

DEVELOPING A COST MODEL FOR ALTERNATIVE DATA COLLECTION METHODS: MAIL, CATI AND TDE

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Key Words: collection methodology, nonresponse error, telephone

1. INTRODUCTION

High quality published data begins with collecting high quality data from respondents. Much of survey processing compensates for weakness in the quality of the collected data and for the data we do not collect. If we received all survey questionnaires back on time, completely filled out and accurate, much of the cost and many sources of collection errors would be eliminated. However, this level of responsiveness is not expected even in mandatory surveys. Therefore, we must find those methods which attempt to maximize response rates and improve quality at low cost.

The choice of a collection method is usually based on a combination of performance and cost factors. For traditional methods, these factors are easily identified and the selection of a collection mode is not difficult. With recent technological advances, new methods are being tested that expand the array of potential collection tools and challenge the survey designer to reevaluate old cost and performance assumptions. The decision of which method or methods to use is now more difficult.

The field of computer assisted data collection is probably the area of greatest and most rapid change in the survey process. It represents the continuation of the automation process which began with the punched card and elementary computers. This field includes the rapidly expanding variety of applications which are based on the telephone system, including Computer Assisted Telephone Interviewing (CATI), Touchtone Data Entry (TDE), and more recently, voice recognition. While telephone collection is not new, the merging of computers with telephones is becoming the method of choice for many surveys.

The use of these technologies may improve data quality as well as provide cost savings. There may be no area more challenging in the Federal arena as measuring and finding ways to reduce costs. Not only do we need to find ways to improve accuracy, but we must do it in an environment of minimal resources.

This paper reviews the structure of the Current Employment Statistics (CES) survey, the application of mail, CATI and automated touchtone self-response to CES data collection, and presents a cost model of the CES survey. The model represents an effort to develop a strategy for implementing significant changes in data collection methodology in the CES. Unit costs for each collection

mode are generated and extrapolated over a 10 year period to provide an indication of future trends in data collection costs. In our paper, we will focus on the enormous potential gains in reducing nonresponse error through automated collection.

2. THE CURRENT EMPLOYMENT STATISTICS (CES) PROGRAM

The CES survey provides some of the most important and the earliest measures on the health of the economy. The published data on employment, hours, and earnings are used extensively in the financial, economic, and business communities, and by government policymakers. The CES historically has been collected by mail in a Federal/State cooperative system. Each month data from over 300,000 establishments are collected by the states and transmitted to BLS for the development of national estimates. While the mail is reliable, it poses many problems for the survey; the timing of the response is uncontrolled, as is the time spent in transit, and there is limited contact with the respondent.

As a result of delays in the mail collection process, CES estimates are generated three times for each reference month. These estimation points are referred to as "closings". After the first closing, preliminary estimates are released about three weeks after the end of the reference period, based upon only two weeks of collection.

Under mail collection, approximately 50 percent of the sample units report data in time for first closing estimates. First closing estimates are regarded as the most important, because they are one of the earliest available measures of the nation's economic health. These preliminary estimates often receive greater attention from policy-makers and the public than subsequent revised and final estimates. A second set of estimates are produced from an additional three weeks of collection, based on about 75% of the sample. The final estimates are published about eight weeks after the reference period, based on about 87% of sample receipt.

3. COLLECTION METHODS DEFINED

Mail: The CES program was developed when mail was the only practical collection method. While mail offers reliability, there are two weaknesses for a survey with strict timing requirements. First, timeliness is compromised by the time a letter spends in transit from the respondent to the state. Second, there is little or no contact with the respondent. Respondents fill out the form

when time allows, not necessarily as soon as the source data become available. Few explanations are available for unusual data movements, and sample attrition can be high due to insufficient resources for nonresponse prompting. Under mail, virtually all of the activities are conducted manually as the data are readied for estimation.

Mail collection in the CES uses a single form which is shuttled to and from the respondent each month. A postcard is sent after a period of delinquency.

CATI: Computer Assisted Telephone Interviewing links the power of a computer to the collection of data directly from a respondent over the telephone. The application of CATI in the CES program addresses timeliness problems. Under CATI, the interviewer calls the respondent at an appointed time. The computer assists by automatically controlling questionnaire branching, conducting on-line editing for reconciliation directly with the respondent, scheduling future calls and capturing a variety of management information about the interview. Thus, virtually all monthly data collection activities are conducted through the CATI system. The use of CATI in the CES eliminates the monthly mail handling activities and postage costs. CATI adds new costs in the form of equipment purchase and replacement and telephone charges.

