Reverse Commuting: Prospects for Job Accessibility and Energy Conservation

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The problems of job accessibility and energy consumption associated with metropolitan decentralization have not been solved by conventional mass transit. The potential exists for new public transportation options that increase accessibility to suburban jobs and use energy more efficiently. The factors constraining low-wage urban labor from commuting to suburban jobs and the demand for reverse commute services are examined, and public transportation options that would increase accessibility and conserve energy are identified. The focus is on the Baltimore metropolitan area. The suburban activity centers in the metropolitan area are relatively inaccessible by transit from many areas of Baltimore City. Travel times for reverse commute transit are often greater than those for suburb-to-city transit. Low-wage urban labor uses transit, automobile, and paratransit modes for commuting in the city but desires higher wages and automobiles or higher-quality public transportation for commuting to the suburbs. Additional paratransit options could increase accessibility and vehicle loads, resulting in a large saving of energy. Creating busways and high-occupancy-vehicle lanes that can be used cost-effectively for the reverse commute should be considered. Government and private-sector employers should aggressively market ridesharing to the urban labor force and pay financial incentives to attract labor to suburban jobs and to paratransit services.

The continued decentralization of metropolitan areas has reduced the accessibility of low-wage inner-city residents to employment and has promoted increased energy consumption for commuting to work. It is a worthy societal objective to increase the accessibility of labor to suburban employment opportunities. Public transportation officials must market services that are in demand and that promote other societal objectives, such as increased energy conservation and improved air quality.

Cervero noted that the suburbanization of work places aggravates the high jobless among inner-city minorities (*1*). Inadequate public transportation for a reverse commute and the high cost of housing in suburban areas deter inner-city labor from reaching jobs at these activity centers. Ottensman found that Milwaukee districts with the poorest people and the lowest-quality housing experienced the greatest deterioration in accessibility to employment opportunities because of suburbanization (*2*).

A National League of Cities report found that the growth and concentration of poverty in urban areas has been caused by the relocation of jobs to the suburbs and the decreasing demand for unskilled workers (*3*). The percentage of people in Baltimore living in extremely poor neighborhoods, primarily blacks and Hispanics, grew from 28 to 34 percent between 1970 and 1980. These neighborhoods have been transformed into expanding ghettos that are far from job opportunities.

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Notess found that a typical black worker in Buffalo, New York, could reach more than 25 percent more jobs by a half-hour bus trip in 1952 than in 1968 because of the movement of jobs to suburban locations (*4*). The average journey to work from the inner city by automobile took 12 min in 1968, whereas the average travel time by bus was 30 min.

A National Urban Coalition study found that transit systems were oriented toward collecting suburban residents for line-haul service to the central business district (CBD) (*5*). Reverse commuters often found collection points in the city to be inconvenient and the suburban destinations to be considerable distances from job sites. Bigler and Keith reported that the time and cost of reverse commuting by transit were almost prohibitive to the urban poor (*6*).

The dispersed job locations of suburban areas also cause greater energy consumption during the journey to work relative to higher-density areas. Anderson, using 1986 data from UMTA [now the Federal Transit Administration (FTA)], found that ridership, a function of density, was a significant influence on energy use by urban public transportation modes (*7*). He compared the energy use per passenger mile of eight modes. Energy use consisted of energy for propelling and heating or cooling the vehicle and energy for constructing the vehicle and the way. The modes that were found to use the least total energy per passenger mile were the vanpool and personal rail transit. The modes that used the most were dial-a-bus and light rail.

In response to the concern over energy use and public transportation policy in the 1970s, Lutin analyzed energy consumption by various modes for work trips in New Jersey (*8*). He calculated the number of work trips by automobile and transit (bus and rail), energy consumption per vehicle mile, and vehicle occupancy. Because of the overwhelming number of trips by automobile and existing work trip patterns, relatively minor increases in automobile occupancy yielded greater savings in energy than substantial diversions of automobile users to transit.

Lutin concluded that increased bus service in low-density suburbs will most likely result in inefficient use of energy because transit ridership and population density are positively related. Pikarsky noted that low-density suburbs have not been served by conventional mass transit in an energy-efficient manner (*9*). Cox stated that because transit often cannot be used effectively in suburban areas, its reliability is limited during an energy emergency (*10*). However, for urban and suburban areas, mass transit has been the traditional tool for promoting energy conservation in the work commute.

