COMMODITY FLOW SURVEY: IMPROVING METHODS TO ENHANCE DATA QUALITY AND USEFULNESS

Introduction and Background

This resource paper provides a foundation for a workshop discussion on potential survey methods improvements for the 2007 Commodity Flow Survey (CFS). It presents background information on the CFS, such as survey objectives, data users and uses, and 2002 CFS survey methods. The paper offers brief discussions on methods issues and challenges and presents survey design considerations that would enhance data quality and usefulness.

CFS Survey Goals

The CFS provides information on the flow of goods in the United States, specifically data on shipments originating from manufacturing, mining, wholesale, auxiliary warehouses, and selected retail establishments in the 50 states and the District of Columbia. While it is an establishment survey, the survey’s focus is on the characteristics of shipments -- neither on establishments nor on more detailed carrier information. The survey’s goals are to estimate the characteristics associated with the ultimate origin and destination of shipments, the distances traveled by shipments of goods, the commodities shipped, the modes of transportation used to transport shipments, and the volume of shipments measured by weight and value. To collect data to meet the survey goals, a three-stage sample design is used (i.e., establishments, reporting weeks, shipments) stratified by geography, industry, and size of establishment. During post-processing, CFS data are aggregated at the level of states and Bureau of Economic Analysis regions. While such aggregation is necessary so that the data meet certain statistical reliability and respondent confidentiality criteria, it limits the usability of the data for analyzing intrastate commodity and vehicle flows, as well as analyzing flows between metropolitan areas.

Users and Uses of CFS Data

CFS data have a range of users and of uses. According to a 2003 Letter Report on the Commodity Flow Survey of the Committee to Review the BTS Survey Programs¹, data from the CFS are used by various government agencies for policy and program purposes; by academic researchers; and by consulting companies, whose clients can range from businesses, state departments of transportation (DOTs), federal agencies, and associations (Transportation Research Board, 2003). Uses of the data include: analyzing trends in goods movement over time, conducting economic analyses, forecasting future demand for good movement and associated infrastructure and equipment needs, establishing benchmarks for estimating national accounts, and analyzing and mapping spatial patterns of commodity and vehicle flow. Primarily, CFS data are used at the national or state levels, where it is most reliable. In recent years there has been increased interest in CFS data from state DOTs and metropolitan planning organizations (MPOs) that reflect their growing interests in freight issues. The aggregated data, however, are of less utility for these sets of users, who require data at finer levels of geographic detail than is currently provided.

¹ This committee was convened by the Transportation Research Board and the Committee on National Statistics in response to a request from BTS.
CFS History

Data on the flow of goods in the United States have been collected since the 1960s. The predecessor to the CFS, the Commodity Transportation Survey (CTS) was conducted by the Census Bureau between 1963 and 1983. These surveys produced measures on the flows of goods and materials according to mode of transportation. The early implementations covered only shipments of more than 25 miles made by manufacturing establishments, and they excluded Alaska and Hawaii (Davie, 2003). The 1977 implementation covered the entire U.S., and included shipments of 25 miles or less. The last CTS was conducted in 1983, but data were not published because its small sample size had resulted in estimates with substantial bias.

National transportation policy and program requirements in the early 1990s resurrected interest by the Department of Transportation and the Census Bureau in restoring a commodity-based survey to be conducted as part of the Economic Census, under the authority granted by Title 13, United States Code. Title 13 directs the Census Bureau to conduct economic censuses every five years, for years ending in “2” and “7”. The Title’s language also makes response mandatory, establishes penalties for nonparticipation, and requires that the Census Bureau maintain the confidentiality of the information provided by respondents (US Census Bureau, 2000). The first of the series, however, was conducted in 1993, rather than 1992. Consequently, a CFS has been conducted by the Census Bureau under primary sponsorship from the BTS in 1993, 1997, and 2002 (see Table 1).

