while the effective minimum wage, average public assistance and average workers compensation impact the reservation wage. We also include the state unemployment rate to measure the slack in the labor market. Time invariant state effects are controlled through state fixed effects.

3. Data and Estimation

Individual-level data were obtained from the Current Population Survey (CPS) Outgoing Rotations Groups (ORG) files for 1992-2005. The structure of the CPS is that an individual is interviewed each month for four months, leaves the sample for eight months, and then returns to the sample and is interviewed again monthly four more times. Respondents are asked detailed economic questions in months four and eight of their stay in the sample and these data are contained in the ORG files. For our study, we use only their first instance in the sample (the economic data from the fourth month) and restrict our sample to employees aged 16 to 65 years.

The state-level data are drawn from a variety of sources. The capital data are from Yamarik (2013), while the population and labor force participation data are from the U.S. Census Bureau (2012a). The NAICS share is constructed using data from the U.S. Bureau of Economic Analysis (2012). The unionization, minimum wage and unemployment data are from Hirsch and Macpherson (2012), U.S. Department of Labor (2012) and the U.S. Bureau of Labor Statistics (2012), respectively. Lastly, the average public assistance and average workers compensation are from the U.S. Census Bureau (2012b).

We estimate variations on (6) using OLS where the standard errors are clustered on state-year. The dependent variable is the natural logarithm of the hourly wage rate in 2011 dollars. We use four specifications. The base specification includes individual controls for education, age, age-squared, sex, marital status, race and Hispanic plus state-level average education.[2] The second specification adds individual dummies for union membership, coverage by a collective bargaining agreement, industry, and occupation as well as state fixed effects. The third specification includes the NAICS share of output at the state level and the cohort fixed effects.[3] The final preferred specification, based upon equation (6), adds the state-level *time-varying* controls for labor demand and supply. For clarity, we present individual-level variables in lower-case and state-level variables in upper-case.

[2] The CPS records individual schooling by categories of primary school completed or highest secondary and tertiary degree obtained. We use the imputation method of Jaeger (1997) to convert this into a years of schooling variable.

[3] The inclusion of the cohort fixed effects requires the removal of the individual gender and occupation variables due to perfect multicollinearity.

4. Results

Table 1 presents the estimates of the private and external returns to schooling (the complete results for column 4 are presented in Appendix A). The coefficients for the individual controls have the expected sign and are significant at the one percent level. Of particular note, the coefficients imply that union membership and collective bargaining agreement raise individual wages by 15.2 and 6.0 percent, respectively. For the state-level variables, higher levels of capital per worker, population density, NAICS share, workers compensation, public assistance and unemployment increase the individual wage; while labor force participation, unionization and minimum wage have no impact.

We estimate a human capital externality in the range of 2.4 to 5.5 percent in columns 1-4. By controlling for individual education, age, age-squared and a few demographic dummies; an additional year of average schooling raises the individual wage by 2.4 percent in column 1. By controlling for individual unionization, industry and occupation effects and then time-varying state effects, these estimates increase to 3.6 and 5.5 percent in columns 2 and 4, respectively. At the same time, the private return to schooling falls from 8.3 percent in column 1 to 5.0 percent in column 4.

We next use the share of college-educated workers as the measure of state-level aggregate schooling in columns 5-8. Rosenthal and Strange (2008) have found that proximity to college-educated workers raises individual wages, while proximity to less-than-college workers lowers individual wages. The coefficient estimates for the college share range from 0.34 to 0.40 and follow a similar pattern as columns 1-4. Under the complete specification, a one percent increase in the share of college-educated workers raises the individual wage by 0.40 percent, which translates into a human capital externality of 10.0 percent per year of schooling.[4]

Ciccone and Peri (2006) show that the positive link between individual wages and state-level education does not necessarily imply an externality. Suppose that workers of different education levels are imperfect substitutes. An increase in the average level of schooling will therefore have two distinct effects on the wage distribution. First, the increase in the relative supply of college-educated workers will lower the wages of highly-educated workers and raise the wages of low-educated workers. Second, human capital externalities will raise the wage of both groups.