TDE: Touchtone data entry is a new technique which allows respondents to report their data directly to a computer using a touchtone phone. The features of TDE involve digitized phrases asking questions to which the respondent enters answers by pushing the appropriate keys on the touchtone phone. The monthly mail handling is reduced to a single postcard to remind the respondent that it is time to call in their data. TDE reduces manual operations by transferring key entry to the respondent. Short nonresponse calls which only remind the respondent to call in are placed as publication deadlines approach. There are no edits in the current TDE system; editing is conducted for TDE units in the same manner as other mail responses. Most respondents have indicated that they like this collection method, and some strongly prefer its convenience. Testing has shown that they will continue using it on a timely basis over an extended period.

The applicability of TDE to the survey process, especially for short, repetitive surveys, is easily seen. Since touchtone technology is becoming widespread in the private sector, and is widely available and accepted by the general public, the application of TDE to one-time or special purpose surveys is a fertile field for experimentation.

In addition to touchtone, BLS is just beginning to test Voice Recognition. The advantage of voice is that it covers the entire telephone population, and may be the most natural and convenient method of reporting.

Voice recognition is essentially the same method as TDE, except the respondent answers the computerized questions by reading the string of digits and the words "yes"

and "no". Although voice technology is new and expensive, the cost structure of voice collection is similar to TDE. As voice recognition becomes widespread, the costs will drop.

4. COMPUTER ASSISTED METHODS RESEARCH

The Bureau of Labor Statistics has been testing the use of CATI in the CES survey since 1985 and TDE since 1987. The CES is an ideal environment to use automated collection methods. The CES collects only 5-6 items each month from a fixed panel of respondents. Thus, interviews are short, and investments in interviewer training and start-up costs can be amortized over ongoing collection. This study of costs is limited to data collection in the existing CES. Considerations of impact on sample design, questionnaire changes, edits, and other issues are excluded.

In 1987-1988, BLS conducted CATI tests in nine states. These tests targeted late respondents for CATI collection. Improvements in performance, including increased timeliness of response and lowered attrition, show CATI's effectiveness in improving the reporting behavior of sample units that had previously participated in the survey under mail collection. CATI collection covered over 5,000 respondents monthly for a two year period in 9 states. Response rates during this period averaged about 85%, versus 50% for mail. In addition to improving response rates, CATI has dramatically reduced sample attrition by one-half to one third.

The tests of TDE focussed on units previously collected by CATI. TDE includes many of the same sample monitoring features of CATI and promises to be more cost-effective than simple mail collection because it eliminates many of the labor-intensive activities associated with the traditional mail method.

Table 1 provides the overall response rates for each of the collection methods studied. Both CATI and TDE significantly improve response rates and maintain high rates over extended periods.

Table 1. Impact of CATI and TDE on Enhancing Response Rates Percent of Sample Received by Publication Deadlines

Closing (collection period)	Mail	CATI	TDE
First Closing (2 weeks)	50%	85%	85%
Second Closing (5 weeks)	75%	98%	98%
Third Closing (8 weeks)	87%	100%	100%

5. COST MODEL

The data collection function is the series of activities which follow sample selection and precede estimation. Data collection is comprised of a series of activities for capturing

the data, converting the data to machine-readable form, performing editing and edit reconciliation, and following-up for nonresponse. The conduct of these activities varies greatly under mail, CATI, and TDE. Major monthly cost categories for these three collection modes are outlined in Table 2.

Table 2. Major Cost Categories for CES Collection Modes

Major Cost Categories	Mail	CATI	TDE
LABOR			
mail out	x		x
mail return	x		
data entry	x	x	
edit and edit reconciliation	x	x	x
nonresponse follow-up	x		x
NON-LABOR			
postage	x		x
telephones		x	x
hardware		x	x

The dominant cost categories for each collection method are labor, postage, telephone charges and computer hardware. The three major collection modes are influenced by these four factors differently.

The cost categories presented in Table 2 can be used to evaluate the costs of other collection methods. By comparing the activities of the alternative method to the current method, a determination of affordability can be made.