<table>
<thead>
<tr>
<th>Survey Costs</th>
<th>1993</th>
<th>1997</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 million</td>
<td>19 million</td>
<td>13 million</td>
</tr>
<tr>
<td>Sample Sizes</td>
<td>200,000</td>
<td>100,000</td>
<td>50,000</td>
</tr>
</tbody>
</table>


Overview of CFS Methods

The design of the CFS has remained virtually static between 1993 and 2002. The Letter Report on the Commodity Flow Survey recommended that the 2007 CFS would benefit greatly from modifications that would update the 2002 CFS methods to use available funds more effectively, increase the sample size, and improve the overall usability of the data. An overview of 2002 CFS methods is presented to provide a basic knowledge foundation for discussions of potential improvements.

Sample Design

The CFS has historically relied on sample sizes of 200,000 (1993) and 100,000 (1997). The 2002 CFS sample was significantly smaller -- comprised of 50,000 establishments drawn from a universe of approximately 760,000 U.S. establishments. While nearly a 50 percent reduction from 1997, the sample design used for the 2002 CFS was still extremely complex due to the fact that the population of shipments is extremely large and variable, and shipping records are kept in
a geographically wide-ranging universe of establishments (Black et al., 2000). An overview the 2002 CFS sample design is presented below.

**First Stage**

The first-stage sample frame consisted of a subset of establishment records from the Business Register maintained by the U.S. Census Bureau that lists all known establishments located in the United States or its territories. This list includes establishments classified in mining (except oil and gas extraction), manufacturing, wholesale, or electronic shopping and mail order retail industries, as well as auxiliary establishments (e.g. warehouses and central administrative offices) with shipping activity. The list does not include establishments classified in forestry, fishing, utilities, construction, transportation, services, all other retail industries, farms and government-owned entities (except government-owned liquor stores). The sampling frame was stratified by geography, and industry and primary stratum were formed using geographic-by-industry combinations. Because the 2002 sample was about half the size of the 1997 sample, certainty components were used to ensure coverage of less frequent types of shipments (e.g., air, water, rail, and hazardous materials). It was decided to identify those establishments which made the bulk of these types of shipments in 1997 and to select them with certainty. This design strategy was used to reduce the sampling variability of the estimates.

**Second Stage**

The frame for the second stage of sampling consisted of 52 weeks from January 6, 2002 to January 4, 2003. Each establishment selected into the 2002 CFS sample was systematically assigned to report for four reporting weeks, one in each quarter of the reference year. An establishment’s assigned reporting week was in the same relative position for each quarter.

**Third Stage**

Each respondent was asked to construct a sampling frame consisting of all shipments made by the establishment during each of the four reporting weeks. Each respondent was instructed to count or estimate the total number of shipments comprising the sampling frame and to record this number on the questionnaire. For each assigned reporting week, if an establishment made more than 40 shipments during that week, the respondent was asked to select a systematic sample of the establishment's shipments and to provide information for only those sampled shipments. If an establishment made 40 or fewer shipments during that week, the respondent was asked to provide information on all of the establishment's shipments made during that week.

**Data Collection**

The 2002 CFS was a mail survey. The questionnaire, itself, was 7 pages in length, designed with a row and column orientation (see Figure 1). The statement, “your response is required by law”, was on the front page, along with a statement of confidentiality, and contact information for support. Included in these 7 pages were instructions for selecting the sample of shipments. A separate 8-page instruction booklet accompanied the questionnaire. Each establishment was mailed a questionnaire, instruction guide, and a commodity coding manual for each of its four reporting weeks. These packets were mailed once every quarter.

For each reported shipment, respondents were asked to provide information on shipment identification number, the date on which the shipment was made, value, weight, commodity code, commodity description, mode(s) of transportation, U.S. destination or port of exit for exports, an indication of export shipment, and the United Nations or North America number for hazardous
materials shipments. For a shipment that included more than one commodity, the respondent was instructed to report the commodity that made up the greatest percentage of the shipment’s weight. For an export shipment, the respondent provided the mode of export and the foreign destination city and country.

**Figure 1: Excerpt of 2002 CFS Questionnaire**

![Excerpt of 2002 CFS Questionnaire](image)

### Data Processing

An automated editing system was introduced in 1997 that enabled Census staff to identify and correct problematic reports.\(^2\) The edit check program checked for inconsistencies, range errors, critical omissions, and assigned a series of flags for missing or incorrect data. Respondents who reported shipments having typically large value or weight when compared to their rest of the reported shipments were contacted to verify the reported numbers. This was done to reduce estimation problems caused by large and infrequent shipments.