We therefore estimate our augmented Mincerian model for different levels of education. If externalities exist, then an increase in the state-level college share should be greatest for the wages of the lowest-educated workers since there is mostly a labor demand effect. However, as the education level increases, then the estimated externality should decrease due to the ever-increasing labor supply shift.

Table 2 presents the estimates of the private and external returns to schooling for different levels of education using the full specification from (6). We divide our sample into four sub-samples based on individual education attainment: (i) less than high school (ii) high-school graduates, (iii) some college and two-year college degrees and (iv) four-year college graduates and higher. We measure aggregate schooling as average years of schooling in columns 1-4 and as the share of college-educated workers in columns 5-8. The individual years of schooling variable is dropped due to the multicollinearity generated from the sample selection.

[4] As with Moretti (2004a), it takes a change in the college share of 0.25 to increase average years of schooling by one in our sample. As a result, the external return of an additional average year of schooling is 0.25 x 0.40 = 0.10

We find that the effect of average education is greater for lower-educated workers. For the lower-educated groups, a one year increase in average schooling raises the wages of high school drop-outs by 8.3 percent and high-school graduates by 7.8 percent. Likewise, a ten percentage point increase in the share of college-educated workers raises the wages of high school drop-outs by 3.7 percent (a 9.3 percent externality) and high-school graduates by 4.2 percent (a 10.5 percent externality). For the higher-educated groups, a one year increase in average schooling raises the wages of some college-educated workers by 3.5 percent and 4-year college graduates by 4.4 percent. Similarly, a ten percentage point increase in the share of college-educated workers raises the wages of some college-educated workers by 1.9 percent (corresponding to a 4.3 percent externality) and 4-year college graduates by 3.0 percent (a 6.9 percent externality). Similarly, a one year increase in average schooling raises the wages of some college-educated workers by 3.5 percent and 4-year college graduates by 4.4 percent. Therefore, the positive coefficient for state-level education is indicative of a human-capital externality.

We next examine whether differences in educational externalities could be a source of regional divergence across U.S. states. City-level analysis by Moretti (2004b), Shapiro (2006) and Diamond (2012); and state-level analysis by Ciccone and Peri (2006) and Lindley and Machin (2012) have documented that geographic areas with highly-skilled workers experience higher wage and housing price growth relative to those with low-skilled workers. Moretti (2012) coined this phenomenon "The Great Divergence". At the very least, states with highly-skilled workers will generate larger *total* externalities due to their larger stock of education attainment. However, individual workers in these same states may also experience a larger *marginal* externality if their fellow workers are more innovative.

We test the role of education externalities in explaining the "The Great Divergence" in Table 4. We divide our sample along two state-level dimensions: initial education and initial innovation. We use the share of college educated workers in the 2000 U.S. Census to rank educational attainment. We use the State New Economy Index of Atkinson (2002) to rank innovation.[5] We split the 50 states into halves to produce four sub-samples: (i) low-education, low-innovation; (ii) low-education, high-innovation; (iii) high-education, low-innovation; and (iv) high-education, high-innovation. The results using average years of schooling are presented in columns 1-4 and those using the share of college-educated workers are shown columns 5-8.

We find that education externalities are larger in the high-education, high-innovation states. In the low-education, low-innovation states, an extra year of average state-level schooling increases the individual wage by 1.5 percent. However, the externality increases to 5.6 for the high-education, high-innovation states. Likewise, a ten percent increase in the share of college-educated workers in the low-education, low-innovation states raises the individual wages by 4.5 percent (a 11.2 percent externality), while that same ten percent increase in the high-education, high-innovation states increases the individual wage by 5.8 percent (a 14.5 percent externality). These results are suggestive that there are larger *marginal* externalities in those locales where fellow workers are more innovative.

[5] The State New Economy Index is a composite measure of (i) knowledge jobs, (ii) export orientation and FDI, (iii) economic dynamism and competition, (iv) internet use by consumers and business, and (v) research and development (Atkinson, 2002).

5. Conclusions and Discussion

This paper examined the role of human capital externalities in explaining individual wages. We identified the externality by directly controlling for individual job characteristics and state labor market conditions. Under our preferred specification, we estimated that an extra year of state-level schooling increased individual wages by 5.5 percent, which is roughly equivalent to the private return of 5.0 percent. We then estimated the human capital externality across different samples and found that it was larger for individuals with low levels of education and for states with high levels of education and innovation. These two results imply that the estimated externality is capturing spillover effects and is explaining some of the wage divergence across U.S. states.