Methodology and Data Sources: A two-part strategy was developed to capture detailed data on survey activities in order to estimate costs in the states. Current costs were known only at the aggregate level for each state. Thus, detailed costs for activities affected by the introduction of CATI or TDE were unknown.

The first part of the study collected the "before CATI" distribution of costs for 24 detailed activities in four major functional groups. Only the activities for data collection are covered in this paper. Five of these activities, listed in Table 2, cover existing duties which are directly affected by changing collection methods.

The second part of the study was gathered data on costs and workload factors from the state monthly CATI and TDE activities. For example, the CATI instrument captured measures such as call duration, number of calls to complete data collection, calls per interviewer, and calls per day. These data provided insight into state operations and supplied information about cost factors for CATI and TDE. Also, staff salary and benefit levels, administrative rates and costs for standard non-personal services were collected and

a few states provided detailed telephone bills. The only remaining costs were management activities outside of the CATI instrument. These, and equipment amortization costs, were estimated.

Cost Model Assumptions: Several assumptions were made about the level of workload and equipment requirements. The CATI assumptions are: 350 units per interviewer during a 10 day collection period, 6 hours per day spent on collection (8 hours paid), and 3.5 minutes per interview. The TDE assumptions are: 2 minute interview initiated by the respondent, 30 phone calls per hour per phone line, 2 phone lines per TDE board, 25% of the sample receive 1 minute nonresponse prompting calls, and the microcomputer can hold 2 TDE boards.

The following factors were included in the model: salaries and benefits, administrative overhead allocations, standard non-personnel services, postage, amortization of computer hardware to cover replacement, and telephone charges, including fixed monthly line charges and variable call costs.

The following factors were excluded from all three methods because the costs could not be treated equally for all three methods or the proportion of existing activities related to the data collection function could not be identified: start up costs for research and development, ongoing systems design and maintenance, training, and emergency back-up features for CATI and TDE.

Other Important Considerations: Critical decisions concerning changes in the data collection methods are not made solely on costs; there are many other considerations to include in these decisions.

Organizational Impact: The design of an effective production environment is essential to timely, ongoing output of data. The success of CATI and TDE in compressing the collection period to 2 weeks may pose peak period staffing problems. Also, the cost model assumes that managers can perfectly capture and reallocate resources as collection methods change. For example, TDE eliminates key entry at the state. This model presumes these resources can be captured and reinvested in equipment and telephone charges, and that any remaining savings can be redirected towards improving the quality of other survey functions. Also, we assume postage savings under CATI and TDE are identifiable and may be similarly captured and redirected.

Staffing for Research and Development: The development of new techniques usually requires a small staff dedicated to accomplishing the change desired. Also, this staff must have a wide variety of skills, including economics, statistics, methods test design, computer systems design, questionnaire development, and analytical, writing, and presentation skills.

Systems Design, Programming, and Maintenance: There are significant start up costs, although these can be easily amortized over large, recurring surveys. These costs

will vary with the complexity of the application and the experience of the development staff. Ongoing maintenance depends on the frequency and magnitude of the changes. We estimate maintenance adds about 3% to the costs of CATI and TDE, although there is no comparable figure for maintaining the key entry, editing and nonresponse features of the states' mainframe computer systems used for mail collection.

Training: Training requirements for staff to maintain mail operations are small. Under CATI, a broader range of skills is required, including telephone communications skills and some working knowledge of the computer. The TDE system requires little special knowledge, keeping costs low.

Emergency Procedures: As we increasingly rely on technology to do work for us, we are increasingly at risk when it fails. In the highly decentralized Federal-State cooperative system, each separate state collection site requires back-up procedures and equipment to ensure uninterrupted service to respondents. A mixed mode collection environment using CATI and TDE would require a back-up computer and associated equipment standing ready for instant replacement. It may also be practical to have established "call forwarding" services ready to route incoming TDE calls to an alternative collection site. We estimate the costs of on-site back-up equipment adds about 1.4% to CATI and TDE costs.

Results of the Cost Model: The results of the cost model are provided in the form of an index, with the ongoing monthly cost of mail operations in 1989 equal to 100. This provides an easy comparison of the relative costs of the three collection methods. TDE proved to be the least expensive of the three collection modes, approximately 30 percent less than that of mail. In contrast, CATI was 20 percent more expensive than mail.

