The Decennial Census and Transportation Planning: Planning for Large Metropolitan Areas

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The purpose of this resource paper is to describe the use and application of decennial census data for transportation planning purposes in large metropolitan areas in the United States. In particular, use of the 1980 Urban Transportation Planning Package (UTPP) and the 1990 Census Transportation Planning Package (CTPP) will be discussed.

Large metropolitan areas are defined as regions with populations of 1 million or greater. Though this conference makes a distinction between large metropolitan and small to medium-sized metropolitan areas, the uses and applications of census data can be quite similar. Whereas transportation problems such as pollution and traffic congestion are typically an order of magnitude more severe in the larger metropolitan areas, this may or may not lead to more immediate and sophisticated uses of census data. The prime distinctions between large and small to medium-sized metropolitan areas are probably staffing levels and staff proficiency in managing large data sets such as the 1990 census.

Review of Literature: Use and Application of Census Data in Transportation Planning

The use of decennial census data in transportation planning has been covered extensively in the transportation research literature. The reader should specifically review three special reports issued by the Transportation Research Board covering census/transportation conferences held in 1970 in Washington, D.C. (*1*); in 1973 in Albuquerque, New Mexico (*2*); and in 1984 in Orlando, Florida (*3*). Also useful is the collection of articles in *Transportation Research Record 981*, published in 1984 (*4*). The reader also can refer to the Federal Highway Administration (FHWA) publications entitled *Transportation Planners' Guide To Using the 1980 Census* (*5*) and *Case Studies—Applying the Urban Transportation Planning Package (UTPP) in Transportation Modeling* (*6*). An ITE informational report entitled *Use of Census Data in Transportation Planning* includes sections on how census data have been used in transportation analysis (*7*). These reports provide a general overview of the use of 1970 and 1980 census data in transportation planning.

The Albuquerque and Orlando conferences were integral components of the formal and informal efforts of the Bureau of the Census to determine the census content for the 1980 and 1990 decennial censuses. Details on the Census Bureau's content determination efforts are

described in a series of *Content Determination Reports*, including a report on place-of-work and journey-to-work issues (*8*). This 1994 Irvine, California, conference will be an important element of the content determination process for the 2000 decennial census.

Complementary to the literature on the use of census data in transportation planning are several reference works on census trend data. The most popular are Pisarski's *Commuting in America* report published by the Eno Foundation (*9*); the 1986 FHWA report *Journey-to-Work Trends* (*10*); and a new report by FHWA, *Journey-to-Work Trends in the United States and Its Major Metropolitan Areas: 1960–1990* (*11*). Also of interest is a 1992 report by Pisarski analyzing results of the 1990 census (using Summary Tape File 3A data) and the 1990 Nationwide Personal Transportation Study (NPTS) (*12*).

Getting the Data Out: Disseminating the 1990 Census

Processing and disseminating the 1990 census data was (and still is) a mammoth operation. For the 1990 census, the Bureau of the Census collected data from 92 million households in the United States at a cost of approximately $25 per housing unit, for a total cost of $2.6 billion (*13,14*). Approximately one household in six, or 15 million households, was given a census long form to fill out. Given the amount of data and the complexity of the data processing operations, the Census Bureau has staged the release of new census data on an almost continuous basis since 1990.

The staged release of census products has aided metropolitan transportation planners by effectively distributing the work load over a period of years. Census data products are like a giant jigsaw puzzle with new pieces added over time until the "picture" is finally complete. Had the opposite been true, with census data dumped all at once on eager clients, the rush to get the big picture probably would have thwarted efforts to carefully review results at a greater level of detail.

One of the findings of the 1984 Orlando conference was the desire to have staged releases of census journey-to-work data. Many metropolitan transportation planners had to wait until 1983 or 1984 data to get basic data on 1980 census county-to-county commute patterns. The 1984 conference said, "Get us county-to-county data as soon as possible; get us the zone-to-zone or tract-to-tract data after that." In response to these concerns and other data user comments, the Census Bureau, the U.S. Department of Transportation, and some volunteer transportation professionals devised a split package scheme for disseminating 1990 census journey-to-work results—the Census Transportation Planning Package/Statewide Element (CTPP/SE), containing place-to-place and county-to-county commuter flow data as well as place-of-residence and place-of-work tables, and the Census Transportation Planning Package/Urban Element (CTPP/UE), containing zone-to-zone or tract-to-tract data (and zone-of-residence and zone-of-work tables). In addition to the CTPP/SE and the CTPP/UE packages, the Bureau of the Census developed a new product, the Summary Tape File S-5, which included 1990 census county-to-county commuter flows (without stratification by means of transportation).

