International Experience in Journey-to-Work Data from National Censuses

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Outline

- Changing U.S. census
  - American Community Survey (ACS)
  - Impact on CTPP
- Review of international experience (focus on journey-to-work data)
  - Australia and New Zealand
  - Canada
  - France
  - Germany
  - The Netherlands
  - The United Kingdom
- Findings and conclusions
U.S. Census 2000: Overview

- 22nd Census in U.S. decennial census history conducted on April 1, 2000
- Counted 281 million people and 115.9 million households
- Tabulated data prepared for 9 million census blocks
- Questionnaire format
  - Short form: Household and member demographic characteristics
  - Long form: Detailed socio-economic and journey-to-work characteristics
- 1/6th of households receive long form
Changing U.S. Census

- Issues with traditional decennial census format
  - Rapidly changing community characteristics – long form data obsolete within few years
  - Large expense every 10 years
- Goals for future U.S. census (2010 and beyond)
  - Provide timely and relevant data cost-effectively
  - Improve coverage
- Solution: Continuous Measurement Approach
American Community Survey (ACS)

- Continuous survey approach
  - Annual and multi-year estimates of population characteristics
  - Small area characteristics updated every year
- Annual national sample of about 3 million addresses (250,000 addresses per month)
  - Approx equivalent to 2.5% sampling rate per year
- Full implementation initiated in 2005
  - Annual estimates for communities of 65,000 or more
  - 3 year cumulations for communities of 20,000-65,000
  - 5 year cumulations for communities of <20,000
Features of ACS

- Differences with traditional decennial census (TDC)
  - Five year sample fraction: ~12.5% ACS to ~17% TDC
  - TDC estimates based on ~18 million housing units; ACS 5-year estimates based on ~11 million housing units
  - ACS samples every year and spreads sample over 12 mo
  - ACS subsamples for personal visit follow-up
- ACS estimates have higher sampling error
- Preliminary indications: ACS estimates have lower potential non-sampling error (non-response)
Census Transportation Planning Package

- Three sets of standard tabulations make up CTPP
  - Part 1: Residence based tabulations
  - Part 2: Work-place based tabulations
  - Part 3: Residence – Work (journey-to-work) flows

- Used extensively in transportation planning
  - Develop zonal socio-economic and demographic data
  - Analyze socio-economic and demographic characteristics
  - Validate travel demand models using flow tables

- Census 2000 CTPP subjected to disclosure avoidance procedures and rules
  - Rounding and Thresholds
Disclosure Avoidance Rules for CTPP 2000

- **Part 1: Residence based tables**
  - All tables rounded
    - Zero = 0; 1 through 7 = 4; 8 and above = nearest multiple of 5

- **Part 2: Work-place based tables**
  - All tables rounded (same rules)

- **Part 3: Worker flows**
  - All tables rounded (same rules)
  - Some tables with thresholds
    - Any cell with 3 or less records (flows) is suppressed

- Christopher and Srinivasan (2005) discuss adverse implications of these procedures on CTPP
Disclosure Avoidance for PUMS Data

- PUMS data is most disaggregate data from census
  - Individual records: 5% state files and 1% national file
  - Detailed individual records useful for constructing joint distributions needed for synthetic population generation
  - Increasing importance in context of activity-based microsimulation models

- Disclosure avoidance methods:
  - Data swapping: edit data or exchange records
  - Top-coding: Grouping cases above a certain value
  - Geographic population thresholds
  - Age perturbation in large households
  - Collapsing categories that do not meet a threshold
Issues and Challenges

- ACS format has important implications for CTPP
  - Smaller sampling rates and larger sampling error
  - Geographic resolution for reporting data
  - Work place geocoding errors and allocation inaccuracies
  - Implications of rounding and thresholds – many worker flows suppressed

- What are other countries doing and what is their experience in resolving these issues?
  - Identify methods, techniques, lessons, etc.
## Geographic Resolution

<table>
<thead>
<tr>
<th>U.S.</th>
<th>U.K.</th>
<th>Canada</th>
<th>Australia/New Zealand</th>
<th>France</th>
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<tbody>
<tr>
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<td>County</td>
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<td>Statistical Div</td>
<td>Metropolitan Area</td>
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<td>Census Sub Div</td>
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<td>District</td>
<td>Cen.Agglomeration</td>
<td>Statistical Sub Div</td>
<td>Urban Unit</td>
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<tr>
<td>Block-Group</td>
<td>Ward</td>
<td>Dissemination Area</td>
<td>Stat. Local Area</td>
<td>Municipality/Commune</td>
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<td>Output Area</td>
<td>Block</td>
<td>Cen Collection Dist</td>
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<tr>
<td>Block</td>
<td>Post Code</td>
<td>Block-face</td>
<td>Mesh Blocks</td>
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</tbody>
</table>
Australia: General Information

