RESULTS FROM THE INDIVIDUAL DIARIES FEASIBILITY TEST FOR THE CONSUMER EXPENDITURE DIARY SURVEY

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Executive Summary

Introduction

Household expenditures have characteristics that make them susceptible to misreporting: they cover a wide spectrum of goods and services, they are highly variable in value as well as in the frequency of when they are incurred. Ideally, to maximize accuracy in reporting, expenditures should be recorded at or near the time of their occurrence and by the person who incurred them.

The Consumer Expenditure (CE) Diary Survey currently uses a single paper diary for capturing household (consumer unit, CU) out-of-pocket expenditures. CE's current household paper diary instrument has two main features that do not facilitate respondents' contemporaneous recording of their expenditures: [1] the paper diary's 8½" X 11" size is cumbersome to carry around, and [2] a single household diary can only be with 1 person at a time, making it impossible for a person in a multi-member household to make diary entries in a timely manner. Additionally, having a single person in the CU maintain the diary for all members of the CU has drawbacks, including missed expenditures, misreporting details of the expenditures, and the additional burden imposed on a single diarist in a multi-member CU (Edgar et al., 2006). Providing paper diaries also limits the information that we can collect about when and how CU members make entries. Offering each CU member an individual web diary has the potential to address these limitations of the current CE CU-level paper diary.

In 2014, the CE Program conducted the Individual Diaries Feasibility Test (IDFT) in an attempt to address these limitations of the current CE Diary instrument. This test featured web personal (individual) diaries – mobile (smartphone) or desktop/tablet – for each eligible member of a CU. The U.S. Census Bureau, who also conducts the CE production data collection, implemented this feasibility test.

The advantages that the CE Program hoped to reap from individual web diaries were:

1. facilitate respondents' "real time" recording of expenses since the web diaries utilized by this test (smartphone, tablet computer) would be more portable than a 8½" by 11" paper diary;
2. to take advantage of the ability (technically) to monitor respondents' use of their web diaries during the diary keeping period, in order to provide reminders/prompts to respondents *during* the diary keeping period as needed;
3. the ability (technically) to measure the lapse in time from when an expense was incurred and when it was recorded in the web diary. This would indicate the extent to which contemporaneous reporting was occurring, something not possible with paper diaries; and
4. minimize omissions of incurred expenses to which a single diarist proxy reporting for all eligible household members would be susceptible.

The IDFT sought to examine the extent to which the CE Diary Survey can benefit from these advantages of individual web diaries in the feasibility test protocol as designed. Analysis in this report primarily sought to address the high-level comparisons of web diaries versus paper diaries, and reporting at the individual-level versus one respondent reporting for the entire household. Although these comparisons were confounded with each other in the study design, the analysis sought to examine these comparisons separately.

The research questions of the IDFT were the following:

1. Feasibility. What are the operational issues that arise in fielding individual web diaries as intended by the test protocol?
2. Participation. Do individual web diaries improve survey cooperation compared to household-level paper diaries?
3. Contemporaneous reporting. To what extent do web diaries that can be accessed from any internet-enabled location lead to contemporaneous reporting of expenses incurred?
4. Comparison of reporting in households with individual diarists to households with a single proxy diarist, a primary research objective. What effect did diary-keeping at the individual household-member level, compared to allowing one respondent proxy report for the entire household, have on the overall number of household entries?
5. Individual web mode data quality, a primary research objective. Do web diaries result in improvements in data quality over paper diaries? Within the web mode, were there differences in data quality between mobile and desktop diaries?
6. Ideal household characteristics for the web mode. What household characteristics were associated with web diaries having a larger number of entries?
7. Respondent feedback. What can we learn from respondents about web diaries and their association with reporting behavior?