Other standard census products were an important component of metropolitan planning organizations' (MPOs') census analysis plans. These products included the 100 percent count data in the redistricting tape and Summary Tape File 1A, as well as the sample data in Summary Tape File 3A and the Public Use Microdata Sample (PUMS).

By law, the Bureau of the Census must provide total population counts by state to the President of the United States by December 31 of each census year for purposes of apportionment of the House of Representatives. In January 1991 the Census Bureau released place, county, and state total population counts as part of its *Thank You America* count program. This was followed in March 1991 by the release of the Public Law 94–171 tape. The PL 94–171 redistricting tape provided block-level population characteristics by race and ethnicity and for persons of voting age (18 or over). Within months, the rest of the 100 percent count items included in the 1990 census were released in the Summary Tape File 1A (STF1A) data sets.

The most significant release of census data in 1992 was the first long-form, or sample, data included in the much awaited Summary Tape File 3A (STF3A). The STF3A tape file included small-area (block-group) data on all sample long-form data: means of transportation to work, commute vehicle occupancy, average commute time, intracounty versus intercounty commuting, household vehicle availability, household income, and number of employed residents.

The release of STF3A was a benchmark for census analysts, a cause for celebration as well as consternation. Carpool shares went down compared with 1980 census values. Drive-alone shares went up. Transit and walk shares declined. The share of workers working at home increased dramatically. Metropolitan transportation planners were turned into "spin doctors" overnight trying to explain the 1980 to 1990 trends only a matter of hours after receiving the data themselves. The savvy transportation planner quickly assembled trend data and came up with logical answers for the inevitable question: What do the numbers mean? It was the Census Bureau's job to disseminate the data files to the local clients, the MPOs. It was the MPOs' duty to analyze the data in terms of trends, highlights, and missed and met expectations, and to articulate the reasons why these trends were occurring. Census data could then be readily digested by the public, the policy makers, and the media.

In December 1992 the Census Bureau released Summary Tape File S-5. This popular data file included all county-to-county worker flow data for the entire United States. No data on means of transportation were provided, but the basic county-to-county commute "puzzle" was filled in with STF S-5.

The CTPP/SE packages followed in spring 1993. By fall 1993 and early 1994, the CTPP/UE packages were streaming into MPOs.

The major disadvantage of a March 1994 conference on the decennial census and transportation planning is the all too brief time that metropolitan and state transportation planners have had to analyze the CTPP/UE. Certain metropolitan areas may have received their CTPP/UE packages as early as October 1993. Other major metropolitan areas still may not have their package. Probably less than half of the approximately 300 urban element packages are available now. On the other hand, all states and metropolitan areas have had nearly a year to review results from the CTPP/SE.

Despite the prematurity of this March 1994 conference, the immediate concern is to consider the Census Bureau's tight deadlines for determining content for the 2000 census. This process, scheduled from 1993 to 1996, will culminate in a national content test in 1996, with the final 2000 census questions to be transmitted to Congress in 1997. Usefulness of data tabulations in the CTPP/SE and the CTPP/UE, as well as specifications for 2000 journey-to-work tabulations, may wait until CTPP data users have had sufficient time to fully explore and analyze the new 1990 data sets. Recommendations for 2000 census content cannot wait.

Use of Census Data in Metropolitan Transportation Planning

The following sections discuss various uses and applications of census data in metropolitan transportation planning, including trend analysis; travel demand model estimation, calibration, and validation; demographic and land use allocation model estimation, calibration, and validation; census data and estimation of small-area employment data; census data and household travel surveys; transit market analysis; miscellaneous transportation planning applications; and nontransportation planning applications of the journey-to-work data.

Trend Analysis

The most common application of census data is for trend analysis. How have things changed and why have they changed? How have growth rates changed over the decades? What are the emergent trends? Trend analyses afford an excellent opportunity for detailed cross-sectional and cross-temporal review of the sociodemographic conditions within and between metropolitan areas.