RESEARCH HYPOTHESES, OBJECTIVES, AND METHOD

It is apparent from the literature that problems with job accessibility and energy consumption associated with metropolitan decentralization have not been solved by conventional mass transit. Low-wage urban labor, not unlike other income groups, demands frequent, high-quality, and speedy transportation services for commuting to suburban employment. Suburban activity centers are relatively inaccessible from many areas of the city, but the potential exists for new public transportation options that increase accessibility to suburban jobs and use energy more efficiently.

The objectives in this paper are to examine the transportation factors constraining low-wage urban labor from commuting to jobs at suburban activity centers, examine the determinants of demand for reverse commute services, and identify those public transportation options that would increase accessibility and conserve energy. The focus is on conditions within the Baltimore metropolitan area and conditions similar to those in other large metropolitan areas.

The research methodology includes review of local studies and reports on regional commuting and economic trends, application of a survey to low-wage unemployed urban labor, statistical analysis of survey data, and analysis of secondary data on work trips.

The analyses concentrate on areas of Baltimore City and on suburban activity centers as designated by the Baltimore Regional Council of Governments (BRCOG): Baltimore-Washington International Airport (BWI), Columbia/Route 1, Hunt Valley, Owings Mills, Towson, and White Marsh (Figure 1). All of the suburban activity centers are major nodes of industrial, commercial, and residential growth. They have been selected as planned growth areas that would receive the bulk of development in their counties. All except Towson are outside the circumferential highway, I-695, along major corridors radiating from Baltimore City. These centers have had abundant vacant land, which in a robust economy has contributed to rapid rates of growth.

METROPOLITAN AREA EMPLOYMENT AND COMMUTING

Urban decentralization has involved jobs at all skill levels and middle- to upper-income households; low-income, transit-pendent households have remained in the inner city. Firms in many suburban locations have difficulty attracting low-wage and low-skilled labor. As of May 1991, the unemployment rate in the city of Baltimore was 9.5 percent; for the metropolitan area as a whole, the unemployment rate was 6.6 percent (*11*). Howard County, in the corridor between Baltimore and Washington, D.C., and the fastest growing county in the metropolitan area, had an unemployment rate of 4.1 percent. In 1988 the metropolitan area had average annual unemployment rates of 3.2 percent for whites and 12.2 percent for blacks (*12*).

According to employment estimates by BRCOG, between 1980 and 1985 the metropolitan area's labor force and employment grew by 2 and 7 percent, respectively (*13*). During the same period, Baltimore City's labor force declined from 360,000 to 340,000, a decrease of 6 percent. The number of jobs in Baltimore City declined from 458,600 to 424,400, a decrease of 8 percent.

In the six suburban activity centers selected for study [Regional Planning Districts (RPDs) 201, 202, 306, 309, 314, 315, 317, 605, 606, and 607], the labor force grew from 128,650 to 146,180 between 1980 and 1985, an increase of 14 percent (*13*). Employment increased 25 percent, from 171,550 to 214,370. The activity centers contributed to 81 percent of the metropolitan area's labor force growth and 55 percent of the metropolitan area's employment growth between 1980 and 1985.

The contrast between city and suburban counties is also apparent from the differences for work-trip destinations and choices of mode to work. During the 1980s several changes occurred in the commuting patterns, choices of travel mode to work, and vehicle ownership, according a comparison between BRCOG's 1988 household travel survey and 1980 census data (*14*). Each jurisdiction in the metropolitan area had an increase in the percentage of internal commuter trips between 1980 and 1988; more trips originated and ended in the jurisdiction of residence. The percentage of commuter trips originating in Baltimore City and ending in other jurisdictions, for example, fell from 30 to 24 percent of all commuter trips originating in the city.

The suburban counties attracted relatively fewer commuter trips by Baltimore City residents, despite a city employment base that continued to erode. Apparently, Baltimore City residents have become less willing or less able to commute to suburban jobs.