The design of the CFS has remained fairly stable over the past 10-year period (see Table 2). While this serves a purpose in ensuring stable measures of key estimates for trend purposes, it fails to fully utilize innovations in methods and advances in data collection technology over the

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\(^2\) A primary reason for the reduction in sample size for the 1997 survey was to enable staff to identify and follow-up with problem reporters.
same 10-year period. This does not mean that zero changes have been in the CFS design. Some changes in the CFS design were made between the 1993 and 1997 CFS. Some specific examples of these changes included:

- Reducing sample size 200,000 establishments in 1993 to 100,000 establishments in 1997 to allow for more intensive follow-up of ‘problem’ reporters and ensure higher quality, more timely and accurate data;
- Changing the measure of size estimate used in first-stage sampling from an employment or pay-roll based measure to an estimate of annual total value of shipments to more efficiently and reliably stratify the establishments represented in the sampling frame;
- Reducing the number of primary strata from 18,000 to 3,400 through the use of clustering to offset increases in sampling variability due to the decrease in sample size;
- Shortening the reporting period from two weeks to one week to reduce respondent burden;
- Improving the respondents’ third-stage sampling instructions, along with an example and illustration of shipment sampling;
- Identifying and including all large shipments made during the year for all selected establishments; and
- Identifying establishment to be sampled with certainty based on prior CFS reports.

According to the Census, these changes were made to improve timeliness of data products, reduce respondent burden, and lessen the influence of large and frequent shipments (Black, 1997). Post-evaluation of these modifications (via statistical measures) demonstrated improvement over the 1993 sample design.

<table>
<thead>
<tr>
<th></th>
<th>1993</th>
<th>1997</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>200,000 selected from universe of about 790,000 establishments</td>
<td>100,000 selected from universe of about 770,000 establishments</td>
<td>50,000 selected from universe of about 760,000 establishments</td>
</tr>
<tr>
<td>Basic Sample Design</td>
<td>3-stage design (establishment, reporting period, shipment), stratified by industry and geography</td>
<td>Same as 1993</td>
<td>Same as 1993</td>
</tr>
<tr>
<td>Industry Coverage</td>
<td>Based on 1987 SIC, manufacturing (not printing), mining (not mining services and oil and gas extraction), wholesale, retail catalog and mail order houses, auxiliaries</td>
<td>Same as 1993</td>
<td>Based on 1997 NAICS, manufacturing (not prepress services), mining (not support activities and oil and gas extraction), wholesale, retail electronic shopping and mail order houses, auxiliaries</td>
</tr>
<tr>
<td>Data Collection Mode</td>
<td>Self-administered, Mail questionnaires</td>
<td>Same as 1993</td>
<td>Same as 1993</td>
</tr>
<tr>
<td>Data Entry Mode</td>
<td>Key from paper</td>
<td>Same as 1993</td>
<td>Optical scanning with key from image</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------</td>
<td>--------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Reporting Period</td>
<td>2-weeks in each of the four calendar quarters of reference year</td>
<td>1-week in each of the four calendar quarters of reference year</td>
<td>Same as 1997</td>
</tr>
<tr>
<td>Shipment Sample</td>
<td>Respondents constructed frame and drew sample, reporting characteristics for each sampled outbound shipment</td>
<td>Same as 1993</td>
<td>Same as 1993</td>
</tr>
<tr>
<td>Shipment Data Items</td>
<td>Total value, Total weight, Commodity that contributes most to shipment’s weight, mode(s) of transport, origin, destination, containerized (Y/N), hazardous materials (Y/N), export, mode of export and destination</td>
<td>Same as 1993</td>
<td>Total value, Total weight, Commodity that contributes most to shipment’s weight, mode(s) of transport, origin, destination, hazardous materials (UN/NA), export, mode of export and destination</td>
</tr>
<tr>
<td>Commodity Classification</td>
<td>Standard Transportation Commodity Classification</td>
<td>Standard Classification of Transported Goods</td>
<td>Same as 1997</td>
</tr>
<tr>
<td>Modes of Transport</td>
<td>For-hire truck, private truck, rail, air, inland water, deep sea water, pipeline, parcel, USPS, or courier, other, unknown</td>
<td>Same as 1993</td>
<td>Same as 1993</td>
</tr>
</tbody>
</table>


Evaluations after the 1997 and 2002 CFS surveys confirmed the need for further research and improvements in the design of the CFS. In fact, it was uncertainties about the availability and level of funding that severely limited opportunities for research on and implementation of methodological improvements for the 2002 CFS (Transportation Research Board, 2003).