Methodology

The test group in this study comprised households whose members were assigned individual web diaries (*the ID sample*), and the control group was composed of a subset of CE Diary production cases (*the Restricted Production (RP) sample*). The sample for the ID test group was drawn from 1,216 addresses within primary sampling units (PSUs) in three Census regions: Chicago, Los Angeles, and Philadelphia. These PSUs were specifically selected as they ranked highly on the following criteria: (1) internet usage, (2) mobile device usage, (3) English speaking CUs, and (4) multi-person CUs. For the test, Census interviewers asked if respondents at each address had access to the internet at home through a computer, laptop, or mobile device. Only CUs who reported having access to the internet at home were eligible to participate. The sample for the production group was drawn from 2,814 production cases in the same regions at the same time period. The RP sample was further restricted to match the ID test sample by only including English speaking CUs with internet access who had their 2 weekly diaries placed at the same time (i.e., those CUs with "double-placed" diaries). The data collection for the test sample spanned 5 months, August through December 2014.

A detailed description of the field protocol, including criteria for determining eligibility, and diary placement, pickup, and monitoring protocol for the ID sample appear in *Appendix A*. Of note is that the assignment of individual web diaries in the ID sample was sequential. After determining that the CU was eligible, the interviewer sequentially assigned respondents to the two types of web diaries. The interviewer first attempted to place the mobile diary with the respondent by asking if the respondent had access to the internet through a smartphone. If the respondent replied in the affirmative, they were automatically placed with that type of diary. If the respondent replied they did not have internet access through a smartphone, the interviewer asked if the respondent had access to the internet through a computer or tablet. If the respondent did, they were placed with a desktop diary. If the individual respondent did not have access to the internet through either a smartphone or through a computer or tablet, that CU member was deemed ineligible.

Completed sample size
The test design resulted in a total of 626 CUs completing at least one diary week in the production sample and 241 CUs completing at least one diary week in the ID sample. However, most of the analysis in this report was carried out on a smaller subset that had completed both weeks of double-placed diaries – 210 ID sample CUs and 200 RP sample CUs.

Response rates (completed sample size)
The response rate for the ID sample was 22 percent, compared to a response rate of 27 percent for production cases, with the low rates partially attributable to CUs screened out for lack of internet access. Among cases placed with diaries, the cooperation rates were 55 percent and 73 percent for the ID and RP samples, respectively (see Findings section 2 for more details).

Findings

We learned the following about the 7 research questions from the feasibility test:

1. There were several obstacles in implementing the test protocol as designed.
- Interviewers mentioned the issue of not having all eligible members present during diary placement, and that some respondents were unwilling to have other CU members (e.g., teenagers) participate. The data indicated a lower than expected prevalence of all eligible household members cooperating with the survey request in multi-member CUs (Table III-4d, and Census, 2015). To maximize within-CU participation, other measures beyond offering individual diaries, such as the offering of incentives, may be needed.
- Despite the advantages of providing easily-accessible diaries, this goal was inhibited in implementation. The resulting need to enter a long website address and the complexity of password requirements made logging in to the web diaries a difficulty for many respondents (Figure III-1a; Table III-7f).
- Interviewers did not consistently implement the web diary monitoring protocol. We suspect this occurred for a variety of reasons: inadequate focus on this new protocol during training, inconsistent communication between headquarters and field staff (Census, 2015), and limited recording of follow-up contacts. This is problematic because the data indicated that when interviewers did make follow-up contacts, CUs exhibited more reporting across diary weeks and a greater number of entries (Tables III-1b, and III-1c).

2. There was no improvement in household cooperation rates for the ID sample compared to the RP sample. Of CUs placed with diaries, only 55 percent of ID sample CUs completed a diary, versus 73 percent of their RP counterparts. Within-household participation rates in the ID sample were also low; in almost half of CUs where multiple members were assigned diaries, only one member made entries (Table III-4d). This mitigated an intended advantage of individual diaries – that more members would be participating in recording expenditures. An advantage of the web diaries was greater proportions of younger members in CUs completing web diaries, especially in CUs assigned mobile diaries (Table IIb).

3. Data constraints limited our examination of contemporaneous reporting of expenses for web diary respondents. Specifically, we did not have a linking identifier that permitted the association of when an item was recorded in the web diary and the item's reported date of purchase. To deal with this constraint, we examined the distribution of logins among those given web diaries, and found steady login rates throughout the day, providing evidence of real-time reporting of expenditures. On average, half of diarists' logins occurred between the hours of midnight and 3pm (Figure III-3).