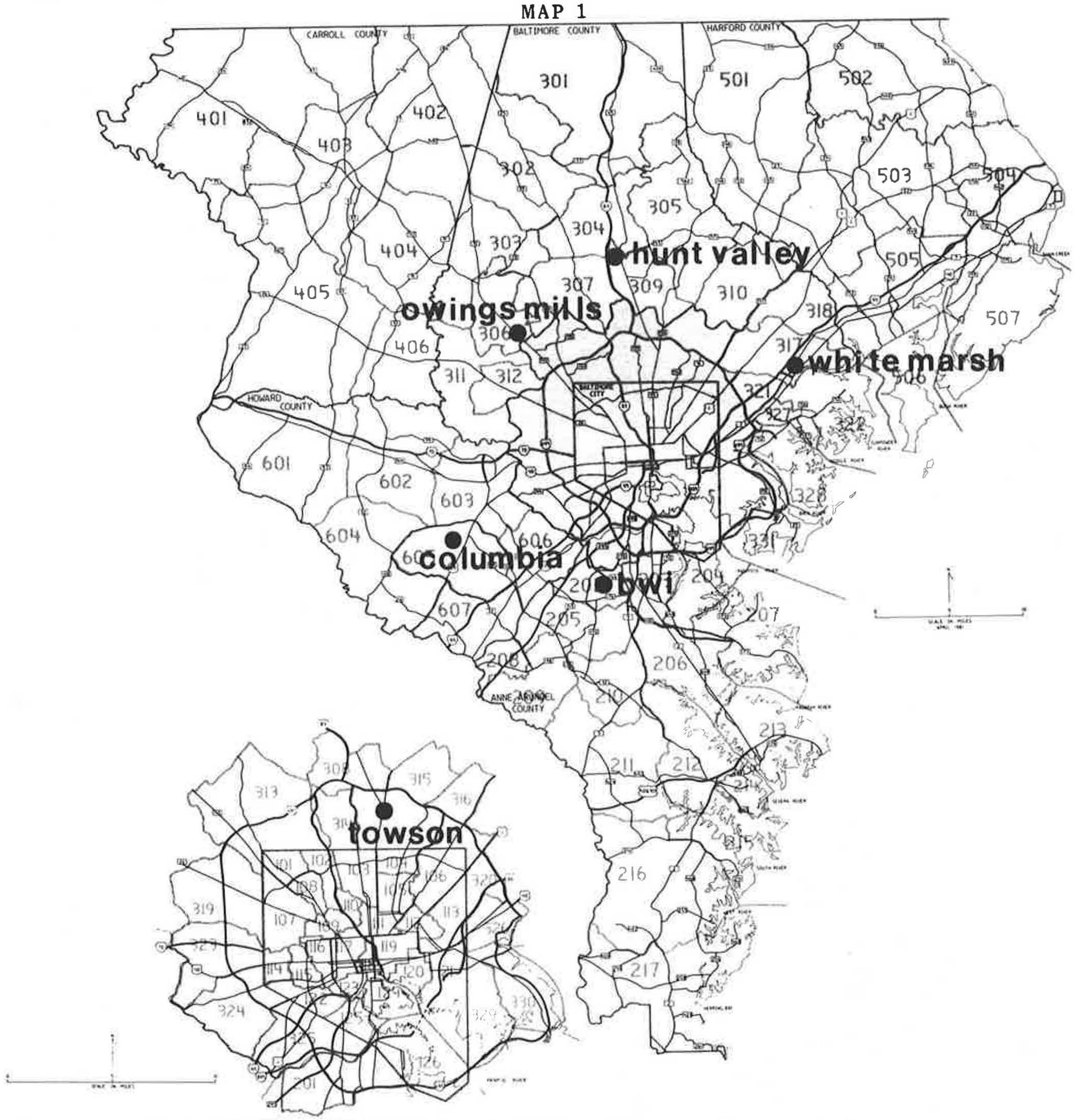
The percentage of commuters in the metropolitan area driving alone grew from 60 to 74 percent between 1980 and 1988, whereas the percentage of commuters in car and vanpools declined from 22 to only 10 percent (*14*). Transit ridership declined from 101.9 million riders in 1980 to 75.0 million in 1985, a decline of 26.4 percent (*15*). In Baltimore City, the percentage driving alone increased from 45 to 56 percent between 1980 and 1988, whereas the percentage using car and vanpools decreased from 20 to 10 percent. The abundance of motor fuels and the decrease in the real prices of fuels during the 1980s contributed to these trends in mode choice.

ACCESSIBILITY ANALYSIS

The intent of the accessibility analysis was to delve into the spatial associations between employment and accessibility to jobs with public transportation. Simulated unconstrained transit travel time data for 1985 were available from BRCOG and were used to calculate a measure of transit inaccessibility to all suburban activity center RPDs from each city RPD. The simulated transit times represented unconstrained or free-flow running times only. No waiting, walking, or transfer times were included, which vary significantly by time of day and add greatly to the total travel time by transit. Simulated peak-hour travel times were not available for various years at the time of this analysis. A measure of relative inaccessibility to individual activity centers through time could not be calculated.