**2007 CFS Issues, Challenges, and Design Considerations**

The *Letter Report on the Commodity Flow Survey* recommended that BTS and the Census Bureau proceed with planning for the 2007 CFS. It was suggested that this planning effort should explore opportunities for methodological improvements, particularly those with a potential to reduce survey costs through more efficient sampling and data collection. Equally important were changes that would mitigate respondent burden to improve response rates, as well as improvements that would enable a larger sample size at finer levels of geography to provide data more useful to a wider range of users. This section of the paper provides an overview of current issues, challenges, and design considerations in fulfilling this recommendation.
Sampling Methods: Issues and Challenges

Sampling for establishment surveys is fundamentally different than for household surveys (Plewes, et al., 1988). The following are examples of the types of issues that differentiate establishment survey samples.

- Establishment surveys rely on list frames, which are subject to problems associated with errors of commission and omission as well as misclassification.
- Selection of establishment samples must be current with respect to economy dynamics – both in terms of the constant cycle of business births and deaths and in terms of economic cycles (i.e., recession periods or industry changes).
- Sample rotation should be considered to ease the burden on businesses that have been participating in the survey for multiple iterations.
- Total universe coverage is impeded by changes in ways of doing business.
- The distribution of establishment populations are typically quite skewed, with a few large firms commonly dominating totals for most characteristics of interest.

Such issues affect the frame development and maintenance, sample design, and estimation practices. Establishment surveys differ from household surveys in another important regard related to sampling. While innovations in sampling, such as dual-frame sampling, are being field tested to more efficiently sample households, innovations in establishment sampling have not been as evident. Perhaps this is because establishment surveys tend to rely on list frames, which lend themselves less than other possible frames to innovative techniques.

Sampling Methods: Considerations

Census and BTS are considering a larger sample size for the 2007 than the 50,000 establishments surveyed in 2002. Obviously, the survey budget will be a determinant in the number of establishments that will be sampled as well as the reporting requirements that will be established. In addition, the final sample design will need to reflect other data needs and methods-related considerations, such as:

- The optimal sample size and design based on survey objectives (i.e., desired precision levels for specific shipment characteristics, modes, trend changes, etc.);
- The level of geographic detail the data will provide – avoiding disadvantageous breakpoints – such as sample size not large enough to determine commodity flows at the requisite level of geographic detail;
- The various trade-offs for first- and second-stage sampling. For example, the advantage of sampling 100,000 establishments canvassed twice per year versus 50,000 - four times per year; and
- The trade-offs between having a larger sample size and tailoring the survey experience to the respondent to increase response rates. Sample size makes an enormous difference in the types of response-inducing procedures that can be employed.

In addition to considerations of sample size adjustments, Census and BTS need to prioritize potential sample design changes on the basis of their contributions to improving sampling.
efficiency and/or minimizing statistical error of the estimates. The menu of potential sample improvements includes:

- Exploring the possibility of a CFS pre-canvass operation that might be used to identify non-shipping auxiliary establishments, to better understand reporting arrangements, and to identify shippers that use less common modes or those that ship hazardous materials or exports;
- Investigating the inclusion and thresholds for selecting establishments with certainty;
- Improving the measure of size estimates critical to first-stage sampling, particularly for auxiliary establishments;
- Examining ways of providing finer levels of geographic and commodity detail, while maintaining the statutory obligation for confidentiality of individual establishments;\(^3\)
- Changing the way shipments are sampled, such as stratifying shipments by size and including all large shipments over a long period (1 month, 1 year) rather than the current 1-week reference period; or
- Exploring ways to minimize respondent errors during third-stage sampling, such as implementing alternative shipment selection procedures.

