Determinants of Median Income

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Abstract

What essential differences account for the variation in median income across U.S. counties? This paper proposes a linear model examining the effects of minimum-wage laws, educational attainment, labor market density, and innovation within each county's median income. Each of these are found to have a significant, positive correlation with median income, suggesting that these factors should be taken into consideration by policymakers seeking to improve incomes for their counties.

Introduction

Basic economic theory dictates that as productivity increases, real wages increase. "Real wages" refers to purchasing power—the amount of goods and services that may be purchased with an individual's "nominal" wages. This idea is intuitively appealing: if a worker is suddenly able to produce two units of a good with the same inputs previously used to produce one unit, she should see a resulting increase in her compensation. The connection between productivity and compensation held true between 1948 and 1973. However, while productivity has continued its rapid growth since 1973, real hourly compensation has stagnated (Mishel, 2012). Stagnation in real wages has been caused in part by a stagnation in nominal wages (Gould, 2015). It appears that more factors, beyond productivity, must be examined to explain the determinants of income.

Moretti (2012) provides evidence to support a theory of the forces of attraction. Carnevale and Rose (2011) find a significant correlation between educational attainment and income. Gould (2015) found that real wages increased most in states that had increased the minimum wage.

I examine the effects of the minimum wage, educational attainment, labor market density, and innovation on median income across U.S. counties by employing a linear regression to quantify the nature and magnitude of these effects. The next section reviews the literature on median income in more detail followed by a discussion of the methodology and data. The results are shown next and a brief conclusion ends the paper.

Literature Review

Much of the literature concerned with wage growth seeks to address income inequality across either social strata or state borders. These studies provide insights into which economic factors influence wages. Moretti (2012) examines the geographical differences between wages across the United States. Prominent among his findings is support for the idea of the "forces of attraction," echoing research first published by Alfred Marshall in 1890 (Marshall, 1920). Essentially, he argues that innovative firms drive wage growth, and are drawn to dense, highly-educated labor markets with specialized knowledge. If this is true, a connection should exist between the median wage and population density, innovation (measured by Moretti via patents filed), and educational attainment.

A body of research suggests educational attainment's influence on income. Recently, Carnevale and Rose (2011), in a report by the Georgetown University Center on Education and the Workforce, found that the lack of a college degree significantly contributes to income inequality. Citing a 2005 wage premium of 74% for workers with a Bachelor's degree compared to workers with a high school degree, they argue that producing more college-educated workers could increase GDP by $500 billion. Furthermore, they refute claims in *The New York Times* and other publications that the U.S. has a surplus of college-educated workers.

Echoing Carnevale and Rose, Gould (2015), in a report for the Economic Policy Institute, found a shortage of college-educated workers. However, Gould's research found that between 2013 and 2014, real wages dropped for college graduates and increased slightly for workers with only a high school degree. Additionally, he finds that an increase in the minimum wage in eighteen states caused an increase in the real wage for the 10th percentile of national earners. Wages increased by an average of 1.6% in those eighteen states, as opposed to only 0.3% in states without an increase in the minimum wage.

Model and Methodology

By collecting these various explanations for wage growth and differences, a portrait of the determinants of income can be created. (When measuring income, it is generally best to examine median income to avoid the skewing present in measures of average income.) Ideally, this model of median income examines the effects of productivity, the minimum wage, educational attainment, labor market density, and the presence of innovative firms.

According to economic theory and the ideas presented heretofore, each of these factors should be positively correlated to median wages across the U.S. As the minimum wage increases, other jobs may increase their nominal wages to remain competitive, or to counteract the resulting inflation. Besides the forces of attraction examined by Moretti (2012), both innovation and education are theorized to increase the productivity of labor, and thereby income. Increasing the density of the labor market increases the number of people earning income; these wage-earners are then able to increase their consumption, producing a multiplier effect. Effectively, as more goods and services are purchased, the wages of employees involved in the manufacture and provision of those products should also increase, pushing up the median wage from the bottom.