4. The primary research objective of comparing expenditures between individual diarists versus one household proxy reporter found higher expenditures collected from proxy reporters. Proxy reporters using paper diaries reported 21 percent more median entries than diarists assigned individual web diaries, among multi-member CUs (Table III-4e). Some of this difference may be accounted for by the low within-household participation in ID sample CUs (Table III-4d). However, there was some suggestion that individual web diaries may have limited underreporting associated with proxy reporting; as household sizes increased (and as more diarists participated in making entries), the gap in entries in favor of household paper diaries was reduced (Table III-4f).

5. The primary research objective of identifying whether the web mode improved data quality suggested higher reporting via the paper diary mode.
   i. *There was a 31 percent smaller number of median entries* (Table III-5a) and a *46 percent lower median expenditure total among ID sample CUs* (Table III-5c). Half of this difference in entries was from RP sample CUs' greater reporting in the 'All Other Products, Services, & Expenses' section (Figure III-5a).
   ii. *Both groups had a drop-off in diary entries in the second week of the diary reporting period,* although this was 10 percent greater in the ID sample (Table III-5l).
   iii. *There was a higher prevalence of interviewers entering all expenses for the CU – "total recall" – in the ID sample* (Table III-5f), however only 10 percent of CUs that did directly record entries in a web diary had any entries collected from recall or receipts (there was no equivalent comparison possible for the RP sample).
   iv. *There were slightly higher (though still low) item non-response rates in the ID sample* (e.g., for expenditure values and item descriptions; Table III-5i).
   v. *Rounding of reported expenditure values.* The extent of rounding of expenditures was relatively consistent across diary modes (Table III-5k, Figure III-5b).
   vi. *Duplicate entries among web diarists.* There was evidence of some duplicate reporting of items in multi-member ID sample CUs, which was higher for the 'Food Away from Home' section in the desktop mode (Table III-5g; there is no equivalent comparison possible for the single diarist RP sample).

6. Characteristics of ideal web CUs
We identified characteristics that were associated with a larger number of entries and higher expenditure amounts among CUs given web diaries. A design that focuses on CU members with higher education levels, that emphasizes and supports interviewer monitoring to ensure compliance with the diary-keeping task, and that encourages respondents to log in early in the reporting period is expected to result in higher expenditure reporting among web diarists (Table III-6, Figure III-6). Among ID sample CUs, CUs only assigned desktop diaries reported more than those that were only assigned mobile diaries.

7. Respondent feedback
Web diarists in the ID sample who responded to debriefing questions provided largely positive responses about the ease of recording expenses and they felt their data were secure (Table III-7a, Table III-7c). Some respondents in the mobile mode noted that they liked the ability to use a smartphone and see summaries of their expenditures; desktop mode diarists mentioned preferring that mode to a paper diary (Table III-7e). However, respondents in the mobile mode who indicated that the reporting process was difficult were associated with 30 percent fewer logins (Table III-7b). Suggested improvements for the web diaries included providing scanner functionality, making the login process easier, and permitting access via multiple devices (Table III-7f).

We did not have access to cost information for tasks related to the actual implementation of the field test at a sufficient level of detail. Therefore we were unable to estimate the cost impacts of web individual diaries compared to production diaries.

Despite suggestions individual web diarists engaged in contemporaneous reporting and limited proxy reporting in larger CUs, we conclude that overall, providing CUs with individual web diaries did not represent an improvement over having CUs report by a single proxy diarist using a paper diary. This may in part be attributable to the obstacles in implementing the test protocol as designed.