- New Zealand very similar to Australia
- Australian Bureau of Statistics (ABS) conducts census once every five years (2001-2006)
- Journey-to-work data used extensively by state transport authorities
- Respondents provide work place address; two-stage geocoding process
  - Based on respondent record
  - Based on facility/business name index
  - Geocoded to DZN (workplace destination zone)
  - Elaborate work place geocoding procedure
Australia: Reporting Geography

- Until 2001, SLA (Statistical Local Area) was smallest geography at which data was reported
  - SLA is aggregation of DZN
- In 2006, census data reported for new smaller geography called Mesh Block (20-50 households)
  - More homogeneous geographic units
- Developed G-NAF (Geocoded National Address File) in 2004 and updated quarterly
  - Primary source of geocoding in 2006 and beyond
  - Extremely accurate – multi-agency collaborative effort
Confidentiality of tabular data maintained

Assessing size of table
- Compare number of cells to total population in table; if difference is small, table is suppressed

Introducing random error
- Randomly adjust cell values with small values; detailed methodology not released
- Tables are internally consistent
- Value of tables as a whole not impaired
- Allows releasing tables with small cell values
Canada: General Information

- Statistics Canada conducts census once every five years (2001-2006)
- Questionnaire format:
  - Short form: 80% of households
  - Long form: 20% of households
- Long form includes all short form questions plus 52 additional questions
- JTW questions asked for all persons 15 years or older who worked any time since Jan 1, 2000
Canada: JTW Data Details

- Information collected
  - Work status, employer address, nearest landmark/street intersection (if address unknown), mode to work

- Typical two-step work place geocoding procedure
  - Automated system (computerized)
  - Computer-assisted clerical coding
  - Uses National Geographic Base as reference file

- Systematic 3-step imputation technique for missing JTW data
  - Canadian Census Edit and Imputation System (CANCEIS) to impute JTW variables
  - Additional modules to impute work place location
Canada: Disclosure Procedures

- Confidentiality of tabular data maintained
- Data suppression based on population living or working in an area
  - Standard areas: Threshold = 40 (weighted)
  - User-defined areas: Threshold = 100 (weighted)
  - All areas: Threshold = 250 (weighted) if income included
  - Rounding to the nearest 5 except for counts below 10 (rounded to zero or 10)
- No formal CTPP, but similar tabulations produced for provinces and municipal governments
France: General Information

- French Rolling Census closely parallels ACS concept
  - Last traditional census in 1999
- Goals of French Rolling Census
  - To spread burden over a longer period
  - Meet demand for more timely and fresh data
  - Improve data quality by exploiting technical advances
- Budget allocation: 1/7th of traditional census budget each year
  - Implies a 1/7th sampling rate each year (~14%)
France: Sampling Strategy

- Key geographic unit is “commune” (37,000 total communes)
  - Large and small communes defined by population of 10,000
  - Total population equally split between large and small communes
  - Small communes visited once every 5 years (sampled at rate of 20 percent)
  - Large communes visited every year (sampled at rate of 8%)
- Total sampling rate = 20% x 50% + 8% x 50% = 14%
France: Sampling Strategy

- Small commune: Five rotating groups
  - Rotating samples of communes over a 5 year period
  - \(~ 30 \text{ million inh} \times \frac{1}{5} \times 100\% = 6 \text{ Million per year}\)

- Large commune: Five rotating groups
  - Based on a building register
  - 40% households drawn from each group every year
  - 8% drawn/yr → 40% of all households in 5 years
  - \(~ 30 \text{ million inh} \times \frac{1}{5} \times 40\% = 2.4 \text{ Million per year}\)

- Total: 8.4 M per year or 60 M in 7 years
Data collection methodology

- Collect information over a five year period cycle
- Produce every year statistically reliable/significant data for the medium year

Let current year = Y

- Produce statistically reliable data for year “Y-2” using data from years “Y-4”, “Y-3”, “Y-2”, “Y-1”, and “Y”

No special information about journey-to-work or work place based data

Smallest geographical resolution of published data not clear
France: Rolling Census

- **Merits**
  - Timely data that is maximum of 3 years old
  - More detailed data at same expenditure
  - Improved quality of data even in large communes
  - Updated sampling base of households

- **Issues**
  - Quality of building register
  - Precision of estimates for small geography(?)
Germany: General Information

- Last traditional census in 1987
- New German census is combination of administrative registers and survey data
  - Population registers
  - Employee registers
  - Housing census (postal survey)
  - Sample survey
- Test surveys conducted to test effectiveness of new system
  - Check accuracy of population register
  - Check for duplicate entries in population register
Germany: JTW Data and Disclosure

- Some journey-to-work questions included in census:
  - Name and address of work and school location
  - Means of transport to work or school
  - Travel time to work or school

- Disclosure protection
  - All personal and identifiable information deleted
  - Data published/released only for “parts of municipalities”
  - Some individual data (excluding names and addresses) may be transmitted to municipal governments only
Germany: New Microcensus

