Research on Commuting Expenditures and Geographic Adjustments in the Supplemental Poverty Measure

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Abstract
For the forthcoming Supplemental Poverty Measure (SPM), the U.S. Census Bureau will use the method proposed by the 1995 National Academy of Sciences (NAS) Panel on Poverty and Family Assistance – subtracting a flat amount from a family's resources for 'other' work-related expenses, with an annual inflation adjustment (see Short 2001). This research examines the appropriateness of applying a flat amount for work-related expenses by investigating geographic variation in average commuting expenses for automobile commuters across 100 urban areas, regions, and divisions, as defined by the U.S. Census Bureau, using two methods: (1) state gas prices and (2) federal reimbursement rate. This research found that these two methods produce significantly different cost estimates. Cost estimates also vary by population size, region, and division. Overall, this research found that there is significant geographic variation in commuting costs and recommends the SPM be adjusted accordingly.

Key Words: poverty, commuting expenditures, geographic adjustments

1. Introduction

The Supplemental Poverty Measure (SPM) will adjust poverty thresholds for geographic differences based solely on differences in housing costs. This is consistent with the 1995 National Academy of Sciences (NAS) Panel on Poverty and Family Assistance proposal to subtract a flat amount from a family's resources for 'other' work-related expenses, with an annual inflation adjustment (see Short 2001). This research examines the appropriateness of applying a flat amount for work-related expenses by investigating geographic variation in average commuting expenses for automobile commuters across 100 urban areas, regions, and divisions, as defined by the U.S. Census Bureau, using data on travel time to work from the American Community Survey (ACS). Two methods are used to translate travel time to travel costs: (1) state gas prices and (2) federal reimbursement rate. The following sections contain background information on the SPM and available commuting data through an overview of government-sponsored surveys, an explanation of data and methods utilized in this research, a discussion of the statistical analysis, conclusions, and future work and considerations.

1.1 Background

The official poverty measure in the U.S. uses an individual's or a family's cash income to estimate poverty rates. The official poverty measure has been in use since the 1960s and will not be replaced by the SPM. In 1995, the National Academy of Sciences (NAS) released a report (see Citro and Michaels 1995) presenting recommendations for modifications to the existing poverty measure that more accurately account for variation in household expenses across time, geography, and demographic groups. This new measure of poverty provides not only a new threshold of need and a more complex definition of available resources per family. Specifically, on the threshold side of the SPM, there is a budget for the three basic categories: food, clothing, and shelter (including utilities). Other basic needs such as household supplies, personal care, and non-work-related transportation are included within the threshold calculations by applying a 20 percent multiplier to the food, clothing, and shelter component (Citro and Michaels 1995, 151). The resource side of the SPM accounts for resources that a family unit has available to spend on items included in the threshold. Within the resource side, there are deductions for expenditures such as child care, medical-out-of pocket expenses, and other work-related expenses such as commuting costs. The NAS report recommended defining family resources as:

> Recommendation 1.2. "… Family resources should be defined – consistent with the threshold concept – as the sum of money income for all sources together with the value of near-money benefits (e.g., food stamps that are available to buy goods and services in the budget, minus expenses that cannot be used to buy these goods and services. Such expenses include income and payroll taxes, child care and other work-related expenses, child support payments to another household, and out-of-pocket medical care costs, including health insurance premiums" (Citro and Michaels 1995, 5).

The NAS report makes further recommendations on how these work-related expenses should be incorporated into adjusting family resources:

> Recommendation 4.2. "… for each working adult, deduct a flat amount per week worked (adjusted annually for inflation and not to exceed earnings) to account for work-related transportation and miscellaneous expenses…" (Citro and Michaels 1995, 10).

The NAS report states that significant geographic difference in commuting expenses do not exist and therefore family resources should not be adjusted differently based on location. This is in direct contrast to the report's views on housing and cost-of-living. The NAS report states, "evidence of cost-of-living differences among geographic areas – such as between metropolitan and nonmetropolitan areas – suggests that the poverty thresholds should be adjusted accordingly…we recommend that the housing component of the poverty thresholds be indexed to reflect variations in housing costs across the country" (Citro and Michaels 1995, 8).