In contrast to trend analysis are the area profile analyses, in which all census data for a geographic area are included in a series of printed tables. These area profiles are an extremely popular way of disseminating census data, especially STF1A and STF3A data. Census analysts, as part of the state data center and regional data center programs, use commonly available software packages such as SAS or other data base software to prepare these tabulations. Federal Highway Administration staff, working with MPO staffs, are currently preparing program code to create area profile reports using data from the CTPP Parts A, B, 1, and 2.

An important element of trend analysis is understanding the changes in census content over the decades. Common questions, such as What was the average commute trip duration for residents in your region in 1970? What was the drive-alone share in 1960 and 1970? How many ferry commuters resided in your region in 1980? can only be answered, "The data do not exist because census takers did not ask the same question in earlier censuses." A useful addition to any trend analysis report is a brief summary of census content changes over the analysis period.

Examples of trend analysis reports include publications by the MPOs in Chicago, the San Francisco Bay Area, Philadelphia, San Diego, and Seattle. These reports are the best source for understanding changes in commute patterns and socioeconomic characteristics within regions. In contrast, the *Journey-to-Work Trends* report published by FHWA provides the best information on trend comparisons between regions.

The Chicago Area Transportation Study (CATS) publishes a monthly, two-color, six-page newsletter, *Transportation Facts*, which includes census trend information and other results from its household travel surveys. CATS also recently published a report containing profiles for all Illinois counties on transportation-related data from the STF3A and CTPP/SE (*15*).

The San Francisco Bay Area's Metropolitan Transportation Commission (MTC) has produced a series of working papers describing county, place, and "superdistrict" results based on STF1A (*16*), STF3A (*17*), STF S-5 (*18,19*), the CTPP/SE (*20*), and the CTPP/UE (*21*). Trend analyses include county-to-county commuters from 1960 to 1990; change in total population since 1860; change in households since 1940; and change in household vehicle availability since 1960. In addition, MTC has released an electronic publication (computer file on floppy diskette) that includes place-to-place workers, by detailed means of transportation, comparing 1980 UTPP and 1990 CTPP/SE commuter flows (*22*). To maximize the use and understanding of census data, MTC provides copies of census working papers to Bay Area public and private libraries, as well as to interested members of the public, professionals, and policy makers.

The Delaware Valley Regional Planning Commission (DVRPC) in the Philadelphia region has published a report documenting county-to-county commuter flows by means of transportation, comparing the 1970, 1980, and 1990 journey to work (*23*). The report includes useful "desire line" maps showing changes in commuting patterns—within the Pennsylvania suburbs, within the New Jersey suburbs, commuting to Philadelphia, reverse commuting from Philadelphia, and interregional commuting.

The San Diego Association of Governments (SANDAG) produces a multicolor bimonthly newsletter, *SANDAG INFO*, which contains graphics as well as tabular results.

The Puget Sound Regional Council (PSRC) in the Seattle region publishes a monthly data newsletter entitled *Puget Sound Trends*. PSRC, as the regional data center for the Seattle region, also provides area profile reports in hard copy and computer format and maps showing census tracts, census blocks, and ZIP codes.

The aforementioned reports and products are just a sample of the ways in which census data are processed and disseminated by MPOs in the United States. These tabular and graphic reports are excellent ways of providing information to the clients and partners of the MPO.

Travel Demand Model Estimation, Calibration, and Validation

One of the most common uses of census journey-to-work data is in travel demand forecasting. The census not only provides base-year benchmark sociodemographic information for use as input into standard travel demand model simulations, but also the journey-to-work commuter

flow matrices can be adapted by the transportation planner into an observed work trip table for aggregate validation of work trip distribution and mode choice models.

The following working definitions are provided for the terms estimation, calibration, and validation. Also discussed are the terms aggregate and disaggregate. These are offered as working definitions rather than as accepted fact because of their various and conflicting usage in the profession. *Estimation* is the process of determining model coefficients and constants using statistical software packages. Logit models, cross-classification models, and regression models are *estimated*. *Calibration* is the process of adjusting model coefficients and constants using manual (or mechanical) procedures. The friction factors and k-factors in gravity models are calibrated. The modal constants in regression and logit models are also calibrated (adjusted) to match observed choices. Often the terms calibration and estimation are used interchangeably, generally leading to confusion in communication between transportation planning professionals. *Validation* refers to the process of comparing model-simulated choices with observed choices. Validation is typically a stage in the model development process, whereas calibration is the actual activity to achieve a validated model. "Observed" choice data bases are independent estimates of sociodemographic or travel behavior characteristics. Observed data bases include, for example, census data, traffic counts, transit on-board surveys, and household travel surveys.