- Microcensus after 1987 conducted every year on 1% of all households in Germany
  - 370,000 households (820,000 persons)
- All households have same probability of selection
- One-stage stratified area sampling scheme
  - Sampled areas are sampling districts
  - Every year, 1/4th of households are rotated off; every household stays in sample for four years
- Several programs
  - Annual Program: Person and household characteristics
  - Annual Supplement: Employment and training
  - Four-year Additional Program: Commuting, housing, health
The Netherlands: General Information

- Dutch census in 2001 is integration of microdata from registers and surveys
- Registers
  - Population register
  - Job files
  - Fiscal administration
  - Social security administration
- Surveys
  - Employment and earnings survey
  - Labor force survey
- Innovative data linkage and integration strategies
The Netherlands: JTW Data

- Household members asked to report trips for one day
- Origin and destination address information collected
- Workplace address information extracted from trip survey records
- Missing trips imputed; follow-up with respondents where possible
The Netherlands: Confidentiality

- Published tables subjected to confidentiality protection rules
  - Table cells with less than 10 persons always suppressed
  - Table cells with 25 or more persons always published
  - Table cells with 10-24 persons published only if they form part of a cross-classification (e.g., age by sex) in which no cells contain less than 10 entries
  - Also, 50% of cells in cross-classification should have 25 or more persons
  - Threshold of 25 persons corresponds to an estimated relative inaccuracy of at most 20 percent
U.K.: General Information

- U.K. Office of National Statistics conducts decennial census in U.K. and Wales
  - Other agencies for other parts of U.K.
- Last census in 2001
  - Single census form delivered to all households
- Journey-to-work questions asked of all persons aged 16-74 years
- Census JTW questions:
  - Home address one year ago
  - Commuting destination
  - Means of travel to work or study
U.K.: JTW Data Tables

- Work place data in Census 2001
  - Standard tables and theme tables published down to the “Ward” level contain a range of JTW data tables
  - Census Area Statistics tables based on daytime work place population; less information but finer level of geography
  - Census Area Statistics published for output area (~125 households)
  - Special Workplace Statistics (SWS) tables include employment and JTW information down to “Ward” level

- Workplace data capture and coding involved multi-step process to assign work locations to post codes
- Samples of Anonymized Records: 3% of persons and 1% of households
U.K.: Imputation Procedure

- Elaborate imputation procedures applied to three data sets
  - Migrant origin, workplace and study address
- Methodology based on donor imputation of postcodes
- Identify the optimum combination of variables on which a potential donor matches an intended recipient
- Technique maximizes the accuracy of the imputation
- Preserves joint and marginal distribution of the data
U.K.: Disclosure Control

- Small cell adjustment
  - Small counts randomly adjusted
  - Totals and subtotals calculated based on adjusted data
  - Tables independently adjusted; counts of same population in two different tables may not be same
  - Tables of higher geographic levels not necessarily sum of tables of lower geographic levels

- Record swapping

- Thresholds
  - Standard tables: At least 1000 residents and 400 households
  - Census Area Statistics tables: At least 100 residents and 40 households
  - Summary Profiles: At least 50 residents and 20 households

- Design of Table
  - Average cell count in a table greater than or equal to one
U.K.: O-D Flow Data Disclosure

- O-D table cells with small counts adjusted using disclosure control techniques

- Count Adjustments
  - Cells with small values adjusted independently upwards or downwards based on prescribed probabilities
  - Does not introduce systematic biases into the count
  - More cells adjusted, larger variation from the true values
  - Other sources of variation: coverage error, respondent error, processing error, record swapping

- Rounding
  - Small cell values rounded to multiples of 3

- Suppression of data on industry at the ward level and below
  - Problem in using data for trip attraction analysis
Conclusions

- Moving away from traditional decennial Census format
- Common goals for this transition
  - Cost
  - Timeliness and quality of census data
- Methodological difference in new Censuses
  - Administrative registers + survey-based
  - Continuous measurement or rolling census approach
  - Mid-decade census
- Common Issues
  - Data dissemination, accuracy, and disclosure control
Conclusions

- **Workplace geocoding**
  - Accuracy of workplace geocoding of major concern
  - Australia uses separate zonal structures for residence and workplace – capture most O-D flows
  - At least a two-stage process: automated followed by more manual geocoding procedures
  - Development of nationwide geocoding reference address file
    - TIGER (U.S.)
    - G-NAF (Australia)
    - National Geographic Base (Canada)
Conclusions

- Disclosure avoidance techniques
  - Rounding small cell values to multiples of 3 (U.K., Australia, and New Zealand)
  - Data swapping commonly applied to microrecords in U.S. and U.K.
  - Use of thresholds applied to both tabular data and release of data for small geographical units
  - Random data perturbation applied in U.K. and Australia; allows release of tables with small cell values

- Accuracy
  - France also using five year cumulations for small geographies, but with larger sampling rates