The total travel times from each city RPD to all of the suburban activity center RPDs were used as a measure of

MAP 1



REGIONAL PLANNING DISTRICTS

BALTIMORE CITY

101 UPPER PARK HEIGHTS
102 MOUNT WASHINGTON
103 ROLAND PARK
104 CHINQUAPIN
105 GOVANS-NORTHWOOD
106 HAMILTON
107 FOREST PARK
108 LOWER PARK HEIGHTS
109 DRUID HILL
110 HAMPDEN
111 WAVERLY
112 CLIFTON
113 GARDENVILLE
114 TEN HILLS
115 IRVINGTON
116 ROSEMONT
117 WEST BALTIMORE
118 METROCENTER
119 EAST BALTIMORE
120 HIGHLANDTOWN
121 CANTON
122 MORRELL PARK
123 CARROLL PARK
124 SOUTH BALTIMORE
125 CHERRY HILL
126 BROOKLYN

ANNE ARUNDEL COUNTY

201 BROOKLYN HEIGHTS
202 FRIENDSHIP
203 GLEN BURNIE
204 MARLEY NECK
205 STEWART CORNER
206 SEVERNA PARK
207 MOUNTAIN ROAD
208 MARYLAND CITY
209 FORT MEADE
210 ODENTON
211 CROFTON
212 EPPING FOREST
213 BROADNECK
214 ANNAPOLIS
215 HILLSMERE
216 DAVIDSONVILLE
217 DEALE

BALTIMORE COUNTY

301 HEREFORD-MARYLAND LINE
302 PRETTYBOY
303 FOWBLESBURG
304 SPARKS
305 JACKSONVILLE
306 REISTERSTOWN-OWINGS MILLS
307 CHESTNUT RIDGE
308 LUTHERVILLE
309 COCKEYSVILLE-TIMONIUM
310 FORK
311 HARRISONVILLE
312 RANDALLSTOWN
313 PIKESVILLE
314 RUXTON
315 TOWSON
316 PARKVILLE
317 PERRY HALL-WHITE MARSH
318 KINGSVILLE
319 LOCHEARN
320 OVERLEA
321 ROSSVILLE
322 WINDLASS
323 SECURITY
324 CATONSVILLE
325 ARBUTUS-LANDSDOWNE
326 ROSEDALE
327 MIDDLE RIVER
328 ESSEX
329 DUNDALK-TURNERS STATION
330 NORTH POINT
331 EDGEMERE

CARROLL COUNTY

401 TANEYTOWN
402 MANCHESTER
403 WESTMINSTER
404 FINKSBURG
405 MOUNT AIRY
406 ELDERSBURG

HARFORD COUNTY

501 JARRETTSVILLE-NORRISVILLE
502 CARDIFF-DARLINGTON
503 BEL AIR-FALLSTON
504 ABERDEEN-HAVRE DE GRACE
505 EDGEWOOD-JOPPA
506 ARMY CHEMICAL CENTER
507 ABERDEEN PROVING GROUNDS

HOWARD COUNTY

601 COOKSVILLE
602 WEST FRIENDSHIP
603 ELLICOTT CITY
604 CLARKSVILLE
605 COLUMBIA
606 ELKRIDGE
607 LAUREL

FIGURE 1 Suburban activity centers.

relative inaccessibility from areas within the city. The measure is calculated using the following formula:

$$Ai = \sum_{j=1}^{n} TTij \quad (1)$$

where

Ai = relative accessibility from city RPDi to all suburban RPDj's (total travel times),
$TTij$ = travel time between RPDi and RPDj,
i = (1,..., m), and
j = (1,..., n).

The RPDs in a distinct cluster of greatest total travel time to all suburban activity center RPDs were then mapped to show the spatial pattern of inaccessibility.

The areas of relative inaccessibility by transit are in northeast and east Baltimore because of the distance between these areas and activity centers primarily west and south of the city (Figure 2). The CBD and immediate environs are areas of high accessibility because a large amount of transit service begins and ends there. The southwestern tier of RPDs is a significant area of relative inaccessibility because of the long distances from the northern activity centers and because of the absence of transit links to the Columbia and Route 1 activity center in 1985.