Aggregate refers to survey or census records tabulated or analyzed at any level greater than the original level of data collection (e.g., 1990 census block-level data are aggregate data as well as place- or county-level data). Most 1990 census products, including the STF1A, STF3A, and the CTPP/SE and CTPP/UE, are aggregate data. *Disaggregate* refers to survey or census records maintained at the original level of data collection (e.g., the household level or the person level). Household travel surveys collected and maintained by MPOs and state departments of transportation are disaggregate data sets. The census PUMS is a disaggregate data set of individual census household and person records, even though the geographic identification is suppressed at the fine level of geography (less than 100,000 population groupings).

This last point about the CTPP/UE being an aggregate data set and the PUMS being a disaggregate data set may be confusing, given the very small geographic areas associated with the CTPP/UE in contrast to the very large geographic areas associated with the PUMS. This is a critical distinction, given that disaggregate choice models cannot be estimated using the CTPP/UE since the analyst does not have information on each household's or worker's characteristics and choices. Disaggregate choice models can, on the other hand, be estimated from PUMS data given that the analyst does have full information on each household's and worker's characteristics and choices (though not any detailed geographic characteristics).

Can models be estimated using the CTPP/UE data sets? Yes, aggregate gravity models can be calibrated using zone-to-zone observed trip tables. Yes, aggregate mode choice models ("diversion curve" models) can be calibrated using the same observed trip tables. *Should* travel demand models be estimated using the CTPP/UE data sets? Aggregate models should be avoided when the analyst can develop disaggregate models instead. (The reader should refer to transportation planning textbooks for the arguments in favor of and against disaggregate and aggregate demand models.) On the other hand, since all gravity models are aggregate models, it is appropriate to use the CTPP/UE as a fallback data set to calibrate an aggregate, home-based work person trip distribution model.

Demographic and automobile ownership models, other than land use models, can be estimated or validated, or both, using census data. Examples of demographic models include the following:

- Household income distribution models,
- Distribution of households by number of workers in household model,
- Distribution of households by number of persons in household model, and
- Distribution of households by number of vehicles available model.

Pearson (*24*) describes the estimation of aggregate households by household size and households by vehicle available models using the 1980 UTPP. Purvis (*25*) discusses the estimation of

disaggregate households by workers in household and households by vehicles available models using the 1990 census PUMS. These two papers demonstrate the viability of using census data in estimating disaggregate and aggregate demographic and automobile ownership models for use in regional travel demand forecasting systems.

Part 1 of the CTPP/UE contains numerous zone-of-residence cross-tabulations that will be invaluable for aggregate validation of demographic and automobile ownership models. For example, Table 1-13 includes a cross-tabulation of workers in households (six categories) by persons in households (five categories) by zone or tract of residence (*26*). If the transportation planner carries a household size segmentation through his or her travel model set, Table 1-13 provides excellent observed data on workers in households by household size for validation at a zone, superzone, district, superdistrict, county, and regional scale. (In fact, the CTPP/UE is the only source of small-area census data that includes the distribution of households by workers in households. The STF3A file only has total employed residents by small area of residence, not differentiating between workers-in-households versus workers-in-group quarters units.) A commonly used market segmentation in travel demand model systems is households by household size and vehicles available. Table 1-17 is the only small-area census source for data on distribution of households by household size by vehicles available. The analyst may use this table for the estimation of aggregate models for splitting households by household size and/or vehicle availability level, or the analyst may use this cross-tabulation for the aggregate validation of these demographic models.

Trip generation models cannot be estimated using census data because of the total lack of information on trip frequency per household or per worker. On the other hand, the census workers-at-work data can be adjusted and factored to create observed home-based work person trip tables by means of transportation. Work trip generation and trip distribution models can then be calibrated to match, or closely approximate, the observed work trip travel patterns.