**Instrument Design: Issues and Challenges**

Some changes were made to the CFS questionnaire between the 1993 and 1997 CFS. For example, the respondent instructions for the third-stage sampling were revised to include a written example of the sampling procedure with a diagram. Also an illustration was designed to depict how information about each sampled shipment should be recorded by providing examples of a multiple-mode shipment as well as an export shipment of hazardous materials. However, these changes were predicated on Census Bureau and BTS staff experience gained from the 1993 CFS and not from pretesting of the 1997 questionnaire (Black et al., 2000). Nor was the effectiveness of the changes evaluated with respondent debriefing subsequent to the 1997 CFS.

Pre-existing issues with the design of the questionnaire that would affect adequacy of response or usefulness of instructions have never been explored with respondents, themselves.

As Dillman (2000) notes, establishment surveys, more than other types, are frequently designed in ways that make them very difficult to complete. He cites “tradition” as the cause, more than anything else. Mandatory, government surveys, like the CFS, have often been thought of as “forms” that had to be made as short and precise as possible, rather than as queries to be read, fully comprehended, and thoughtfully answered. For some of these same reasons, pretesting of mandatory establishment surveys has been uncommon. Willimack et al. (2002) outlined various ways to improve the design and testing of establishment surveys, such as cognitive interviews, focus groups, site visits, record-keeping studies, and consultation with subject area specialists and other stakeholders. They also recommend documenting respondents’ feedback and conducting ongoing quality evaluations to diagnose questionnaire problems. Finally they recommend the use of experimental comparisons of the original and revised items.

Information on problem reports, missing data, and nonresponse from both the 1997 and 2002 CFS suggest that it is time to pretest the questionnaire and instructions. At the same time, it is

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\(^3\) Although the 1997 CFS, with a sample size of 100,000 establishments, collected potentially useful local-level data, these microdata cannot be made available to the public because their release could compromise the confidentiality of data providers.
important to assess ways in which the burden on respondents may be minimized, above the changes made to the 1997 questionnaire, as this was a clear recommendation from the Letter Report on the Commodity Flow Survey. Respondent burden is significant because it is associated with nonresponse (discussed in a subsequent section of this paper). At the same time, the relationship between privacy / confidentiality and nonresponse is also significant. As Prewitt (2004) discussed, “even though the census is mandatory, 71% of the public [in a poll] said that an intrusive census questions should go unanswered and another 13% were unsure, leaving only 16% saying that a question considered invasive should be answered.” He places blame for this situation on a “new urgency” about privacy and confidentiality resulting from unimpeded access to individual’s personal information brought about by new technologies and data mining. Pretesting the CFS materials would provide insight into the best ways to collect data that may be viewed as confidential business information, and therefore, left unanswered.

Instrument Testing: Considerations

BTS’s priorities for the 2007 CFS include doing a general content review of the questionnaire and cognitive testing of the questionnaire and the accompanying instructions for possible improvements. The agency is interested in analyzing how respondents are understanding and responding to the questions on the survey instrument, and whether or not there are better ways of capturing the information of interest. Dillman (2000) suggested conducting cognitive interviews on-site when pretesting establishment survey questionnaires. This option should be considered for the 2007 CFS as it would be helpful in ascertaining how businesses are organized and determining what questions should be asked of businesses, of whom within the business, and when in the business year. Important research questions are:

- Identifying in terms of job title or position, who is the person within the business organization most likely to know or be able to find the answers to survey questions;
- Identifying which person in the organization (establishment) has the authority to grant permission for reporting;
- Determining whether establishments keep records at the level that is required for answering the items on the questionnaire;
- Examining whether survey questions be structured to conform to the business' record-keeping practices, including its fiscal year; and
- Determining if there particular times of the year when requested data are more readily available?