To test this hypothesis, cross-sectional data from all U.S. counties (excluding Puerto Rico) were gathered from the United States Census Bureau and the U.S. Patent and Trademark Office for a total of 3,142 observations. Data on the minimum wage were collected at the state level, as counties do not generally have separate minimum-wage laws. Unfortunately, attempts to collect data on labor productivity at the county level, or even state level, failed—those data are not collected by the Census Bureau, Bureau of Labor Statistics, nor the Department of Labor. These data were collected and subsequently used in a linear regression of the form:

MedInc = B1 + B2MinWag + B3EduAtt + B4LabMar + B5Innov

where MedInc refers to per capita median income; B1 refers to the intercept of the regression; and MinWag, EduAtt, LabMar, and Innov refer to the minimum wage, educational attainment, labor market density, and relative innovation (measured by patents filed), respectively.

A summary of the data for 3,142 U.S. counties can be found in Table 1. The summary includes the minimum, maximum, median, and mean values for each variable. MedInc and MinWag are measured in dollars. EduAtt and LabMar are measured as percentages. Innov is measured in number of patents filed across a fifteen-year period: 2000-2015.

Table 1: Data Summary

Variable	MedInc	MinWag	EduAtt	LabMar	Innov
Min	19,146	7.25	2.6	20.6	0
Max	123,966	11.5	40.9	90.1	142,998
Median	44,798	7.25	12.3	60.1	22
Mean	46,544	7.826	13.19	59.5	551.6

Results

The initial regression is shown in Table 2. Following the initial regression, White's test indicated that heteroscedasticity was present. This is a common problem in cross-sectional analyses. When performing a linear regression, it is assumed that the individual values of the dependent variable (median income) are "spread around their mean values with the same variance" (Gujarati, 2006). That is, the residuals of the regression are homoscedastic. White's test measures whether the variance of the residuals of the regression is constant across all values of the independent variables. If this spread is not constant—that is, if heteroscedasticity is present—the standard errors that underlie the statistical tests related to the regression are biased and the tests are unreliable. The solution is to calculate robust standard errors in the form of White's robust variance-covariance matrix.

The linear regression, White's test for heteroscedasticity, and the correction for heteroscedasticity were all completed in the statistical package R. The uncorrected regression results can be found in Table 2; the results after correcting for heteroscedasticity can be found in Table 3.

The results from the regression matched the predicted results: all variables displayed a positive correlation with median income at better than 1% significance. That is, there is less than a 1% chance that any variable's coefficient is actually equal to zero. This holds for both the uncorrected and corrected regression results. Approximately 60% of the variance in the dependent variable is explained by the regression model as indicated by the adjusted R-squared. In addition, the high *F* value of the regression as a whole, with the given degrees of freedom (DF), indicates that the regression as a whole is statistically significant. The *p*-value for the F-test indicates that the regression is statistically significant at better than 1%.

The intercept listed in Tables 2 and 3 indicates the predicted median income in a county with no minimum wage, educational attainment, labor market, nor innovation. Taken alone, it has no real economic meaning—such a county could not exist. However, the intercept contributes to a mathematical estimate of median income based on the values of the variables and their coefficients. By combining the intercept with the coefficients of the variables, data may be inserted into the model to create an equation to predict median income in dollars. Using the corrected regression results:

$$MedInc = -11766 + (1146.4)MinWag + (958.79)EduAtt + (614.73)LabMar + (0.21366)Innov$$

By looking at the individual coefficients, one can see that for each dollar increase in the minimum wage for a state, counties within that state will see the median income rise by an estimated \$1,146.40. This amounts to 2.46% of the mean reported median income. For each percentage point by which educational attainment (as measured by the proportion of the population with a Bachelor's degree or higher) increases, median income rises by an estimated \$958.79, or 2.06% of the mean reported median income. For every percentage point by which participation in the labor force increases, median income rises by an estimated \$614.73, 1.32% of the mean reported median income. For every patent filed within a county, median income increases by an estimated \$0.21.

Although this last figure may seem small, consider that the most innovative county, Santa Clara County, CA, had 142,998 patents filed between 2000 and 2015. This amounts to a projected rise in median income of \$30,029.58, equal to 64.52% of the mean reported median income. Santa Clara County's reported median income is $93,854. The county also reported educational attainment of 26.1% and labor market participation of 67.1%. As with other Californian counties, the minimum wage is assumed to equal the state minimum wage of $10. This information can be inserted into the model to produce the following equation:

MedInc = -11766 + (1146.4)(10) + (958.79)(26.1) + (614.73)(26.1) + (0.21366)(142998)

Simplifying this equation produces:

MedInc = -11766 + 11464 + 25024.419 + 16044.453 + 30552.95268

By adding these numbers together, a median income of $71,319.82 is predicted for Santa Clara County. The difference of $22,534.18 could be ascribed to variables not accounted for in this model, perhaps including the county's labor productivity rate, or participation in stock market exchanges. Further studies to attempt to determine the nature of these other variables may be warranted.