Furthermore, the estimated magnitude of the human capital externality is consistent with prior research that used a similar identification scheme. Rauch (1993), Rudd (2000) and Lange and Topel (2006) use individual worker characteristics and city- or state-level conditions for identification and estimate a human capital externality between 3 and 7 percent.[6] In contrast, past research that achieves identification through instruments like compulsory schooling and demographic factors produce a wide range of estimates ranging from 0 (Acemoglu and Angrist, 2001) to 25 percent (Moretti, 2004a).

The existence of positive human capital externalities has important policy implications for state governments. As a result of the recent economic crisis, the growth rate of total state spending on education fell from 4.8% for 2000 FY to 2006 FY to 2.9% for 2006 FY to 2011 FY (U.S. Census Bureau, 2012b). In the largest state of California, the growth rate of state spending

[6] The lone exception is Rudd (2000) who estimated an insignificant human capital externality when state fixed effects are included.

on education fell even more precipitously from 4.7% to 1.2%, resulting in substantial tuition increases and enrollment limits.

The potential for this trend to affect the long-term health of state economies has been noted by conservative and liberal groups alike. The National Association of State Budget Officers (2013) issued a report suggesting that states need to halt tuition increases and find options to increase need-based aid for students. The Center on Budget and Policy Priorities (2013) also issued a report warning that cutting state support for higher education while implementing large tuition increases will harm the economy in the long run.

Our results support the notion advanced above that investing in education is as important for state-level economic performance as it is for the individual students who do so. The implication for policymakers is that the continued transfer of cost from the state to the individual student could lead to underinvestment in human capital relative to the socially optimal level.

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Table 1

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
years of schooling$_{i,s,t}$	0.0834***	0.0566***	0.0499***	0.0499***	0.0833***	0.0566***	0.0499***	0.0500***
	(0.000212)	(0.000219)	(0.000268)	(0.000268)	(0.000212)	(0.000219)	(0.000268)	(0.000268)
AVG. YEARS OF SCHOOL$_{s,t}$	0.0243***	0.0361***	0.0341***	0.0551***				
	(0.00638)	(0.00584)	(0.00597)	(0.000268)				
COLLEGE SHARE$_{s,t}$					0.356***	0.350***	0.335***	0.403***
					(0.0535)	(0.0490)	(0.0510)	(0.0522)
Observations	868,035	868,035	773,381	773,381	868,035	868,035	773,381	773,381
R-squared	0.383	0.483	0.509	0.509	0.383	0.483	0.509	0.509
Individual Controls:								
age & demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
union & collective bargain	No	Yes	Yes	Yes	No	Yes	Yes	Yes
industry dummies	No	Yes	Yes	Yes	No	Yes	Yes	Yes
occupation dummies	No	Yes	No	No	No	Yes	No	No
cohort fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
State Controls:								
state fixed effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
NAICS share	No	No	Yes	Yes	No	No	Yes	Yes
time-varying state factors	No	No	No	Yes	No	No	No	Yes

Notes: The dependent variable is the natural logarithm of hourly earnings in 2011 dollars. Each regression includes individual years of schooling and an aggregate average measure of schooling. The additional individual and state controls used are shown at the bottom with details provided in Appendix A. The standard errors in parenthesis are corrected for clustering on state-year where *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 2

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AVG. YEARS OF SCHOOL$_{s,t}$	0.0831***	0.0784***	0.0341**	0.0434*				
	(0.0182)	(0.0141)	(0.0167)	(0.0259)				
COLLEGE SHARE$_{s,t}$	-0.100	-0.0319	0.000876	0.0571	0.374***	0.416***	0.194**	0.296**
	(0.154)	(0.116)	(0.135)	(0.193)	(0.110)	(0.0812)	(0.0944)	(0.129)
Individual Sample:	less than high school	high school graduates	some college	4-year college and higher	less than high school	high school graduates	some college	4-year college and higher
Observations	103,794	258,409	227,051	184,127	103,794	258,409	227,051	184,127
R-squared	0.399	0.365	0.421	0.331	0.399	0.365	0.421	0.331