The 1980 and 1990 censuses asked persons in the long form "At what location did this person work [most of] last week?" and "How did this person usually get to work last week?" If the person was an employed resident but was absent from work the last week of March 1980 or March 1990 because of sickness, vacation, labor dispute, and so forth, that worker would not have provided information on the usual means of commuting or usual place of work. This is referred to as weekly absenteeism. Any information on "within week" variation in commute behavior, such as daily absenteeism or commuting 1 day per week by transit or carpooling, or commuting from home to work in one mode (say, casual carpool) and commuting from work to home in another mode (say, public transit), would not be accounted for in census journey-to-work data. No census information is available on moonlighting—increasing the number of jobs held by an employed resident.

The census is not an origin-destination survey. The census does not ask "From whose home did this person usually leave for work LAST WEEK?" This is the traveling salesman phenomenon, in which the person could be away from his or her real home on business and view a hotel or motel as a "home" during the census period. This is a cause for amusing and illogical commuter flows (e.g., persons reporting walk commutes from San Francisco to Los Angeles or subway commuters living in Honolulu and working in New York City). Typically a metropolitan area will have a small fraction of workers making absurdly distant commutes. The recommendation is to laugh them off and put them aside—there will always be unusual outliers in census (and survey) data sets that cannot be treated seriously in transportation planning analysis.

Metropolitan transportation planners have developed several techniques for factoring journey-to-work commuter matrices into observed home-based work trips. Mann describes procedures used for the Washington, D.C., metropolitan area to convert the 1980 UTPP commuter matrices to observed work trip tables (*27*). These procedures were implemented in the Puget Sound region as described by Deardorf and Schneider (*28*). Kollo and Purvis describe the use of the San Francisco Bay Area 1981 household travel survey in computing work trip rates per commuter to convert journey-to-work matrices to observed home-based work trips (*29,30*). Walker discusses the Philadelphia region procedures for conversion of 1980 UTPP

commuter matrices (*31*). The 1980 UTPP adjustment procedures for the Washington, D.C., Seattle, San Francisco, and Philadelphia regions are based on a traditional definition of home-based work person trips that includes mechanized modes (drive alone, carpool, transit passenger) but excludes nonmechanized modes (walk, bicycle, other). The resulting home-based work trip rates range from 1.57 person trips per commuter in the Bay Area to 1.78 person trips per commuter in Philadelphia and range from factors of 1.54 to convert drive-alone commuters and 2.15 to convert carpool commuters into observed home-based work carpool trips for the Washington metropolitan area.

Probably the most legitimate technique for converting the 1990 CTPP/UE commuter matrices into observed home-based work trips is using work-trips-per-worker trip rates collected as part of regional household travel surveys. Several metropolitan areas in the United States conducted household travel surveys between 1989 and 1991, including Los Angeles, San Francisco, Sacramento, Chicago, Boston, Minneapolis, Atlanta, and San Antonio. Perhaps even data from the Nationwide Personal Transportation Survey could be used for estimating work-trip frequency per worker trip rates for metropolitan areas without current travel survey information.

Multiday household travel surveys would be an ideal source of information for adjusting and factoring census journey-to-work commuter flows. The Bay Area MTC, for example, collected multiple weekday travel diaries from nearly 1,500 households in spring and fall 1990. This type of data set could be used for analyzing daily versus weekly absenteeism patterns, work trip mode switching during the week, and the different travel modes used in the trips from home to work as well as from work to home.

The calibration and aggregate validation of home-based work-trip attraction models may be more problematic given potential differences in independent estimates of total employment compared with the CTPP/UE workers at zone-of-work. The CTPP workers at zone-of-work, derived from Parts 2 and 3, excludes the weekly absentees and moonlighting. Weekly absenteeism (only by area-of-residence) can be estimated from the STF3A or the CTPP/UE Part 1 tables. Moonlighting rates can be estimated from local sources, such as household travel surveys, or from national sources, such as the Current Population Survey conducted by the Bureau of Labor Statistics and the Bureau of the Census.

Other errors in the census workers-at-work data will include standard sampling error, geocoding errors, allocation errors, and the use of "default" or "workers-at-large" zones for communities or counties with incomplete address coverage in the census TIGER files. Ideally, the default or workers-at-large zone should be no more than 1 to 2 percent of the region's commuters.