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I. Introduction

The Consumer Expenditure (CE) Diary Survey currently uses a single paper diary for capturing a consumer unit's (CU) expenditures. Household expenditures have characteristics that make them susceptible to misreporting - they cover a wide spectrum of goods and services, and consequently, they are highly variable in value as well as in the frequency of when they are incurred. Ideally, expenditures are recorded at or near the time of occurrence, and by the person who incurred them. CE's current, household-level, 8½" X 11" paper diary instrument has two main features that deter contemporaneous recording of expenditures: [1] the paper diary's size is cumbersome to carry around, and [2] the household level diary can only be with 1 person at a time, making it impossible for a household with multiple members to make entries in a timely manner. Additionally, having a single person in the CU maintain the diary for all members of the CU has drawbacks, including missed expenditures, misreporting details of the expenditures, and the additional burden imposed on a single diarist in a multi-member CU (Edgar et al., 2006). Providing paper diaries also limits the information we can collect about when and how CU members make entries. Offering each CU member an individual web diary has the potential to address these limitations of the current CE household level paper diary.

In 2014, CE conducted the Individual Diaries Feasibility Test (IDFT), featuring individual web-based diaries - a desktop diary and a mobile diary. The U.S. Census Bureau, who also conducts the CE production data collection, implemented this feasibility test. The test sought to address the feasibility of administering the test protocol as designed. In addition, there was interest into insights the test could provide about data quality, even though the test sample size was small. The questions of interest were:

1. Feasibility. What are the operational issues for implementing individual web diaries for a household as intended by the test protocol?
2. Participation. Do individual web diaries improve survey cooperation?
3. Contemporaneous reporting. To what extent do web diaries that can be accessed from any internet-enabled location lead contemporaneous reporting of expenses incurred?
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7. Respondent feedback. What can we learn from respondents about web diaries and their association with reporting behavior?

Analyses for this report examined comparisons between a single diarist in the paper diary sample (control) versus individual diarists reporting in the web diary sample at the CU level (test), as well as comparisons at the diary mode level. Although these comparisons were overlapping in the study design, the analysis examined these comparisons separately. This report describes the feasibility test study design, highlights findings to the research questions, and presents conclusions about the test of individual web diaries.

II. Study Design

Study sample
The test group in this study comprised households from the IDFT whose members were assigned individual web diaries (*the ID sample*), and the control group comprised a subset of CE Diary production cases (*the Restricted Production (RP) sample*). The sample for the ID test group was drawn from 1,216 addresses within primary sampling units (PSUs) in three Census regions: Chicago, Los Angeles, and Philadelphia. PSUs from these regions were specifically selected as they ranked highly on the following criteria (1) internet usage, (2) mobile device usage, (3) English speaking CUs, and (4) multi-person CUs. For the test, Census interviewers asked if respondents at each address had access to the internet at home through a computer, laptop, or mobile device. Only CUs who reported having access to the internet at home were eligible to participate in the test. The sample for the production group was drawn from 2,814 production cases in the same regions at the same time period. The RP sample was further restricted to match the ID test sample by only including English speaking CUs with internet access who had their 2 weekly diaries placed at the same time (i.e., those CUs with "double-placed" diaries).

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The data collection for the test sample spanned 5 months, August through December 2014.

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The test design resulted in a total of 626 CUs completing at least one diary week in the production sample and 241 CUs completing at least one diary week in the ID sample. However, most of the analysis in this report was carried out on a smaller subset in both samples that had completed both weeks of double-placed diaries – 210 ID sample CUs and 200 RP sample CUs.

Response rates (completed sample size)
The response rate for the ID sample was 22 percent, compared to a response rate of 27 percent for production cases, with the low rates partially attributable to CUs screened out for lack of internet access. Among cases placed with diaries, the cooperation rates were 55 percent and 73 percent for the ID and RP samples, respectively (see Findings section 2 for more details on response rate calculations).

Protocol
A detailed description of the field protocol, including criteria for determining eligibility, and the diary placement, pickup, and monitoring protocol for the ID sample appear in *Appendix A*. The following description highlights key aspects of the protocol.