Notes: The dependent variable is the natural logarithm of hourly earnings in 2011 dollars. Each regression includes individual controls for age & demographics, union and collective bargaining, industry and cohort fixed effects and state-level controls for state fixed effects, NAICS share and time-varying state factors. See Appendix A for details. The standard errors in parenthesis are corrected for clustering on state-year where *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 3

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
years of schooling$_{i,s,t}$	0.0515***	0.0514***	0.0456***	0.0489***	0.0514***	0.0514***	0.0456***	0.0488***
	(0.000539)	(0.000721)	(0.00127)	(0.000361)	(0.000539)	(0.000721)	(0.00127)	(0.000361)
AVG. YEARS OF SCHOOL$_{s,t}$	0.0151***	0.0578***	-0.0133	0.0565***				
	(0.00577)	(0.0181)	(0.0295)	(0.00330)				
COLLEGE SHARE$_{s,t}$					0.455***	0.186	0.0430	0.582***
					(0.0472)	(0.118)	(0.245)	(0.0302)
State Sample:	low educate, low innovate	low educate, high innovate	high educate, low innovate	high educate, high innovate	low educate, low innovate	low educate, high innovate	high educate, low innovate	high educate, high innovate
Observations	230,089	127,955	37,513	371,021	230,089	127,955	37,513	371,021
R-squared	0.494	.506	0.498	0.508	0.494	0.506	0.498	0.509

Notes: The dependent variable is the natural logarithm of hourly earnings in 2011 dollars. Each regression includes individual controls for age & demographics, union and collective bargaining, industry and cohort fixed effects and state-level controls for state fixed effects, NAICS share and time-varying state factors. See Appendix A for details. The standard errors in parenthesis are corrected for clustering on state-year where *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Appendix A

Dependent variable: log of hourly wages	Coefficient	Standard error
Individual and Aggregate Schooling:		
Years of schooling	0.0499	0.000268
AVG YEARS of SCHOOLING	0.0551	0.000268
Individual Age and Demographics:		
Age	0.0431	0.00102
Age-squared	-0.000455	1.37e-05
Married	0.0551	0.00139
Separated, Divorced, Widowed	0.0204	0.00179
Black	-0.0877	0.00164
American Indian	-0.0513	0.00484
Asian	-0.0353	0.00293
Other race	-0.0177	0.00565
Hispanic	-0.0577	0.00176
Union and Collective Bargaining Status:		
Union member	0.152	0.00173
Collective bargaining coverage	0.0598	0.00504
NAICS Individual Industries:		
Mining	0.171	0.00645
Utilities	0.190	0.00585
Construction	0.0348	0.00325
Wholesale Trade	0.00567	0.00319
Retail Trade	-0.180	0.00247
Transportation and Warehousing	0.0403	0.00353
Information	0.0605	0.00334
Finance, Insurance, and Real Estate	0.0192	0.00252
Prof., Scientific, Tech. plus Management	0.0223	0.00286
Administrative Services	-0.0660	0.00360
Educational Services	-0.142	0.00423
Health Care and Social Assistance	-0.0552	0.00231
Accommodation and Food Service	-0.231	0.00297
Other Services (including Arts)	-0.142	0.00361
State Controls:		
NAICS SHARE	0.171	0.00645
ln(*CAPITAL per WORKER*)	0.0558	0.0147
ln(*POPULATION DENSITY*)	0.150	0.0157
LABOR FORCE PARTICIPATION RATE	0.0565	0.0736
UNIONIZATION RATE	0.0108	0.0240
MINIMUM WAGE	0.00150	0.00141
PUBLIC ASSISTANCE PER CAPITA	0.223	0.0521
WORKERS COMP. PER CAPITA	0.0396	0.0194
UNEMPLOYMENT RATE	0.235	0.0825

Observations	773,381
R-squared	0.509

Notes: The results are for column (4) of Table 1. The coefficients for the individual demographic variables are interpreted relative to the omitted categories of *Single* and *White*. The coefficient for each NAICS individual industry is interpreted relative to the omitted *Manufacturing* industry.