For selected pairs of city and suburban RPDs, average travel times by transit in 1985 and automobile in 1986 along with ratios of transit to automobile travel times in both directions were calculated. The selected RPDs consisted of six city RPDs and three suburban activity center RPDs that had substantial amounts of employment and labor force. The city RPDs were

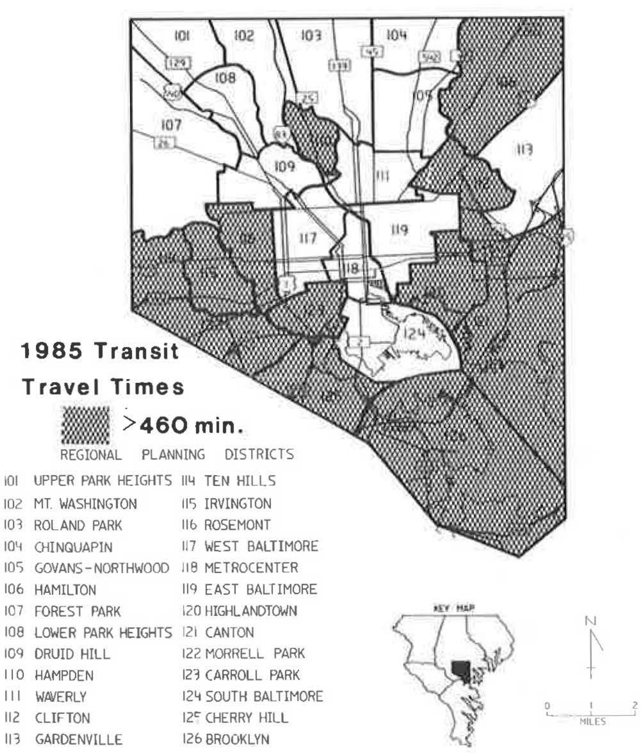


FIGURE 2 Inaccessibility to suburban centers.

also characterized by low median household income and relative inaccessibility. The travel time ratios were compared to discern differences between suburb-to-city and city-to-suburb transit travel times. Transit travel times (running times only) were approximately three times as long as automobile times and ratios of transit to automobile travel time were generally greater for city-to-suburb than for suburb-to-city travel.

The first implication from this analyses is that residents of relatively inaccessible areas of the city are faced with longer transit travel times to suburban activity centers than other city residents. The second implication is that transit-dependent residents of these inaccessible areas often face longer travel times for the reverse commute than do suburbanites commuting by transit to the city. Travel to work generally occurs during a more constrained time period than the trip home. Many low-wage jobs have nighttime shifts when transit is less available. Thus, longer times for the reverse commute to work are an undue burden on transit-dependent, low-wage labor living in the more inaccessible areas of the city.

ATTITUDE SURVEY

A survey of low-wage unemployed residents of Baltimore City was conducted to provide insight into previous job commuting behavior and the perceptions about reverse commuting to suburban jobs. The questionnaires were administered to unemployed workers who applied for unemployment insurance through the Maryland Office of Unemployment Insurance or applied for job training and placement assistance through the Baltimore City Office of Employment Development. The survey results should not be considered as representative of all low-wage unemployed labor in Baltimore City.

Those respondents who stated on the questionnaire that they earned more than \$20,000/year were excluded from the sample. The completed questionnaires totaled 528, and 58 percent of these came from the Office of Employment Development; the rest came from the Office of Unemployment Insurance.

A substantial portion of the questionnaire was devoted to demographic characteristics of the respondents. The majority of respondents were in between 25 and 39 years old. Relatively few were younger than 18 or older than 54. The majority of respondents—51 percent—indicated that they were female. Forty-three percent indicated that they were male and 6 percent did not respond to the question about sex. The majority of respondents—69 percent—described themselves as black. Sixteen percent described themselves as white, and other races constituted only 2 percent. Thirteen percent did not respond to the question about race. The median size of the immediate family was 2.5 members. Almost 72 percent of the respondents reported being high school graduates. Fifty-three percent of respondents reported special skills such as technical, administrative, and mechanical. The respondents' occupations were categorized as follows: 19.3 percent in secretarial and clerical jobs, 35.6 percent in sales and services, and 44.7 percent in construction, general labor and mechanical.

Only 29 percent of the respondents reported owning at least one automobile; the remainder, 71 percent, had no automobile. The median wage at the previous job was \$6/hr. More than half of the respondents reported traveling less than 10 mi, but 25.3 percent did not respond to this question. The remainder traveled more than 10 mi. Travel time is usually reported more accurately and the travel time for all modes ranged from 1 min to 1.5 hr. The modal and median travel times were approximately 30 min.

Approximately 19 percent of respondents took the automobile exclusively to a previous job; 10 percent took the automobile in combination with transit or paratransit; 24 percent took some combination of transit and paratransit modes; and 35 percent took just transit to commute to work. Few respondents used carpools or vanpools. Ridesharers in the metropolitan area have been overwhelmingly white, middle- to upper-income professional employees (*16*). Low-income commuters have not participated greatly in ridesharing despite its financial advantages.