The CTPP/UE data are not equivalent to total employment. Ideally, the CTPP/UE workers at work should be 90 to 95 percent of the regional agency's independent estimates of total employment (i.e., total jobs in the region). The recent study by DVRPC (*23*) used a 2.2 percent weekly absenteeism rate (derived from the 1990 census) and the national multiple jobholding rate of 6.2 percent of employed residents holding multiple jobs (derived from the Current Population Survey). DVRPC used the national moonlighting rates by industry sector, ranging from 4.7 percent for construction workers to 9.3 percent for those working in governments. (DVRPC also used other factors to bring the CTPP more in line with independent estimates derived from Dun and Bradstreet and municipal tax records.)

Trip distribution models can be calibrated using the adjusted and factored observed home-based work person trip tables and network levels-of-service files. This means calibrating the standard friction factors used in aggregate gravity models using either highway travel times or some combined impedance data. Socioeconomic adjustment factors, or *k*-factors in transportation planning jargon, could also be used to adjust county-to-county or district-to-district model-simulated home-based work person trip flows to match or approximate the observed trip patterns. The Seattle (*28*) and Philadelphia (*31*) reports provide more in-depth coverage on the use of the 1980 UTPP in work-trip distribution model calibration.

Work-trip mode choice models cannot be estimated from census data. On the other hand, existing work-trip mode choice models (estimated from disaggregate household travel survey data) can be calibrated and validated to match or approximate CTPP-derived observed home-

based work trips by means of transportation. The modal constants in the model utility functions can be adjusted (calibrated) upward or downward to change the base-year model simulation. These modal constants are typically calibrated on a county-to-county or district-to-district basis.

Travel assignment models can use census journey-to-work travel time data as an element of the traffic assignment process. Walker describes the use of travel time data from the 1980 UTPP in analyzing New Jersey counties in the DVRPC region (*32*). Walker's research is germane in the light of current federal regulations on the Clean Air Act Amendments that relate to the use of "actual" or "observed" data in calibrating travel models for use in developing mobile source emissions budgets. The census journey-to-work data set can be an excellent source of data for the calibration and adjustment of speeds and travel times from traffic assignments.

To summarize this section, metropolitan transportation planners have demonstrated the utility of census data in the estimation, calibration, and validation of regional travel demand model systems. One essential use of census data is for benchmark, base-year socioeconomic small-area data used as input into travel model simulations. Analysts have used census data in statistically estimating and validating demographic and automobile ownership models, work-trip generation and work-trip attraction models, work-trip distribution models, and work-trip mode choice models and for validating the highway speed simulations in traffic assignments.

The 1990 census journey-to-work data included in the CTPP are *not* a substitute for a comprehensive household travel survey. Whereas the census contains invaluable socio-demographic data that are necessary for travel demand model systems, it does not have any information on work or nonwork trip frequency, on nonwork trip distribution, or on nonwork mode choice patterns. Transportation planners must not approach the CTPP data as the sole source of data to develop and maintain adequate travel demand models. This may sound obvious to the majority of metropolitan transportation planners in the United States, but sometimes the obvious needs to be said. The CTPP is a useful, independent, secondary data set to augment the disaggregate household data sets that a successful MPO needs to collect for the development of state-of-the-art or state-of-the-practice travel demand model systems.

Land Use Allocation Model Estimation, Calibration, and Validation

Land use allocation models are used in MPOs in the United States and elsewhere for distributing regional forecasts of employment and workers to districts (zones) within the metropolitan area. Examples of these models are the DRAM/EMPAL system of models used in several metropolitan areas in the United States; the POLIS model used in the San Francisco Bay Area; and the MEPLAN model system applied in various Canadian, European, and African metropolitan environments (*33,34*). The written record on the use of U.S. census journey-to-work data for calibrating and validating urban location models is weak, though efforts are afoot to incorporate 1990 CTPP/UE commuter flow data as they become available.

Twenty years after Lee's Requiem for Large-Scale Models appeared in the *Journal of the American Institute of Planners*, the American urban model-building scene was somewhat reinvigorated by a federal clean air act lawsuit in San Francisco and new federal air quality conformity regulations that "encourage" the use of formal land use allocation models in regions with serious, severe, or extreme air quality nonattainment status, though these models are "not specifically required" (*35*). MPOs are actively reassessing their land use model systems to meet the requirements of the 1990 federal Clean Air Act Amendments and the Intermodal Surface Transportation Efficiency Act of 1991.