Of course, the benefit to be derived from such on-site cognitive interviews would need to weighed against the additional burden this might place on business organizations. Another instrument evaluation option that Willimack et al. (2002) identified was consultation with stakeholders. Given the recommendations in the Letter Report on the Commodity Flow Survey, this would be an important consideration for the 2007 CFS. Stakeholder panels, comprised of CFS data users, could be used to take account of user demands for both data consistency to support survey-to-survey trend analysis and the need to minimize data elements to mitigate respondent burden. Such data user panels might also address how to incorporate new content (or not). Users have called for data on such things as transportation costs and service characteristics for tracking service quality and modeling mode choice. Again, incorporation of new content requires the need to balance user needs with minimizing respondent burden.
It might also be important to establish “pretest” panels comprised of potential business respondents or other subject area experts. An important discussion for a respondent panel would be strategy development for meeting the potentially conflicting requirements for finer levels of geographic and commodity detail with the need to protect the confidentiality of individual level data. Another potential research activity with this type of panel would be to conduct ethnography of the CFS “interview” to examine how responses are affected by respondents’ understandings of the larger survey context. This research activity would address such issues as: Why do establishments think they are being interviewed, and what do they think will be done with the answers. And, how do these considerations impact their CFS reports?

**Mode of Collection: Issues and Challenges**

Transportation survey researchers are currently using a plethora of survey modes for data collection. There are at least five data collection modes in common use today – face-to-face (or intercept), telephone, mail, Internet, and global positioning system (GPS). But this list of survey modes only begins to scratch the surface with the options available for capturing data. There are not only various survey modes to consider, but also sub-modes to consider as well. Telephone and face-to-face surveys can be conducted either by paper-and-pencil or computer. Even computer-based applications have their options: desktop computers (CRTs), laptops, handheld-devices, or Pen Tablet PCs. While setting standards for the selection of a particular survey mode might be welcomed, the reality is that the selection of a survey mode is dependent on the survey situation. And, the survey situation can best be defined as encompassing the target population, eligible respondents, data needs, and budget available.

Yet, for the 2002 CFS and for prior enumerations in 1993 and 1997, all responses have been collected via paper questionnaires. As of October 21, 2003, however, the Government Paperwork Elimination Act (GPEA) required Federal agencies to allow entities the option to submit information or transact with the agency electronically, when practicable. In addition, previous CFS survey respondents have inquired about an electronic reporting option. Preliminary attempts were made to design an electronic questionnaire for the 1997 CFS, but the product proved too burdensome and did not advance past the test stage. Due to the timing constraints involved in initiating the 2002 CFS, the schedule did not allow for further exploration of this option.

**Mode of Collection: Considerations**

New data collection methods could bring important benefits for the 2007 CFS by offering the potential to reduce respondent burden, to increase respondent’s willingness to participate, thereby increasing response rates (effectively increasing the sample size), and with built-in edit checks increasing data quality. While technological development and new modes of data collection provide opportunities for more effective and efficient data collection, it is important to understand the cost-quality-usefulness trade-offs that new methods bring to a survey situation. For example, electronic reporting options developed for the 2002 Economic Census allowed businesses to extract data directly from their own spreadsheets and import it into survey software (Transportation Research Board, 2003). Some Federal agencies have begun to implement electronic options in their establishment surveys and have reported significant benefits (Fox et al., 2004; Hak et al., 2003). They point out such advantages as:

- Reduced respondent burden and potential increase in response rates;
- Improved data accuracy/completeness;
- Quicker dissemination and receipt of survey forms and improved control of survey responses;
Ease of making changes to questionnaire versions and added flexibility in tailoring instruments; and,

Decreased data keying and capture costs (since the respondent enters the data).

The advantages of electronic reporting, however, depend in part on the extent to which establishments are capable of and willing to use an electronic option. Thus, the cost-benefits of such applications need to be researched. The benefits do not always justify the costs and resources required to maintain a dual system. Other noted disadvantages have included:

- Increased concerns of respondents about privacy and confidentiality of submitted information that require additional security protections for survey entry and transmittal of information;
- Limiting respondent ability to answer questionnaire sections “out of order” or to get an overall sense of survey contents, while facilitating the correct navigation through the questionnaire; and
- Providing the opportunity for “mode effects” resulting from the use of both paper and electronic response options.

Thus, the move to new methods or new technologies might be justified on the basis of higher data quality and/or faster processing from collection to final data release. However, these benefits should be weighed against generally greater costs and higher risks, especially in initial applications in a particular survey context.