The 1995 National Academy of Sciences (NAS) Panel on Poverty and Family Assistance proposed subtracting a flat amount from a family's resources for 'Other Work-Related Expenses', with an annual inflation adjustment. Following the panel's recommendations, the flat amount represented 85 percent of the median amount spent on 'Other Work-Related Expenses', as reported by respondents in the 1996 SIPP panel. In *Experimental Poverty Measures: 1999* (Short 2001), transportation-related expenses are defined under the broad category of 'Other Work-Related Expenses'. These expenses are further sub-categorized under 'Mileage expenses', which include the number of miles typically driven to and from work in a typical week, and 'Other expenses', which include any other expenses incurred while travelling to and from work in a typical week, such as bus fares or parking fees. 'Other expenses' may also include non-commuting related expenses such as tools, uniforms, etc. An Interagency Technical Working Group was formed in 2009 and charged with developing a set of initial starting points to permit the U.S. Census Bureau, in cooperation with the Bureau of Labor Statistics, to produce the Supplemental Poverty Measure (SPM).

Currently, commuting costs and other work-related expenses in the SPM are estimated without geographic adjustments and in accordance with NAS panel's 1995 recommendations. The SPM adjusts poverty thresholds for geographic difference based solely on differences in housing costs, in large measure because of the current limitations in data related to other costs. As stated in *Observations from Interagency Technical Working Group*, "Ideally, if more data become available, it would be attractive to move toward a price index that covers all items in the threshold."

1.1.1 Federal Register Notice

A *Federal Register* notice (Vol. 75, No. 101, p. 29513) was issued on May 26, 2010, soliciting public comments regarding specific methods and data sources in developing the SPM. The broad categories that public comments addressed included: Transportation costs associated with different geographical areas, including urban/rural, cross-metropolitan, and transit-rich/non-transit-rich areas, and, commuting expenses for mass transit/personal vehicle usage, as well as access to public transportation, and/or vehicle availability. This research commences the effort to address public comments and concerns in response to this *Federal Register* notice. A more in-depth and broader discussion of background on geographic adjustments in the SPM can be found in Renwick (2011).

Research on commuting expenses is a small part of a larger research effort within the U.S. Census Bureau to more accurately estimate poverty in the U.S. This specific research paper contributes to our understanding of how to estimate commuting expenses for the SPM and seeks to enhance and refine the SPM so that it adjusts commuting expenses for geographic difference. Furthermore, the research presented in this paper explores the degree of variation in commuting expenses across geographic areas using data from the American Community Survey (ACS) and the Texas Transportation Institute (TTI). The following sections include a discussion of the data and geographies used in this analysis, followed by the methodological approach, analysis and results, concluding with a discussion future work and other considerations.

2. Data and Methodology

2.1 Data

This research uses two main sources of commuting data: the 2009 1-year ACS and TTI. The ACS is a national survey that provides data for relatively small geographic areas and includes questions related to means of transportation to work, travel time to work, and time of departure for work. ACS data is used to capitalize on its relatively wide coverage of commuting data across the U.S., including travel time to work. Mean travel time varies across the country. Large, densely populated urban areas tend to have the highest mean travel times, such as New York, NY, Washington, DC, and Chicago, while less populated areas tend to have shorter mean travel times. This variation in mean travel time across the country also likely indicates differences in commuting costs geographically.

In order to translate commuting time to commuting costs, data on vehicle speed and gas prices were obtained from the TTI *2010 Annual Urban Mobility Report* (Shrank et al. 2010). TTI is a transportation research center based at Texas A&M University and provides data and research analysis for the nation.[1] Each year TTI published an annual mobility report containing a variety of travel measures, including speed data and state gas prices. The speed data, which was collected by TTI from INRIX,[2] contains average vehicle speeds in miles per hour in 101 urban areas,[3] based on Census 2000 urban areas. The Federal Highway Administration's Highway Performance Monitoring System (HPMS) database provided traffic volume data (i.e. vehicle miles travelled (VMT)) to TTI for their report.[4] Table 1 lists the variable names and associated descriptions that this methodology utilizes.

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[1] TTI is the largest university-affiliated transportation research agency in the United States consisting of planners, engineers, and researchers located at Texas A & M University in College Station, TX. It was created in 1950 in response to the needs of the Texas Highway Department and has since broadened its focus to address all modes of transportation—highway, air, water, rail and pipeline.

[2] INRIX is a privately-owned company that collected speed data for areas in the U.S. INRIX also provides traffic information and services, and develops apps and tools for drivers, engineers, data-seekers, public and private sector clients. INRIX's "SmartDriver Network" aggregates traffic-related information from a growing community of more than 2 million GPS-enabled vehicles and mobile devices, traditional road sensors and hundreds of other sources, resulting in real-time, historical and predictive traffic services on freeways, highways and secondary roadways, including arterials and side streets.

