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## LETTER

### A Note on Commute Times and Average Income Levels

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**Abstract:** In this paper, the relationship between average commute time and average wage in a population center is investigated. The goal of this research is to determine whether there is a positive relationship between average commute time and wages as economic theory would suggest. While this theory has been investigated to some extent in the past, the results of such studies have been limited to one or a few large metropolitan areas. The results of this study show that there is a positive relationship between the two. These results imply that businesses undergoing network design or redesign decisions should consider commute time in prospective metropolitan areas as part of their location decisions and could save money by choosing an area with shorter commute time.

**Keywords:** Transportation, Regression, Economics, Income, Commute time, Variation.

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## 1. INTRODUCTION

Amazon's recently completed search for the ideal location for their H2 Headquarters has put location analysis in the public's mind, but this is an ongoing business problem that comes with any network expansion or redesign. Common factors considered in location analysis include transport costs, availability of labor, government subsidies, utility rates, land prices, and taxes, but this paper investigates the theory put forth by Moses [1] that wage differences are determined by the structure of transport costs. An, Gordon, and Moore [2] showed a relationship between sprawl and commute time, and this study seeks to extend that research by investigating how commute time, driven by the structure of transport costs, in turn, impacts wages.

This study uses mean household income as a proxy for wages. Household income includes the income for the householder and all other people 15 years old or older in the household, whether or not they are related to the householder. Mean household income is the mean of all household incomes in a specific metropolitan or micropolitan area. One would assume that there is a correlation between mean household income and mean wages if all metropolitan and micropolitan areas have a similar mix of household sizes and income earners. Mean travel time to work (commute time) serves as a proxy for generalized transport costs, and the study uses data from all of the metro- and micropolitan areas in the United States as a sample.

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While this level of data does not allow for the level of granularity seen in other research, it does allow for the inclusion of a much larger sample of cities where previous studies have been limited to one or a few large cities and have not always looked at this specific question. Results of this study should be useful to the leaders of metro- and micropolitan areas that are interested in attracting new businesses to their communities. Short commute times and good transportation infrastructure for both freight and commuters could be used as a selling point along with any incentives they would be willing to offer the prospective business. Given two metropolitan areas with similar incentives and labor force, a company could potentially save money on salaries by locating in a metropolitan area with shorter commute time. While it would have been interesting to include additional environmental and quality of life control variable, the availability of data was limited by the scope of the American Community Survey.

## 2. LITERATURE REVIEW

There has been a small amount of research, both empirical and theoretical, conducted on this topic, and the majority indicates that there is a positive relationship between commute time and wage rate. However, the empirical studies have been limited to a single metropolitan area, two metropolitan areas, or a relatively small country. This study uses data from every Metropolitan Statistical Area (MSA) and Micropolitan Statistical Area ( $\mu$ SA) in the United States using recent data to test whether results on a larger scale are consistent with those previously obtained.

Madden [3] looked for empirical evidence of urban wage gradients using a panel sample of around 6,000 individuals who were in the labor force and household heads for at least two consecutive years and changed jobs and/or residence between 1970 and 1983. Her results showed that wage gradients do exist and that wages are systematically lower in the suburbs (where one would expect to see shorter commute times) than in more urbanized areas. She went on to say that individuals who change job locations trade-off commuting with wages.

Van den Berg and Gorter [4] investigated the relationship between job search and commuting time to see how job searchers are willing to pay for potential commute times. They used a dataset of survey respondents between 15 and 61 in the Netherlands who were not full-time students. The results showed that there was a disutility of commuting time, and it was highest for females with children. Ommeren, Van den Berg, and Gorter [5] continued this research in estimating the willingness to pay for commuting and found that in the Netherlands, the average willingness to pay for one hour of the commute was about half the hourly wage rate. Both results suggest that jobs requiring longer commutes should have higher salaries or wage rates.

Timothy and Wheaton [6] tested the theory that employers would need to pay higher wages when there are longer commute times using data from two large metropolitan areas in the US. They found that seemingly equivalent workers have vastly differing wages within different parts of a metropolitan area. While they found a positive correlation between wage and commuting times, they were unable to determine the underlying cause for this result.

Ommeren and Rietveld [7] developed a theoretical model investigating compensation for commuting but investigated the impact of restricted residential mobility for the unemployed. They found that rent gradients would be less steep than in perfectly competitive labor markets.

Rupert, Stancanelli, and Wasmer [8] explored the relationship between wages and commute time using the 1998-1999 French time-use study. Results showed that commute time had a large impact on job acceptance and that different demographic groups had different levels of bargaining power. Specifically, men had the most bargaining power, and women with young children had virtually no bargaining power.

Fallah, Partridge, and Olfert [9] did not specifically impact the impact of commute time on wage rates but found that higher levels of urban sprawl were correlated with less productive labor as measured by metropolitan area GDP divided by full-time workers. These results show that in addition to higher wage rates, employers could be faced with less productive workers as commute times increase. Related to these results, An, Gordon, and Moore [2] investigated the relationship between urban sprawl and commute time and found a positive relationship between the two.