Future work on building and applying urban location models is challenged by the increasing share of multiworker households and their household location patterns, the increasing share of "footloose" industries and their commercial and industrial location patterns, the increasing share of workers working at home and the whole issue of telecommuting, the confounding issues of local zoning controls and NIMBYism (not in my backyard) in determining the location of housing and jobs, and the increasing importance of community attributes (housing

prices, crime, schools, shopping) in determining a household's location choices. Given these challenges, can we accurately simulate the metropolitan system? The CTPP data can function as a validation data set for urban location models, but they cannot substitute for a theoretically complete, consistent, and practical system of urban location models.

Census Data and Estimation of Small-Area Employment Data

As previously stated, the CTPP workers-at-work data are not equivalent to total employment or jobs. The CTPP workers-at-work universe excludes workers absent from work during the census reference week and does not account for second, or moonlighting, jobs held by employed persons. However, after taking these two characteristics into account, the CTPP can be a fairly good data source for small-area employment data.

Many MPOs use employment record data from state employment security departments or employment development departments. These are employment security files that states must submit to the federal Department of Labor and include data on employment and unemployment statistics. There are problems, however, with state employment security files. They are often difficult to acquire and require careful negotiations with state agencies that may not be too cooperative in sharing this information, and they only include covered wage and salary jobs, typically excluding family- and self-employed workers.

Other MPOs may conduct employer censuses as part of trip reduction programs or ridesharing data bases. These programs will probably exclude small employers of less than, say, 50 or 100 employees.

The best situation is to have two independent sources of employment: the CTPP adjusted for weekly absenteeism and moonlighting and employment security records adjusted for family- and self-employed workers. Unfortunately, the numbers may be pitted against each other, with in some cases the CTPP having the "right" number of jobs and in other cases the employment records having the "right" number of jobs—or neither estimate is correct! The job of the employment data analyst is to creatively adjust and reconcile the two competing estimates of small-area employment.

Census Data and Household Travel Surveys

Small-area census data are critical for use in the weighting and expansion of household travel surveys. Weighting and expansion of survey data are needed to adjust for nonresponse biases and geographic biases that occur as part of any household travel surveying effort. For surveys conducted in the 1989 to 1991 time period, 1990 census data can be used directly in weighting and expanding household surveys. For surveys conducted mid-decade, the analyst must carefully adjust the census to account for changes in the number of households and household composition. The analyst may even choose to reweight household surveys conducted in the mid-1980s by interpolating between 1980 and 1990 census data values.

Survey analysts for the 1990 San Francisco Bay Area and the 1991 Los Angeles household travel surveys used similar, complex weighting schemes. The Bay Area analysts used the 1990 census STF3A data to weight the survey by superdistrict of residence (34) by household size (1, 2, 3, 4, 5 or more) by vehicle availability (0, 1, 2, 3 or more) by tenure (owner, renter) (*36*). The Los Angeles analysts also used the 1990 census STF3A data, expanding the survey by regional statistical area (49) by household size (1, 2, 3, 4, 5 or more) by vehicle availability (0, 1, 2 or more) by structure type (single family, multifamily) (*37*). Further validation of the sample expansion scheme is done by comparing the expanded survey with other census variables such as workers per household, tenure, structure type, sex, age, ethnicity, and so forth. A Chicago study also used 1990 census data in weighting and expanding regional household travel surveys with an increased emphasis on correct expansion for low-response neighborhoods within larger weighting districts (*38*).

Transit Market Analysis

The use of census data in transit market analysis is discussed in the resource paper by Cervero. The role of the MPO is to provide the CTPP to the transit operator partners within a region; host training sessions on use of census data, particularly the CTPP, in transit service analysis; and generally help the transit operator meet analysis requirements. Of special note are the Title VI Federal Transit Administration requirements related to low-income, automobile-free, and minority populations within the transit operator service area.