[3] Tim Lomax, Ph.D. of TTI explained via an email why these 101 urban areas were chosen instead of others or all. He said that the research team at TTI does a fair amount of work with GIS matching and 'logic checking' on the results, so due to resources they aren't able to report on all urban areas.

[4] "The HPMS is a national level highway information system that includes data on the extent, condition, performance, use and operating characteristics of the nation's highways. The HPMS contains administrative and extent of system information on all public roads, while information on other characteristics is represented in HPMS as a mix of universe and sample data for arterial and collector functional systems." Additional information on the FHWA's HPMS database can be found at: http://www.fhwa.dot.gov/policyinformation/hpms.cfm.

Table 1: Variable Names and Descriptions

Name	*Description*
Arterial DVMT	Daily vehicle miles travelled on non-highway roads in urban areas; obtained from TTI
Freeway DVMT	Daily vehicle miles travelled on highways in urban areas; obtained from TTI
Freeway Speed	Average peak speed in miles per hour on highways in urban areas; obtained from TTI
Arterial Speed	Average peak speed in miles per hour on non-highway roads in urban areas; obtained from TTI
Average Speed	Average peak speed in miles per hour for both freeways and arterial roads in urban areas; calculated by authors
Average Distance Traveled	Average distance travelled to work by residents in each urban area; calculated by authors
Mean Travel Time	Average travel time to work for residents in each urban area; obtained from 2009 ACS
Average Fuel Economy	Average amount of fuel burned by an automobile adjusted by speed; regression model obtained from TTI; calculated by authors
One-Way Commuting Cost	Average cost in dollars for residents in each urban area to commute one-way to work; calculated by authors
Average Gas Price	Average cost of gasoline in dollars by state; obtained from TTI
Daily Commuting Cost	Average cost in dollars for residents in each urban area to commute to and from work; calculated by authors
Average Weekly 5-Day Commute	Average cost in dollars for residents in each urban area to commute to and from work over a 5-day work week; calculated by authors
Average Annual Weekly 5-Day Commute	Average cost in dollars for residents in each urban area to commute to and from work over a 5-day work weekly annually, excluding federal holidays, 2-week vacation time, and weekends (251 days per year); calculated by authors
Reimbursement Rate	Government Services Administration's (GSA) Privately Owned Vehicle (POV) reimbursement rate for 2009; obtained from GSA

2.2 Limitations

This research includes commuting cost estimates for 100 urban areas in the U.S. and does not include explicit estimates for the other 339 urban areas, nor does it include non-urban areas, due to lack of speed data. Additionally, this research focuses solely on automobile travel (i.e. car, truck, or van) and does not take into account other modes of transportation such as public transit, walking, bicycling, etc. due to inadequacies in obtaining speed data for other modes of transportation to work. In 2009 in the U.S., approximately 76% of commuters drove alone in a car, truck, or van; if carpoolers are included, this increases to approximately 86% of commuters (U.S. Census Bureau, 2009). Future work may focus on estimating commuting costs for other modes of transportation (see the Future Work and Considerations section). Lastly, the method for calculating distance by using speed data and mean travel time is rather crude because the arterial and highway speeds are averaged. Given these constraints, this research provides an initial step in understanding the geographic variation of commuting costs in the U.S.

2.3 Calculating a Cost Estimate Using Mean State Gas Prices

The *TTI 2010 Annual Urban Mobility Report* provides speed data for 101 urban areas.[5] This research does not include San Juan, Puerto Rico in the analysis so it reports on 100 urban areas in the U.S. TTI delineates the urban areas into subcategories based on population size (Shrank et al. 2010): Small = less than 500,000, Medium = 500,000 to 1 million, Large = 1 million to 3 million, Very Large = more than 3 million. As mentioned previously, TTI reports speed for these urban areas by street type (freeway or arterial) and by period of the day (peak or non-peak). TTI calculates average speed for the 100 urban areas:

(Eq. 1)

$$\text{Average Speed} = \left(\left[\left(\frac{\text{Freeway DVMT}}{\text{Freeway DVMT} + \text{Arterial DVMT}} \right) \times \text{Freeway Speed} \right] + \left[\left(\frac{\text{Arterial DVMT}}{\text{Freeway DVMT} + \text{Arterial DVMT}} \right) \times \text{Arterial Speed} \right] \right)$$

Using average speed from the above calculation and mean travel time from the ACS for each urban area, the authors calculate mean distance traveled:

(Eq. 2)

$$\text{Mean Distance Travelled (in miles)} = \text{Mean Travel Time (in hours)} \times \text{average speed (in mph)}$$