Table 3: Index Values for the Monthly Unit Costs -- 1989

Collection Method	Index Value of Unit Costs
Mail	100
CATI	120
TDE	69

6. FUTURE COSTS

The choice of collection mode, or which combination, will depend on the particular survey application and the existing cost structure. However, it is important to view investments in data collection over the long-term as the relative costs of each of the above inputs do not remain constant over time. Table 4 shows recent annual data on cost trends for the major cost inputs.

Labor and labor-intensive inputs, such as postage, are increasingly more expensive, while capital-intensive factors, such as telephones and computers, become less expensive.

Based on these data, and other historical cost trends, there is a growing advantage to switching to collection methods which use less labor and more capital.

Table 4. Recent Annual Changes in Costs of Inputs into Data Collection

Cost Category	Recent Annual Cost Changes (source)
Labor:	+5.6% for State and local government employee compensation (ECI 1988 annual change)
Postage:	+4.0% for 1st class postage (U.S.P.S.)
Telephones:	-4.0% for interstate toll calls (CPI-U) -3.0% for intrastate toll calls (CPI-U)
Computers:	-7.0% for microcomputers (BLS research study)

Labor costs steadily increase, as measured by the Employment Cost Index (ECI); which includes salaries and benefits. The State and local government component of the ECI shows labor costs rising between 4.4 and 5.6% in each of the last 3 years.

Postage costs are influenced by labor expenses comprising 83% of the Postal Service's \$36 billion budget. The current wage contract guarantees semiannual cost-of-living raises based on the Consumer Price Index for All Urban Wage Earners and Clerical Workers (CPI-W). The CPI-W has averaged a 3.3% annual rise over the last 5 years and has not registered a decrease since 1954.

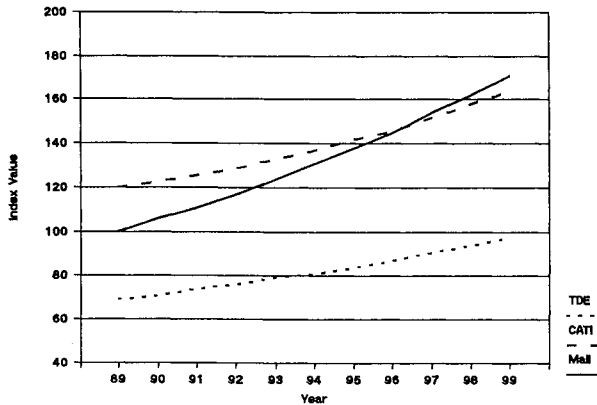
The CPI-U measure for intrastate long distance calls has decreased 5.0% over the 1986-1988 period. Interstate calls have decreased 29% over the last five years, as measured by the CPI-U. While interstate calls are only about 10 percent of the calls in the CES, surveys collected on a centralized basis should note this much larger cost decrease.

The price of all computer products has declined in the last few years, while the quality, measured in speed and memory, has dramatically improved. A BLS research study provides a rough estimate of a 7% annual decrease for microcomputers.

Chart 1 projects these unit costs for the three collection methods over a ten year period, and assumes that recent price trends continue. This projection is not an official BLS estimate of future price trends.

In light of the changing composition of the component costs, the choice of a collection method may differ in the long run. For instance, this projection shows that while CATI appears more expensive in 1989, if all of our assumptions concerning costs prove relatively accurate, then the costs of CATI operations will equal the costs of mail by early 1997. The distance between the mail line and the TDE line represents potential savings.

Chart 1. Estimated Unit Costs by Mode: 1989-1999



Our model illustrates that decisions on implementing alternative methods like CATI should be viewed in terms of estimates of future price changes. Also, decisions on conducting research and development testing need not await a favorable cost-benefit situation.