In the 1990s, many household surveys gravitated toward survey designs that are best described as “mixed-mode” in an effort to combat nonresponse. Dillman (2002) pointed out that the “future of surveying is far more likely to evolve toward the use of mixed-modes for different survey situations.” Simply defined, a mixed-mode survey is one that uses two or more methods to collect data for a single data set. The Internet (or Web) is one of the newest modes be offered to respondents as a way of allowing them to select the mode they prefer. We understand that the Census Bureau and BTS are engaged in research to determine the efficacy of providing the option of a web-based questionnaire for the 2007 CFS, in addition to the mail option. This strategy would enable the CFS to reach different establishments in different ways. For example, establishments equipped to provide data electronically through electronic data interchange systems could provide CFS data by Web data entry, and at the same time, the mixed-mode design would not preclude mail for others. Fox et al. (2004) highlighted the benefits web-based questionnaires offered as a part of a mixed-mode design. These benefits were enhancing response rates, improving data quality, and improving timeliness of reporting. At the same time, they caution that potential for cost savings also exists, although in some cases offering an additional data collection mode might actually increase costs.

The use of new technologies, such as global position system (GPS) and radio frequency identification (RFID), for passive, real-time data capture of shipment movements has been discussed for several years. While the technologies exist, the stumbling blocks to implementation have been cost, distribution of units, and retrieval of units. The actual data on movements can be relayed from the units in real-time to a master storage unit concurrent with the shipping process. But calculations of the volume of units that would need to be purchased, distributed and retrieved for future use amounted to costs greater than the perceived value of the technology application. It is theorized that perhaps the purchase and implementation of the units could be handled in a decentralized manner at the level of the shipper (rather than in a centralized manner by the survey organization). However, this scenario is further complicated by the perceived reluctance of
shippers to allow access to such proprietary, real-time inventory control information. Thus, it is unlikely that such technological innovations would be considered for CFS 2007.

**Nonresponse: Issues and Challenges**

The CFS is conducted every five years as part of the economic census. As such, reporting is mandatory and penalties are established for an establishment's failure to comply. In spite of the mandatory reporting authority, the CFS still suffers from nonresponse. Four levels of nonresponse occur in the CFS – establishment, quarter (reporting week), questionnaire item, and shipment. In other words, not all sampled establishments complete the questionnaire. Furthermore, establishments responding in the first quarter do not always respond to at least one of the remaining quarters. Of responding establishments, item nonresponse also occurs. That is, respondents do not always provide information for every sampled shipment, or omit responses about requisite shipment characteristics. More detail about nonresponse in the 2002 CFS is presented below.

**Unit Nonresponse**

Each establishment selected into the CFS sample was mailed a questionnaire for each of its four reporting weeks. Of the approximate 50,000 establishments sampled in 2002, less than 32,000 responded (i.e., provided usable shipment data) for at least one quarter. Approximately 17 percent of the sampled establishments were determined to be ineligible for the survey (e.g., out-of-scope industries, non-shipping establishments, etc.). However, almost one-quarter of the sampled establishments that were assumed to be eligible did not respond or provided data that was too problematic to be included in the final results. As expected, differential response patterns were detected. For example, specific industry sectors (e.g., manufacturing and mining) and larger establishments exhibited higher response rates. Also, response rates varied significantly based on geographic boundaries. These differences bring into question how data collection methods can be modified to focus on more problematic response areas and increase overall establishment response rates for the CFS. Measures were taken to compensate for establishment level nonresponse, for example, an *industry-level adjustment weight* was applied. This weight utilized information from other surveys and censuses conducted by the Census Bureau to account for establishments from which no usable response was received. It also adjusted for changes in the population of establishments between the time the first-stage sampling frame was constructed and the year in which the data were collected.