To obtain average commuting cost, Shrank et al. (2010, A-19) utilize a regression equation to calculate average fuel economy:

(Eq. 3)

$$\text{Average Fuel Economy} = 8.8 + 0.25\,(\text{Average Speed})$$

Then, the authors calculate the average cost for commuting to and from work for a 5-day work week based on the assumptions that the worker travels to work 52 weeks in a year, excluding weekends and federal holidays for each urban area using speed, travel time, and average fuel economy:

(Eq. 4)

$$\text{Average Annual Weekly 5-Day Commuting Cost (in \$)} = \left(\frac{\text{Average Distance (in miles)} \times (\text{\$/gallon of gas})}{\text{Average Fuel Economy (in mpg)}} \right) \text{x}251$$

2.4 Commuting Cost using GSA's POV Reimbursement Rate

The U.S. General Services Administration (GSA) approves the federal standard for reimbursement rates for privately-owned vehicles (POV) annually. The reimbursement rate for 2009 was $0.55 per mile, based upon fixed and variable costs associated with driving a vehicle, such as gas and wear-and-tear. In this research, the authors calculated commuting costs using the federal reimbursement rate per mile based on a 5-day

[5] For Census 2000, an urban area consists of contiguous, densely settled census block groups and census blocks that meet minimum population density requirements (1000 people per square mile), along with adjacent densely settled census blocks (500 people per square miles) that together encompass a population of at least 50,000 people.[5] There were 466 urban areas as defined by Census 2000 criteria.

workweek and assumptions that the worker travels to work 52 weeks in a year, excluding weekends and federal holidays (251 days annually) for each urban area using speed, travel time, and the reimbursement rate of $0.55/mile:

(Eq. 7) Average Annual Weekly 5-Day Commuting Cost = (Average Distance x $0.55/mile x 2) x 251

3. Results and Analysis

3.1 Descriptive Statistics

Commuting cost estimates using gas have a mean of $1,129.40, standard deviation of $221.20, a standard error of $22.12, a minimum of $754.70, and a maximum of $2024.70 (see Table 7). Those using the reimbursement rate have a mean of $4,773.20, standard deviation of $789.21, a standard error of $78.92, a minimum of $2,912.10, and a maximum of $7,795.50 (see Table 7).

The two sets of cost estimates showed statistical significance for correlation and differences (see Table 2). Specifically, a Pearson's correlation test determined how correlated the commuting cost estimates using gas prices were with those using the reimbursement rate. The correlation coefficient was 0.87033 ($p<0.0001$). The two cost estimates have a strong, positive correlation, meaning that as one increases so does the other – as expected. Additionally, an independent samples t-test failed to accept the null hypothesis that the two samples have equal variances, with a t-value of -44.46 ($p<0.0001$), indicating a statistically significant difference between the two methods for estimating commuting costs.

Table 2: Descriptive Statistics, Pearson's Correlation, and Independent t-test Results

	Gas Prices	*Reimbursement Rate*
Mean	$1,129.40	$4,773.20
Standard Deviation	$221.20	$789.20
Standard Error	$22.12	$78.92
Minimum	$754.70	$2,912.10
Maximum	$2,023.70	$7,795.50
Test Results		
t-test	t-value = -44.46 ($p<0.0001$)	
Pearson's Correlation	ρ=0.87033 ($p<0.0001$)	

3.2 Estimation Results and Analysis

As expected, the cost estimates for the federal reimbursement rates were all markedly higher than those using just gas prices and vary by different geographical areas and scales (see Table 3). Generally, when comparing population size of urban areas, commuting cost estimates using either method increase as size increases. When broken down by division as defined by the U.S. Census Bureau and using the gas prices method, the Middle Atlantic urban areas have the highest average commuting cost estimates, followed closely by New England and Pacific urban areas. [6] West North Central urban areas and West South Central urban areas have the lowest average commuting cost estimates by

[6] Note there is no statistically significant difference in the gas commuting cost estimates for New England and Pacific urban areas.

division when comparing cost estimates using gas prices.[7] Estimates using the reimbursement rate were not significantly different by division. Urban areas in the Northeast region of the country have the highest estimated commuting costs compared to other regions as defined by the U.S. Census Bureau using both gas prices and the reimbursement rate with $1,315.38 and $5,232.57, respectively. More specifically, very large urban areas in the Northeast have the highest estimated commuting costs using gas prices, with $1,522.08. When considering the reimbursement rate, small urban areas in the Northeast, in addition to very large urban areas in the Northeast, have the highest commuting cost estimates, with $5,847.48, and $5,768.40, respectively.[8]