Elasticities measure the responsiveness of the dependent variable (MedInc) to changes in the explanatory variables (MinWag, EduAtt, LabMar, Innov). Elasticities are given by multiplying the coefficient of each explanatory variable by the quotient of the mean of said explanatory variable over the mean of the dependent variable. i.e., coefficient(x) * mean(x)/mean(y). For example, the variable LabMar has an elasticity of 0.78585: for each 1% increase in LabMar, MedInc will increase by about 0.79%. The elasticities for each variable are given in Table 4.

Table 2: Uncorrected Regression Results

Regression Statistics	
Adjusted R-Squared	0.5996
F-Statistic	1177 on 4 and 3137 DF
p-Value	< 2.2e-16

Variable	(Intercept)	MinWag	EduAtt	LabMar	Innov
Coefficient	-1.177e+04	1.146e+03	9.588e+02	6.147e+02	2.137e-01
Est. Std. Error	1.661e+03	1.740e+02	3.233e+01	2.211e+01	3.795e-02
t Value	-7.082	6.587	29.653	27.799	5.630
Pr (> | t |)	1.75e-12	5.24e-11	< 2e-16	< 2e-16	1.96e-08

Table 3: Corrected Regression Results

Regression Statistics	
Adjusted R-Squared	0.5996
F-Statistic	592.17 on 4 and 3137 DF
p-Value	< 2.2e-16

Variable	(Intercept)	MinWag	EduAtt	LabMar	Innov
Coefficient	-1.1766e+04	1.1464e+03	9.5879e+02	6.1473e+02	2.1366e-01
Est. Std. Error	1.8699e+03	1.8492e+02	5.1601e+01	2.6513e+01	4.0780e-02
t Value	-6.2923	6.1995	18.5810	23.1855	5.2395
Pr (> | t |)	3.564e-10	6.403e-10	< 2.2e-16	< 2.2e-16	1.717e-07

Table 4: Elasticities

Variable	MinWag	EduAtt	LabMar	Innov
Elasticity	0.19276	0.27171	0.78585	0.00253

Conclusion

Although not comprehensive, the model specified above does account for the majority of the variation in median income across the U.S. counties. The findings in this regression agree not only with economic theory, but also with the existing literature: each of the four factors examined significantly contributes to median income. These data could be used to inform policy decisions by local or state governments: they provide areas in which to focus in order to increase the median income in a given area. Not only is it necessary to attract highly-educated, skilled workers to an area: governments seeking to increase median income must also make efforts to increase the participation in the labor force, to encourage innovation, and to maintain an appropriate minimum wage.

Based on the elasticities for each variable, it appears the greatest single impact can be made by increasing participation in the labor market. Methods to improve labor market participation rates include job training opportunities, or attracting new firms—and thus employers—to the area. If a number of firms with similar labor needs move to a given area, it may create a specialized labor market and attract still more firms to the area, in a virtuous circle.

It may be prudent to adjust the minimum wage annually based on the cost of living; eleven states currently adjust their minimum-wage laws accordingly (NCSL, 2016). Investing in innovative companies provides two benefits: first, the benefits from innovation itself, and second, a tendency to attract educated workers, which has its own benefits as described by the model (Moretti, 2012). In turn, attracting these firms and workers may help to increase the labor market participation rate.

Innovation's own benefits include an increase in the level of productivity through improving the state of the arts of technology. New technology can improve the capital employed by labor in order to produce goods and services, allowing for more efficient production. Similarly, all else held equal, a more-educated, better-trained employee is likely to be able to produce more, or more efficiently, than a less-skilled employee. Moreover, increasing the proportion of educated workers may lead to increased innovation, and thereby to further increases in labor productivity.

Areas for further study in regard to this subject include identifying other determinants of productivity. Capital expenditures within the county might identify areas where an abundance of capital per laborer allows for increased productive capacity. Measuring the size and quantity of industry clusters within each county might augment studies into labor market density and/or innovation. A measure of mean job satisfaction, while subjective, could indicate whether happier workers are more productive.

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