7. SENSITIVITY ANALYSIS

An important part of any study of costs is assessing the effect of changes in key assumptions on results. Since labor costs dominate all three collection modes, 60% to 80% of total costs, depending on mode, the unit cost model was recalculated using different factors for labor cost increases. The first scenario assumed that labor would increase at a higher rate, 6.6%, the second assumed a lower rate, 4.6%. The original cost scenario used a 5.6% rate of growth. The higher labor cost scenario indicates that CATI unit costs would be equivalent to mail unit costs in mid-1996. The lower labor cost scenario shows that CATI and mail will have equal unit costs in late 1997. Table 5 summarizes the results of varying the assumption about labor costs. All the values in the table are relative to the 1989 cost of mail collection. For each of the three scenarios, the year that CATI and mail costs break even, or that CATI is less expensive, is shown. Regardless of the rate of labor cost increase, TDE is the least expensive collection mode during the period under consideration.

Table 5. Sensitivity of Results to Changes in Assumption About Labor Costs

Scenario	Year	Index Values		
		Mail	CATI	TDE
Labor increases 6.6%	1996	154	154	92
Labor increases 4.6%	1997	144	143	86
Labor increases 5.6%	1997	154	152	91

8. QUALITY IN THE DATA COLLECTION PROCESS

Much has already been written about the effects of CATI on the quality of collected data. In the CES, the primary improvement in quality through use of automated methods like CATI is the improvement of response rates. Of course, there are other error reducing properties of these methods. For example, key entry and verification are conducted at the source of the data, the respondent, suggesting a higher level of accuracy than relying on operators to transcribe handwriting to machine readable form.

9. COST/EFFECTIVENESS MEASURES

Until now, cost and performance data have been viewed separately. We have constructed a single measure which combines cost and performance to obtain a specified sample, in this case 100 units. In the CES, the overwhelming quality issue is nonresponse for preliminary estimates. The unit cost is divided by the first closing response rate, yielding the number of sample units needed to receive 100 units on time. For mail, 200 units would have to be selected to achieve 100 timely responses. The unit cost index values for each method are used to measure the total costs.

Table 6. Cost-Performance Measures for the CES Preliminary Estimates: The Cost of Collecting 100 Randomly Selected Units

Mode	Unit Cost Index	First Closing Performance	Units Needed	Cost Units Per 100 Sample Responses Received on Time
Mail	100	50%	200	20,000
CATI	120	85%	118	14,160
TDE	69	85%	118	8,142

With high response rates and low costs, TDE is still the method of choice in this collection environment. The choice between mail and CATI in a complex survey where TDE may not be feasible is a little less clear. By calculating a cost-effectiveness ratio, (unit cost index/first closing performance) we can more easily see the overall impact of this choice. For a given sample requirement, CATI requires that fewer units be included in the sample than under mail because of the greater response rate. Thus, when taking actual closing performance by mode into account, the higher unit cost of CATI is more than compensated for by its higher response rate.

10. IMPLEMENTATION STRATEGY

The decision on exactly how to use each collection mode will vary by survey application. In the CES, CATI and TDE will be combined to address chronically late mail respondents. These units will first be converted to CATI collection to improve their reporting behavior in terms of timeliness and accuracy. These units will remain under CATI collection for about 6 months -- a time period adequate for reducing nonresponse problems, determining exact data availability dates (for subsequent nonresponse prompting), educating respondents to the importance of their data and reinforcing timely reporting behavior. During this period, these units will receive a record check interview to identify and correct possible sources of response error. Then, the units will be converted to TDE collection to reduce costs while retaining sample control.

If testing of voice recognition collection is successful, those units without touchtone phones or those respondents which prefer voice collection may use voice collection rather than be returned to mail.

11. CONCLUSIONS AND RECOMMENDATIONS

The model used here is a basic tool for survey managers in assessing the potential application of new collection methods.

These new methods indicate that a mixed mode collection environment may be most cost-effective for the CES survey. Survey researchers should not be dissuaded by current costs from considering the use of automated

collection methods. Recent cost trends suggest that the cost-effectiveness of collection methods changes over time. This fact should be considered in decisions concerning choice of collection methods for the future.

We encourage other survey managers to consider the use of the growing spectrum of collection vehicles. While the specific applications and cost structure will vary in each survey environment, managers may wish to reevaluate their current practices.

ACKNOWLEDGMENT

The authors would like to acknowledge the contribution of the many members of the Office of Employment and Unemployment Statistics who participated in the development and implementation of the CES CATI/TDE Implementation project. The authors would also like to thank the staff of the participating State Employment Security Agencies, and the BLS Regional Offices in Atlanta, Boston, Kansas City, and San Francisco, for their contributions in testing these developmental methodologies.

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