Table 3: Annual Commuting Cost Estimates by Geography and Population

	Gas Prices	*SE*	*Reimbursement Rate*	*SE*	*Count*
Small	$994.57	$20.97	$4,344.44	$87.12	22
Medium	$1,129.99	$15.96	$4,762.04	$134.46	33
Large	$1,129.40	$9.80	$4,831.13	$84.13	30
Very Large	$1,325.57	$6.37	$5,310.84	$51.74	15
East North Central	$1,077.95	$10.16	$4,633.11	$88.77	12
East South Central	$1,023.68	$12.80	$4,726.40	$119.68	6
Middle Atlantic	$1,341.13	$13.40	$5,258.37	$106.96	8
Mountain	$1,019.82	$12.48	$4,404.21	$107.83	10
New England	$1,285.95	$12.83	$5,203.10	$104.92	7
Pacific	$1,257.70	$18.01	$4,927.89	$144.03	19
South Atlantic	$1,142.09	$13.76	$4,904.32	$118.67	18
West North Central	$956.75	$8.84	$4,420.43	$81.84	5
West South Central	$979.43	$14.86	$4,455.02	$136.37	15
Midwest	$1,042.30	$9.77	$4,570.56	$86.73	17
Small	$967.86	$8.10	$4,531.53	$72.16	1
Medium	$950.95	$12.88	$4,233.54	$114.54	6
Large	$1,065.50	$13.79	$4,743.31	$129.13	8
Very Large	$1,260.82	$5.14	$4,910.13	$40.39	2
Northeast	$1,315.38	$13.13	$5,232.57	$106.01	15
Small	$1,359.61	$9.43	$5,847.48	$73.54	1
Medium	$1,282.20	$16.40	$5,180.77	$132.58	8
Large	$1,182.40	$21.62	$4,629.92	$186.00	3
Very Large	$1,522.08	$5.30	$5,768.40	$40.95	3
South	$1,061.31	$14.03	$4,704.14	$125.63	39
Small	$972.15	$11.18	$4,474.86	$98.12	12
Medium	$974.37	$12.74	$4,314.30	$112.19	9
Large	$1,116.80	$21.16	$4,889.32	$194.15	13
Very Large	$1,287.52	$6.66	$5,474.65	$56.92	5
West	$1,175.67	$16.10	$4,747.31	$131.55	29
Small	$985.90	$9.27	$3,937.53	$75.06	8
Medium	$1,255.68	$20.34	$5,147.12	$167.95	10
Large	$1,215.40	$21.50	$4,922.77	$174.65	6
Very Large	$1,271.62	$7.20	$5,032.79	$57.58	5

[7] Note there is no statistically significant difference in the gas commuting cost estimates for West North Central and West South Central urban areas.
[8] Note there is no statistically significant difference in the reimbursement rate commuting cost estimates for small and very large urban areas in the Northeast.

Tables 4 and 5 show the top 10 urban areas with highest and lowest commuting costs using gas prices and the federal reimbursement rate. Among urban areas with the highest commuting costs, regardless of whether the estimated by gas prices or reimbursement rates, 9 urban areas concurrently show up on Tables 4 and 5 – though not in the same order. This may indicate that mean travel time has a significant effect on commuting costs because it is an integral component in calculations for both methods. The urban areas with the highest commuting costs are mostly located in the West, Northeast, and the South, and are mostly medium to very large in size. The urban area with the highest annual commuting cost using gas prices is Honolulu, HI, costing approximately $2,023.73 per year for a 5-day weekly commute for 52 weeks per year. A contributing factor to increased gas prices in Honolulu, HI is likely the cost factor associated with shipping fuel gas out to these islands. The urban area with the highest commuting cost using the reimbursement rate is Lancaster-Palmdale, CA costing approximately $7,795.47 per year for a 5-day weekly commute for 52 weeks per year. Since Lancaster-Palmdale, CA is located on the suburban fringe of Los Angeles, CA, higher mean travel times and therefore, higher commuting cost estimates may be associated with long commutes into Los Angeles.

Of the urban areas with the lowest commuting costs, 6 of the 10 urban areas on Tables 6 and 7 are the same, again possibly indicating that mean travel time may be a reliable indicator for commuting costs. All of the urban areas with the lowest commuting costs are either small or medium in size and are in the West, Midwest, and South – none in the Northeast. Boulder, CO has the lowest commuting estimates using gas prices in comparison to all other urban areas with $754.73 (see Tables 6 and 7). When the reimbursement rate is considered, Boulder, CO has significantly lower commuting costs than all urban areas except for Boise, ID, with a cost estimate of $2,912.13 (see Tables 6 and 7). Boulder city, CO has a lower rate of commuters who drove alone to work (51.2%) in comparison to the U.S. as a whole (76.1%), which may cause less congestion in the city, lower travel times, and therefore, lower commuting costs (U.S. Census Bureau, American Community Survey 2009).