Low-wage urban labor used a wide variety of modes to commute primarily to jobs in the city, but there was a predominant reliance on transit and an assortment of paratransit modes. It should be noted that the selected combinations of modes were not necessarily used for each work trip.

When asked if respondents would take a job at each of the six activity centers, earning the same wage they did when employed, 28.3 percent stated they would not work at any of the activity centers, 14.6 percent stated they would accept a job at each one. Almost 9 percent stated they would work only in Towson. Owings Mills and Towson were selected by 3.8 percent, and Hunt Valley, Towson, and Owings Mills were selected by 3.2 percent. The other activity centers singly, or in combination, were selected consistently by less than 2 percent of the respondents. Only 1½ percent did not respond to the question.

Almost a third of the respondents would not commute the long distances to jobs at suburban centers that pay similar wages to those in the city. The shorter distances to Towson, Hunt Valley, and Owings Mills from the northern areas of the city accounted for the higher percentages of selection.

Those who would not accept a job at an activity center were asked what incentives would be needed in order to accept a job. Higher pay was selected by 17.3 percent of respondents. Almost 15 percent selected higher pay and more convenient transportation. Another 10 percent selected a combination of higher pay, flexible work schedule, and more convenient transportation. More convenient transportation exclusively was selected by 8.7 percent; higher pay, more convenient transportation, and cheaper transportation were selected by another 6.8 percent. Child care and other incentives elicited insignificant responses. Approximately 18 percent did not address this question at all, either because they chose not to or because they had already stated they would accept a job at each activity center.

It is evident that higher pay is a critical factor in increasing the accessibility of low-wage city labor to suburban employment. Demand for transportation services that are convenient for commuting to the suburbs is associated with the desire for higher pay.

One question presented a scenario of an available job in the suburbs accessible by private automobile, bus, or van service. The monetary costs, travel times, and waiting times for each alternative were given. A fourth alternative was to not take the job because the trip was too long or costly with any of the transportation alternatives. In response 12.1 percent stated they would not take the trip at all. Approximately 37 percent stated they would take the automobile, and 12.5 percent would take the van. The bus alternative was chosen by 23.7 percent of the respondents. Although the question asked respondents to choose only one of the three options, 5.3 percent chose both van and bus alternatives as the preferred means of transportation. A majority of respondents selected the automobile or van as the desired mode for commuting to suburban jobs. Approximately 10 percent of the respondents did not address the question or did not answer meaningfully.

The next question asked respondents who chose the automobile what incentives they would require to switch to the van or bus. Roughly 37 percent did not respond, either because they did not choose the automobile or because they chose not to answer the question. Some respondents apparently selected incentives even after choosing bus or van. Almost 15 percent stated they would not switch from the automobile, regardless of incentives. The single incentive for switching chosen most often was faster bus or van (7.4 percent). More frequent bus or van service (4.9 percent) and less waiting time (4.9 percent) were next in importance. Cheaper bus or van was picked by only 3 percent of respondents. The rest of the responses involved combinations of incentives. The answers to this question imply that higher-quality public transportation is important for diverting automobile users to transit or paratransit. Many respondents perceive that an automobile is preferable for commuting to a suburban job despite its costs and that transit and paratransit modes are currently inconvenient for that purpose.

To gain a deeper understanding of the relationships among the responses, all of the survey responses were subjected to a factor analysis. All of the variables were reduced to nine factors with Eigen values greater than one. After a varimax rotation of the factors, only the first four factors with the highest Eigen values had loadings that could be interpreted meaningfully (Table 1).

The variables of family size, wages paid in last job, and travel distance to work loaded positively and strongly on the first factor, implying that there are positive relationships among family size, wages, and travel distance. Workers with larger families apparently travel longer distances to earn higher wages.

The second factor exhibited positive loadings by mode of travel to work and automobile ownership. Those who own automobiles use them to travel to work. Those who do not own automobiles use other modes to travel to work. Because wages did not load on this factor significantly, automobile ownership apparently does not vary by level of wage within this low-wage group. It has been shown in other studies that automobile ownership and use are directly and positively related to income, but appears not to be directly related to the small variation in wages paid to low-wage urban labor. The variables of mode choice and travel time to work did not relate to demographic, education, or wage characteristics. Evidently, these variables are a function of location of job opportunities and presence of transportation alternatives.

The third factor related the type of occupation in the last job to the type of new occupation sought. The fourth factor exhibited strong, positive loadings by the variables: sex and race (the majority of respondents were black and female).