Miscellaneous Transportation Planning Applications

Miscellaneous transportation planning applications of the census, including the 1980 UTPP and the 1990 CTPP (excluding transit planning and travel demand forecasting use), are as follows:

- Use of census data for background and "settings" chapters in long-range regional transportation plans,
- Use of journey-to-work commuter flow data in analyzing regional ridesharing programs,
- Use of commuter flow data in apportioning toll bridge revenues according to residential location of bridge commuters, and
- Use of mobility limitation (disability) data in apportioning discretionary state dollars for paratransit programs.

Other transportation applications will crop up as the data are disseminated to potential data users and applied in ways we cannot imagine.

Nontransportation Planning Applications of Journey-to-Work Data

This section discusses the nontransportation planning applications of the 1980 UTPP and the 1990 CTPP data. Other innovative and clever applications of these data will appear as potential users and clients are made aware of the availability and content of the 1990 CTPP.

Hammel (*39*) provides a good introduction to the nontransportation planning applications of the 1980 UTPP.

Census journey-to-work data provide detailed information on commuter flows and daytime population, which can be critical in disaster-preparedness and disaster-response planning. Census journey-to-work data were useful in disaster-response planning efforts after the October 17, 1989, Loma Prieta Earthquake in Northern California and the January 17, 1994, Northridge Earthquake in Southern California. The reader should refer to Fulton (*40*) for a description of estimating daytime population using data from the census journey to work.

City planning applications of the CTPP are numerous, including using the CTPP data in support of revision of general plan circulation, bicycle, housing, land use, seismic safety, and public safety elements; in understanding labor force characteristics of city resident workers; in understanding the characteristics of workers working within the community; and in local employment development programs. The information may be of interest to local policy makers who want to know who is commuting to their cities and where those commuters live, who commutes through the city, and where city residents work.

The journey-to-work data can be used by residential real estate developers to understand the commuteshed for residents of particular neighborhoods or communities. By knowing the current commuteshed of an area, a developer can market a product to workers working within that commuteshed. For example, a developer may use the information to determine the newspaper in which to advertise.

The journey-to-work data can be used by commercial real estate market analysts to determine optimal sites for locating or relocating a firm, on the basis of minimizing employees'

commute times or the characteristics of the labor force currently working within, say, 30 min of a particular site. Another example is U.S. military base planners who use journey-to-work data to understand commutesheds around existing or proposed military bases and the STF3A data on housing prices within that commuteshed to determine site suitability.

The journey-to-work data can be used by radio stations to ascertain how many commuters are in private vehicles during any hour of the day.

The journey-to-work data can be used in Federal Transit Administration-sponsored reverse commuting demonstration programs to understand the current magnitude of inner-city resident workers commuting to jobs in the suburbs. The American Public Transit Association (APTA) has been actively involved in reverse commuting demonstration programs, publishing a report entitled *Access to Opportunity* (*41*) and sponsoring a session on this topic at the October 1993 APTA annual meeting in New Orleans. The Urban Institute in Washington, D.C., and other organizations have also been involved in reverse commuting demonstration programs in the country, including Philadelphia, Baltimore, Milwaukee, Chicago, St. Louis, and Nashville (*42–44*).

CONCLUSIONS

This paper discussed the staged release of 1990 census data and the use of census data in large MPOs in the United States. The various transportation and nontransportation uses and applications were discussed. One conclusion is that the decennial census is a major source of primary, small-area sociodemographic information that is critical for metropolitan transportation planning activities.

The census cannot provide the necessary disaggregate travel behavior information needed by metropolitan transportation planners. The census is not a substitute for a well-conducted household travel survey, but the census does provide critical data needed to adjust household travel surveys and independent estimates of small-area employment. Census journey-to-work data are appropriate for use as an independent, secondary data source for the calibration and validation of regional work-trip generation, distribution, and mode choice models.

Where do we want to be in 10 years, at the next conference on decennial census data and transportation planning? Can we anticipate the inevitable changes in technology and society, and can we anticipate our data needs in 2004? Will the oil wells run dry and will we all be commuting over a virtual reality network? Will there be new "means of transportation" that should be included in the 2000 census? Will we have traffic and travel behavior monitoring systems in place that will render the census obsolete? It may be too obvious that we cannot answer these questions in 3 days, let alone the next 3 years, but a conscious attempt by metropolitan transportation planners is needed to anticipate the travel demands of society after 2000. How can the 2000 decennial census be improved to anticipate these demands?

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