Table 4: Top 10 Urban Areas with the Highest Commuting Costs Using Gas Prices

	Cost	*SE*	*Size*	*Region*	*Division*
Honolulu HI	$2,023.73	$20.66	Med	West	Pacific
Lancaster-Palmdale CA	$1,891.34	$42.18	Med	West	Pacific
New York-Newark NY-NJ-CT	$1,798.43	$2.38	Vlg	Northeast	Middle Atlantic
Poughkeepsie-Newburgh NY	$1,688.46	$36.04	Med	Northeast	Middle Atlantic
Bridgeport-Stamford CT-NY	$1,523.35	$12.81	Med	Northeast	New England
Washington DC-VA-MD	$1,501.52	$6.32	Vlg	South	South Atlantic
Riverside-San Bernardino CA	$1,491.98	$14.12	Lrg	West	Pacific
Stockton CA	$1,454.91	$37.69	Sml	West	Pacific
Baltimore MD	$1,418.24	$8.95	Lrg	South	South Atlantic
Chicago IL-IN	$1,388.73	$4.14	Vlg	Midwest	East North Central

Table 5: Top 10 Urban Areas with the Highest Commuting Costs Using the Reimbursement Rate

	Cost	*SE*	*Size*	*Region*	*Division*
Lancaster-Palmdale CA	$7,795.47	$347.69	Med	West	Pacific
Poughkeepsie-Newburgh NY	$6,739.09	$287.73	Med	Northeast	Middle Atlantic
Stockton CA	$6,622.72	$343.12	Sml	West	Pacific
New York-Newark NY-NJ-CT	$6,484.30	$17.14	Vlg	Northeast	Middle Atlantic
Riverside-San Bernardino CA	$6,185.73	$117.10	Lrg	West	Pacific
Bridgeport-Stamford CT-NY	$6,142.38	$103.34	Med	Northeast	New England
Honolulu HI	$6,107.82	$124.69	Med	West	Pacific
Baltimore MD	$6,055.03	$76.42	Lrg	South	South Atlantic
Washington DC-VA-MD	$5,959.24	$50.16	Vlg	South	South Atlantic
Atlanta GA	$5,899.16	$72.69	Vlg	South	South Atlantic

Table 6: Top 10 Urban Areas with the Lowest Commuting Costs Using Gas Prices

	Cost	*SE*	*Size*	*Region*	*Division*
Boulder CO	$754.73	$18.70	Sml	West	Mountain
Boise ID	$804.92	$12.30	Sml	West	Mountain
Wichita KS	$817.54	$12.56	Med	Midwest	West North Central
Brownsville TX	$833.05	$22.46	Sml	South	West South Central
Tulsa OK	$837.50	$10.32	Med	South	West South Central
Oklahoma City OK	$839.67	$9.67	Med	South	West South Central
Eugene OR	$881.28	$20.43	Sml	West	Pacific
Omaha NE-IA	$889.35	$11.02	Med	Midwest	West North Central
Laredo TX	$911.56	$26.23	Sml	South	West South Central
Little Rock AR	$912.87	$17.25	Sml	South	West South Central

Table 7: Top 10 Urban Areas with the Lowest Commuting Costs Using the Reimbursement Rate

	Cost	*SE*	*Size*	*Region*	*Division*
Boulder CO	$2,912.14	$144.32	Sml	West	Mountain
Boise ID	$3,076.43	$94.03	Sml	West	Mountain
Spokane WA	$3,243.16	$88.28	Sml	West	Pacific
Anchorage AK	$3,392.98	$130.47	Sml	West	Pacific
Wichita KS	$3,671.89	$112.86	Med	Midwest	West North Central
Brownsville TX	$3,693.23	$199.16	Sml	South	West South Central
Eugene OR	$3,734.23	$173.14	Sml	West	Pacific
Bakersfield CA	$3,821.20	$141.90	Med	West	Pacific
Sarasota-Bradenton FL	$3,828.87	$145.47	Med	South	South Atlantic
Oklahoma City OK	$3,860.04	$88.88	Med	South	West South Central

When comparing sizes, regions, and divisions of urban areas, there are significant differences (see Tables 8-13). Urban areas with small population sizes (pop. <500,000) and very large urban areas (pop. 3+ million) have significantly different commuting costs when compared with urban areas of other population sizes (see Tables 8 and 9). These findings indicate that there are differences in commuting costs based upon population size of an area, which indicates geographic variation. This may be due to increased population density and therefore, more traffic, slowing the traffic flow on the road, increasing cost associated with traveling.