TABLE 1 FACTOR ANALYSIS OF SURVEY RESPONSES: ROTATED FACTOR LOADINGS (VARIMAX)

Variables	Factors I	II	III	IV
1) Previous Occupation			.81	
2) Occupation Sought			.75	
3) Residence Zip				
4) Work Area				
5) Work Zip				
6) Own Car		.76		
7) Commute Modes		.83		
8) Travel Distance	.76			
9) Travel Time				
10) Fare				
11) Accept Suburban Job				
12) Job Incentives				
13) Suburban Mode				
14) Mode Incentives				
15) Family Size	.87			
16) Age				
17) Sex				.80
18) Race				.73
19) Education				
20) Skills				
21) Wages	.80			
22) Wages/Family Size				
Cumulative Proportion of Total Variance	16.1%	23.3%	30.4%	37.0%

Note: Only loadings ± 0.7 are shown.

ENERGY CONSUMPTION ANALYSIS

The intent of the energy consumption analysis was to illustrate the impacts of longer reverse commute trips to suburban jobs and of various public transportation scenarios to increase accessibility. The analysis followed the framework established by Lutin for estimating energy consumption for work trips in New Jersey (*8*). Energy consumption is a function of the total number of work trips, work trip length, mode split, energy consumption by mode, and load factor (occupancy). The expression of this function is as follows:

$$Em = (Wb)(Lb)[(WPm)(em)/lm] \quad (2)$$

where

Em = daily work trip energy use by Mode m;
Wb = daily work trips generated in Baltimore City;
Lb = average work trip length in Baltimore City;
WPm = percentage of work trips by Mode m;
em = energy consumption (gal) per vehicle mile by Mode m; and
lm = load factor for Mode m.

Energy consumption by mode was estimated for two modes: automobile and van and transit (bus and rail). The values for daily work trips and average length of trip came from BRCOG's 1986 traffic simulation model. The percentages of work trips by mode (mode split) were derived from the 1988 BRCOG household survey of commuting in the metropolitan area (*14*). BRCOG estimated that 468,564 daily work trips were generated in Baltimore City in 1986. The average trip length to destinations in the city and to destinations within the region were weighted by the household survey's work trip destination percentages, resulting in an average trip length of 4.68 mi. Trip length was assumed to be the same for automobile and van and transit.

The household survey also found that 56.5 percent of Baltimore City commuters drove alone and 9.9 percent were in carpools or vanpools, constituting 66.4 percent of all work trips. Transit accounted for 24.2 percent of work trips.

The data for energy consumption by mode came from FHWA highway statistics for 1986 (*17*). The data are for fuel consumption on highways; yet, the data were considered reasonably representative. Energy consumption for transit consisted of the average operating fuel consumption for buses. It was assumed for the sake of simplicity that rail transit consumed diesel fuel at the same rate as buses. Automobiles achieved on average 18.32 mi/gal or consumed 0.055/gal/mi; transit achieved 5.71 mi/gal, or consumed 0.175 gal/mi.

The load factor (occupancy) for transit was calculated from Maryland Mass Transit Administration passenger-mile and revenue-mile data reported to the U.S. Department of Transportation (*18*). The average number of passengers per vehicle was calculated to be 15.5. This calculation may underestimate the transit load factor in Baltimore City, because the service area includes suburban Baltimore County as well. Data for Baltimore City alone were not available. The load factor for automobiles was calculated using data from the BRCOG traffic simulation, the household survey, and a study done for UMTA on ridesharing (*16*). The automobile and van load factor was calculated to be 1.14.

Energy consumption by the two modes was calculated for five scenarios. The first scenario represents the status quo, and the second represents longer work trips. The second scenario would result if employment opportunities were to continue to migrate to the suburbs and low-wage labor to remain primarily in the city. The percentages used in these scenarios are merely for illustrative and comparative purposes. The three remaining scenarios represent public transportation policies to reduce the energy consumption from longer reverse commute trips. These scenarios are

1. Current values for mode choice, trip distance, and load factors—essentially the status quo.
2. Ten percent increase in average trip distance for all trips from 4.68 to 5.15 mi (5.15 mi used for remaining scenarios).
3. Ten percent increase in transit ridership (diversion of 3.6 percent of automobile and van trips to transit) and transit load factor remains at 15.5.
4. Ten percent increase in transit ridership and a 20 percent increase in transit load factors.
5. Ten percent increase in automobile and van load factor (decrease in automobile and van trips by 8.8 percent).