**Item Nonresponse**

For a given establishment, the respondent was requested to provide the following information about each of the establishment's reported shipments: shipment identification number, the date on which the shipment was made, value, weight, commodity, mode(s) of transportation, domestic destination or port of exit, an indication of whether the shipment was an export, and the United Nations or North America (UN/NA) number for hazardous material shipments. For an export shipment, the respondent was also instructed to provide the mode of export and the foreign destination city and country. A respondent may not have been able to provide value, weight, or a destination for one of the sampled shipments. If this data item could not be imputed, then this shipment did not contribute to tabulations and was deemed unusable. A shipment is deemed *usable* only if it has valid entries for value, weight, and origin and destination ZIP Codes. Similar to unit nonresponse, to account for these unusable shipments, a *shipment nonresponse weight* was also applied.
Nonresponse: Considerations

Issues and considerations discussed under Instrument Design and Mode of Collection identify potential strategies to combat or at least mitigate nonresponse. While such strategies are important, equally important is the need to conduct research in two areas: (1) research into the level of burden that firms are willing to tolerate and ways to mitigate burden and (2) evaluation of CFS nonresponders. Both of these activities will identify the type and level of bias that is present in survey results, help focus future methods research efforts on specific problems, and serve as a useful guide for reducing survey nonresponse in the future.

A Future CFS Design Consideration: Continuous Data Collection

The Letter Report on the Commodity Flow Survey noted a prominent limitation with the CFS, with its five year cycle, was its inability to capture rapid changes in economic cycles. The lack of coverage of the intervening four years means that time trends in freight activity, such as the effects of emerging from a period of recession or severe drought, cannot be studied satisfactorily using CFS data alone. In addition, since freight moving industries were deregulated and computerization allowed tighter inventory control, there has been dramatic changes in how freight is shipped (Loudon, 2000). There is more less-than-truckload shipping and more use of parcel delivery services, and there is more backhaul shipping – to name just a few. A CFS survey design needs to have sufficient currency to capture such rapid changes in shipment methods.

Thus, a longer term issue than the 2007 CFS, but one that warrants serious consideration in the near future, is whether to improve on the timeliness of the CFS by transitioning to an annual or continuous survey, as is being done with the American Community Survey (ACS). The ACS is a nationwide survey that collects socioeconomic and housing information and is the planned replacement for the long form in the 2010 Census. In the past, the long form (LF) data were collected, processed, and tabulated once each decade. Forms were sent to a sample of about one of six households so that reliable estimates were published for small areas such as tracts and block groups. The ACS, when fully implemented, will collect LF data throughout the decade. Although statistics from any individual year of the ACS are not assumed to produce reliable estimates for small area estimates, multi-year (3- and 5-year averages) are assumed to produce reliable, useful, and timely statistics to replace the LF.

Any type of ACS-like change could not take place until after the 2007 CFS, but a change of this magnitude would require several years of planning. Obviously, there are many operational constraints associated with switching the periodicity or enumeration schedule of the CFS (e.g., no longer parallel tracking with economic census). Among other questions that must be addressed are:

- How often are CFS data for specific characteristics needed and at what level of geography?
- How does this impact the ability to monitor freight shipment trends?
- How would the sample design and size need to change for a continuous enumeration?

Conclusions

The CFS methodology can and should be improved. Evaluation of the methodological changes implemented prior to the 1997 CFS indicated that these were successful in providing a more
efficient sample design, lessening respondent burden, and improving timeliness of data products. In the past 10 years, survey methodology has benefited from many research-based improvements in sample design, instrument design, data collection, and nonresponse mitigation. For various reasons, the CFS has not taken advantage of such methodological improvements. It is time to do so. This paper has discussed current issues, challenges, and survey considerations that are relevant to the CFS. It underscores the need for a continuous research and evaluation plan that would enable BTS and the Census Bureau to stay abreast of methodological enhancements, as well as real changes in freight transportation, that impact CFS data quality and usefulness. Such a research plan could provide an increased understanding of the response process and respondent burden to increase response rates, alleviate privacy and confidentiality concerns, improve data quality, etc., for establishment surveys. This is an area in which not enough research is currently taking place. The issues discussed in this paper also draw attention to the value that ongoing dialogue with data users and stakeholders provides. Not only do these persons bring substantive expertise on tough decisions such as whether or not to change the way shipments are sampled, but also their input helps to ensure methods employed are providing data of most importance and utility.

References:


Transportation Research Board (2003). Measuring Personal Travel and Goods Movement