Table 8: Significance Test Results for Urban Areas based on Size of Population using Gas Prices

	Commuting Costs	*SE*	*Small*	*Medium*	*Large*	*Very Large*
Small	$994.57	$20.97	X	•	•	•
Medium	$1,129.99	$15.96		X		•
Large	$1,129.40	$9.80			X	•
Very Large	$1,325.57	$6.37				X

• = Statistical significance at $p<0.10$

Table 9: Significance Test Results for Urban Areas based on Size of Population using Reimbursement Rate

	Commuting Costs	*SE*	*Small*	*Medium*	*Large*	*Very Large*
Small	$4,344.44	$87.12	X	•	•	•
Medium	$4,762.04	$134.46		X		•
Large	$4,831.13	$84.13			X	•
Very Large	$5,310.84	$51.74				X

• = Statistical significance at $p<0.10$

Tables 10 and 11 show the significance test results for the 100 urban areas categorized by region, as defined by the U.S. Census Bureau. Urban areas in the Northeast are consistently different, regardless of method, from those in the Midwest and the South. When gas prices are tested, urban areas in the West are also different from all other regions in the country, suggesting that the Northeast, and possibly the West, have higher commuting costs in general. Interestingly, the Northeast is generally the most populated and dense area of the country – again, suggesting that population size and density may play an important role in traffic and therefore, travel costs (at least for personal vehicles).

Table 10: Significance Test Results for Urban Areas based on Region using Gas Prices

	Commuting Costs	*SE*	*Midwest*	*Northeast*	*South*	*West*
Midwest	$1,042.30	$9.77	X	•		•
Northeast	$1,315.38	$13.13		X	•	•
South	$1,061.31	$14.03			X	•
West	$1,175.67	$16.10				X

• = Statistical significance at $p<0.10$

Table 11: Significance Test Results for Urban Areas based on Region using Reimbursement Rate

	Commuting Costs	*SE*	*Midwest*	*Northeast*	*South*	*West*
Midwest	$4,570.56	$86.73	X	•		
Northeast	$5,232.57	$106.01		X	•	•
South	$4,704.14	$125.63			X	
West	$4,747.31	$131.55				X

• = Statistical significance at p<0.10

Tables 12 and 13 contain significance test results for urban areas based upon divisions as defined by the U.S. Census Bureau. Table 12 shows that there are many significant divisional differences when using gas prices. Specifically, East North Central, the Middle Atlantic, and the South Atlantic are significantly different from all other divisions, when examining results for gas prices. In fact, the only insignificant results, meaning the urban areas that did not have commuting cost estimates using gas prices that are significantly different are: the Pacific and New England, Mountain and East South Central, and West South Central and West North Central.

Significance test results for reimbursement rate commuting cost estimates by division do not show as much support for geographic variation in commuting costs as those calculated using gas prices but there are some significant results (see Table 13). The Middle Atlantic urban areas are significantly different from all other urban areas except for those in New England. Those in New England are significantly different from all expect for those in the Pacific, in addition to the Middle Atlantic. The South Atlantic was not significantly different from the Pacific or East South Central. The West North Central urban areas were similar to the Mountain and West South Central urban areas. This variation in significance indicates that the reimbursement rate in comparison to gas prices captures less of the geographic variation as scale increases. This indicates that the use of state gas prices may give a better estimate of poverty resources when the goal is to take into consideration geographic variation.

Table 12: Significance Test Results for Urban Areas based on Division using Gas Prices

	Cost Estimate	*SE*	*East North Central*	*East South Central*	*Middle Atlantic*	*Mountain*	*New England*	*Pacific*	*South Atlantic*	*West North Central*	*West South Central*
East North Central	$1,077.95	$10.16	X	•	•	•	•	•	•	•	•
East South Central	$1,023.68	$12.80		X	•		•	•	•	•	•
Middle Atlantic	$1,341.13	$13.40			X	•	•	•	•	•	•
Mountain	$1,019.82	$12.48				X	•	•	•	•	•
New England	$1,285.95	$12.83					X		•	•	•
Pacific	$1,257.70	$18.01						X	•	•	•
South Atlantic	$1,142.09	$13.76							X	•	•
West North Central	$956.75	$8.84								X	
West South Central	$979.43	$14.86									X