The changes in the values and the calculated total energy consumption for work trips for each scenario are shown in Table 2.

The most effective of the three public transportation scenarios is Scenario 5, which would increase the automobile and van load factor by 10 percent, because it would result in almost negating the increased energy consumption from the increase in work trip length. A 10 percent increase in automobile and

TABLE 2 SCENARIOS OF WORK-TRIP ENERGY CONSUMPTION: BALTIMORE CITY

Scenarios		Trip Distance [Miles]	Mode Split	Load Factor	Energy Consumption [Gallons]
Scenario I (status quo)	auto/van:	4.68	.664	1.14	70,249
	transit:		.242	15.5	5,992
					76,241
Scenario II (inc. distance)	auto/van:	5.15	.664	1.14	77,304
	transit:		.242	15.5	6,593
					83,897
Scenario III (inc. transit)	auto/van:	5.15	.64	1.14	74,510
	transit:		.266	15.5	7,247
					81,757
Scenario IV (inc. transit/ inc. load)	auto/van:	5.15	.64	1.14	74,510
	transit:		.266	18.6	6,039
					80,549
Scenario V (inc. auto/ van load)	auto/van:	5.15	.664	1.25	70,501
	transit:		.242	15.5	6,593
					77,094

van load factor would result in an 8.1 percent decrease in fuel consumption. Scenario 5 would achieve the lowest fuel consumption results because two-thirds of total work trips are by automobile and van, and a 10 percent increase in automobile and van occupancy would reduce the number of automobile and van trips more than a 10 percent increase in transit ridership would. The effectiveness of Scenario 5 would be even greater for suburban jurisdictions in which automobile and van use is even more dominant.

Although it would dramatically increase transit ridership and load factors would clearly be difficult given recent trends, Scenario 5 would not necessarily be easy to achieve either because ridesharing has decreased in popularity in Baltimore during the 1980s. Yet, ridesharing incentives, such as high-occupancy-vehicle (HOV) lanes, HOV preferential parking, and mixed-use zoning, have not yet been widely instituted in the Baltimore metropolitan area.

These scenarios are not mutually exclusive. Incentives to increase automobile and van occupancy could also enlarge transit vehicle occupancy as well. The result would decrease energy consumption further. Yet, it is clear that expanding transit service to more-distant suburbs will not reduce energy consumption for work trips if, as a result of flow density, transit ridership is low.

Another scenario that is probably most effective for reducing energy consumption for work trips, but one more difficult to implement, is to move from Scenario 2 to Scenario 1. Expanding job opportunities in the inner-city and constructing abundant low-income housing near suburban activity centers would reduce work-trip lengths, thus increasing accessibility to jobs and reducing energy consumption.

CONCLUSIONS AND RECOMMENDATIONS

Job opportunities for low-wage labor have decreased in cities and increased in the suburbs. The jobs at suburban activity centers in the Baltimore metropolitan area are relatively inaccessible in terms of travel time by transit from many areas of Baltimore City. Reverse commute transit travel times are generally greater than suburb-to-city travel times. Thus, low-wage urban labor's inaccessibility to job opportunities and the potential for increased energy consumption have grown.

Low-wage urban labor has used primarily transit and paratransit modes for commuting to jobs in the city, but many desire higher wages and automobiles or higher-quality public transportation for commuting to suburban jobs. To increase inaccessibility of the low-wage unemployed to suburban jobs and to conserve energy, low-wage labor should have more opportunities to live closer to suburban activity centers and use an assortment of reverse commute services. Public policies that promote more low-income housing in mixed-use developments and greater HOV use during the commute to work would result in substantial energy savings.

Additional paratransit modes, such as carpools, vanpools, jitneys, or shared-ride taxis, coupled with HOV lanes, HOV preferential parking, increased fuel taxes, and congestion pricing would increase automobile and van occupancy. Paratransit can provide door-to-door service to dispersed origins and destinations. During off-peak hours paratransit can provide cost effectiveness and energy efficiency. Exclusive guideway transit systems may be appropriate for some high-density corridors of residential and commercial development, although they incur high capital costs and tend to be geographically inflexible.

State and local government should reduce the regulations that inhibit the private sector from operating public transportation services and should create more opportunities for private-sector services under contract. Serious thought should be given to creating busways and HOV lanes that can also be used cost-effectively for the reverse commute. Government and private-sector employers should aggressively market van services, carpooling, and vanpooling to the urban labor force. If labor is in short supply, employers should pay the financial incentives to attract labor to suburban jobs and to reverse commute services.

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