Based on the body of literature with regards to income and commute time, there seems to be a lack of breadth in studies on the topic. This study seeks to remedy that situation by looking with less detail but at a much larger sample of cities than used in prior research.

### 3. DATA AND ANALYSIS

Data for this study came from the US Census Bureau’s 2012-2016 American Community Survey (ACS) 5-Year Estimates for 551 Micropolitan Statistical Areas (μSA) and 382 Metropolitan Statistical Areas (MSA) for a total of 933 observations. Descriptive statistics of the variables used are shown in Table 1, and these descriptive statistics clearly show a high level of variation in the variables used in the analysis. Mean household income ranges from 33 to 141 thousand US dollars and mean travel time ranges from 11 to 39 minutes.

**Table 1. Descriptive statistics of variables.**

Variable	Mean	Std. Dev.	Minimum	Maximum	N
Mean household income (000s US Dollars)	63.82	12.66	32.90	141.49	933
Mean travel time to work	21.70	3.73	11.50	38.60	933
Population (000s)	321.69	1,091.60	13.03	20,031.44	933
Percent of population working	60.31	6.52	23.83	80.36	933
Percent of population with higher education	22.93	8.65	8.30	64.60	933

In addition to these primary variables of interest, several control variables were included in the model to account for differences in the population of the metro- and micropolitan areas. These control variables were limited to those available in the ACS and included population, percent of the population working, and percent of the population with higher education. These variables were included because the population is often driven by the existence of jobs with better wages in a certain area, percent of the population working could significantly impact overall household income, and individuals with higher education would be expected to demand higher wages.

The following model was estimated using the ordinary least squares regression analysis. Specifically, the OLS command in Shazam statistical software with the option for a heteroskedastic consistent covariance matrix was used for estimation because initial testing showed heteroskedasticity in the residuals.

$$MHI = \alpha + \beta_1 MTTW + \beta_2 POP + \beta_3 WORK + \beta_4 HE + \varepsilon$$

Where:

MHI = Mean household income (000s)

MTTW = Mean travel time to work in minutes

POP = Population of metro area (000s)

WORK = Percent of population that is working (pop. over 16 in labor force / total pop.)

HE = Percent of population with a bachelor’s degree or higher

$\varepsilon$  = Error term

### 4. RESULTS

The results of the estimation are shown in Table 2 and monetary figures are all given in US dollars. These results

indicate, with a high level of confidence, that, on average, a 1-minute increase in mean travel time to work is correlated with an additional \$817.73 in mean household income. Furthermore, an additional 1,000 people in the metro area are correlated with an additional \$0.92 in mean household income, an additional 1 percent of the population working is correlated with an additional \$805.13 in mean household income, and a 1 percent increase in population with higher education is correlated with an additional \$691.10 in mean household income. These results are much as expected and show that metro- or micropolitan areas with longer commute times (and, as An, Gordon, and Moore [2] found, more urban sprawl) also have higher average household income levels.

**Table 2. Results of statistical analysis.**

Variable	Estimated Coefficient	Standard Error	P-value
Mean travel time to work	0.81773	0.09071	0.000
Population (000s)	0.00092	0.00024	0.000
Percent of population working	0.80513	0.06754	0.000
Percent of population with bachelor's or higher	0.69110	0.05821	0.000
Constant	-18.62500	4.70500	0.000

R<sup>2</sup>: 0.6562  
F Statistic: 14,080.685 (P-value: 0.0000)

These results imply that metropolitan and micropolitan statistical areas with shorter commute time, whether it is due to less urban sprawl or a better transportation system, would have an advantage over other cities when businesses are conducting location analyses. Locating in an area with a shorter commute time would lead to the ability to offer lower wages without any loss of goodwill with the employees. These results also further validate the theory set forth by Moses [1].

## CONCLUSION

Using data from 933 metro- and micropolitan statistical areas in the United States, it was shown that there is a statistically significant positive correlation between average commute time and average household income. These results are consistent with the results of previous research in the field but are based on a much broader (but less granular) sample of population centers. These results of prior research are discussed in section 2 of this note, but generally all found a correlation between commute time and wages. The results of this study suggest that businesses looking for new locations for factories, warehouses, or headquarters should consider the commute times before making the decision. In order to extend

this research, it would be beneficial to investigate the impacts other environmental consideration might have on mean household income. This could include variables such as mean home price per square foot, mean residential and/or commercial rent per square foot, cost of living index, a measure of entertainment or dining opportunities, etc. These are all things that could have an impact on mean household income. Another interesting extension of this research would be to examine what happens to commute times and income levels over time after a large employer begins operations in a metro- or micropolitan area.

## CONSENT FOR PUBLICATION

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## CONFLICT OF INTEREST

The author declares no conflict of interest, financial or otherwise.

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