• = Statistical significance at $p<0.10$

Table 13: Significance Test Results for Urban Areas based on Division using Reimbursement Rate

	Cost Estimate	*SE*	*East North Central*	*East South Central*	*Middle Atlantic*	*Mountain*	*New England*	*Pacific*	*South Atlantic*	*West North Central*	*West South Central*
East North Central	$4,633.11	$88.77	X		•		•	•	•	•	
East South Central	$4,726.40	$119.68		X	•	•	•			•	
Middle Atlantic	$5,258.37	$106.96			X	•		•	•	•	•
Mountain	$4,404.21	$107.83				X	•	•	•		
New England	$5,203.10	$104.92					X		•	•	•
Pacific	$4,927.89	$144.03						X		•	•
South Atlantic	$4,904.32	$118.67							X	•	•
West North Central	$4,420.43	$81.84								X	
West South Central	$4,455.02	$136.37									X

• = Statistical significance at $p<0.10$

4. Conclusions, Future Work, and Other Considerations

The two methods for estimating commuting costs, gas prices and reimbursement rate, do not produce the same results. The estimates using the reimbursement rate were significantly higher than those using the gas prices because the reimbursement rate includes not only fuel but also 'wear-and-tear', thus producing higher commuting cost estimates. Regardless of the method used, the top 10 urban areas with the highest and lowest commuting costs were relatively consistent, and the correlation of all areas for the two means is high. The urban areas with the highest commuting costs tend to have larger populations, while those with the lowest costs generally to have the lowest population sizes. Very large urban areas (pop. 3 million+) and small urban areas (pop. <500,000) had significantly different commuting costs than other sized urban areas. Urban areas in the Northeast also had significantly different commuting costs from the Midwest, South, and West, regardless of method. Additionally, when considering gas prices, urban areas in the West also have significantly different commuting cost estimates in comparison to all other urban areas. Generally, these results indicate that the Midwest and the South have lower commuting costs than the Northeast and the West.

When broken down further by division, results using the reimbursement rate are more inconsistent than those using the gas price method. Using gas prices, the East North Central, Middle Atlantic, and the South Atlantic urban areas have significantly different commuting costs compared to urban areas in other divisions. The findings at the division level further indicate that as the geographical scale changes commuting cost indicators also change. It appears from the statistical test results that the use of gas prices, in comparison to the reimbursement rate, provides additional geographic variation. These findings provide a case for further research on geographic adjustments in the SPM to determine the appropriate geographic scale of analysis.

Currently, the U.S. Census Bureau adjusts the SPM by subtracting work-related transportation costs from family resources. This research implies that a geographic adjustment to the work-related transportation costs may provide a more precise measure of poverty. Ideally, the geographic adjustment of the SPM should be simple and replicable. Further research is needed to better understand the most appropriate method for estimating commuting costs and the best geographic scale in which the adjustment should take.

Further research is needed to explore possible data sources or methodology for estimating speeds, travel times, and distance, and ultimately, cost estimates for commuting in the additional 339 urban areas as well as non-urban and rural areas. A method for obtaining mean distance traveled to work for all areas in the U.S. may be possible using the ACS microdata. Researchers can then use this distance data to estimate commuting costs using gas prices, the federal reimbursement rate, or some other method.

Additionally, some urban areas in the U.S. have significant forms of public transit that are available to commuters, such as the New York, Washington, Boston, Philadelphia, and Chicago metro areas. Future work may include the cost estimation for utilizing public transit in urban areas where it is available. In fact, the disuse of public transportation in these urban areas would likely drive up the cost of commuting due to additional delays on highways and arterial streets.

Lastly, the Center for Neighborhood Technology (CNT), a think-tank based in Chicago, IL, created an index that takes into account geographical variation in housing and transportation across the U.S. The H + T Affordability Index is an indicator of housing affordability based on the housing location and its associated transportation cost. The CNT estimates transportation costs by summing three regression models to derive a total household cost for transportation including automobile ownership, automobile use, and transit usage (see Haas et al. 2008). The CNT obtained data for these models from several different surveys including the 2000 U.S. Census, CTPP 2000, 2001 National Household Travel Survey, and the CTOD National TOD database derived from the NTAD 2003 and transit agency files. The H + T Affordability Index is a methodologically complex index. It may be worthwhile in the future to better examine this index, or perhaps a simpler variation of it, for usage in the SPM in an effort to better reflect the resources and needs of the population in poverty (U.S. Census Bureau, 2010).

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