Assignment of individual web diaries within the ID sample
After determining that the CU was eligible, the interviewer sequentially assigned respondents to the two types of web diaries. The interviewer first attempted to place the mobile diary with the respondent by asking if the respondent had access to the internet through a smartphone. If the respondent replied in the affirmative, they were automatically placed with that type of diary. If the respondent replied they did not have internet access through a smartphone, the interviewer asked if the respondent had access to the internet through a computer or tablet. If the respondent did, they were placed with a desktop diary. If the individual respondent did not have access to the internet through either a smartphone or through a computer or tablet, that CU member was deemed ineligible. If a CU member wasn't present during placement, the interviewer tasked the main diarist with answering the placement questions on behalf of the absent member and would assign the appropriate type of web diary for the absent member to

complete. Participating diarists were charged with proxy reporting for any ineligible or non-participating members. The diary keeping period was 2 weeks, as it was in the production sample.

Pickup
Unlike in Production, for the ID sample, the pickup interview did not feature any actual diary to pick up. Instead, the interviewer carried out the recall interview and recorded any receipts the respondent kept. The interviewer also asked the income and debriefing questions.

Web diary monitoring.
A primary advantage of web diaries over paper diaries is the ability of data collectors to monitor if the web diarists are routinely logging in. In additional to the routine follow-up calls interviewers are instructed to do, this test involved tailored follow-up calls for diarists who stopped logging in to their instruments. Census maintained lists of all diarists who had logged in at least once for either the mobile or desktop web diaries. Census staff notified interviewers in each regional office if a diarist had gone 3 consecutive days without logging in. Interviewers were trained to contact the designated diarists to remind them to continue making entries and to determine if they had encountered any technical problems accessing the instrument (Census, 2014).

Training and Materials
Interviewers were provided with in-person training on the test protocol. Color coded User Guides were designed for each web diary mode, and distributed at diary placement (BLS, 2014). In addition, online videos for data entry and editing in each web diary mode were developed and posted on YouTube. Respondents were given the URL for these videos during diary placement. The three videos and their view counts were:

> Part 1: Getting Started – 86 Views
> Part 2: What to Enter in the CE Diary – 53 Views
> Part 3: Entering and Editing Expenses – 52 Views

Sample characteristics
Select characteristics of the ID and RP households are shown in Table II-a for CUs with 2 weeks of completed diaries, excluding CUs in which all entries came from the interview through recall and receipts ("total recall" CUs). Among these CUs, there were more homeowners (70.7 percent vs. 63.2 percent), fewer single-person CUs (16.5 percent vs. 23.7 percent), and a lower prevalence of converted refusals (1.2 percent vs. 3.7 percent) in the ID sample compared to the RP sample.

Table II-a. CU-level sample characteristics

	ID	RP	Diff (ID-RP)	% Difference
Sample size (N, no. of cases)	164	190	-	-
Owned dwelling unit (%N)	70.7	63.2	7.5	11.9%
Dwelling unit (%N)				
In MSA	100	100	0	0.0%
20% or more of population live in poverty	4.9	9.5	-4.6	-48.4%
No. of persons in the CU (% N)				
Single person	16.5	23.7	-7.2	-30.4%
2-3	59.8	49.0	10.8	22.0%
4+	23.8	23.4	0.4	1.7%
Multiracial CU (%N)	8.5	11.1	-2.6	-23.4%
No. aged 16+ in CU (mean)	2.2	2	0.2	10.0%
Type of web diary mix within CU (%N)		n/a		
Mobile only	31.7	.		
Mobile and Desktop	11.6	.		
Desktop only	56.7	.		
No. of contact attempts (mean)	0.8	0.8	0	0.0%
No. of contacts with sample unit (mean)	0.4	0.5	-0.1	-20.0%
No. of attempts by personal visit (mean)	0.7	0.8	-0.1	-12.5%
Doorstep concerns (%N)				
None	85.4	85.3	0.1	0.1%
Not interested/hostile	1.2	3.7	-2.5	-67.6%
Converted refusal (%N)	1.8	6.3	-4.5	-71.4%

N = 354 CUs completing both diary weeks, excluding total recall CUs

Characteristics of individual diarists by their CU's mix of assigned diary types are shown in Table II-b. Compared to desktop-only CU diarists, mobile diarists were more likely to be under age 50, college graduates, white, of Hispanic origin, and live in larger CUs. Younger members appeared particularly receptive to the mobile diary, as 41 percent of mobile diarists were between the ages of 16 and 34 compared to 27 percent of paper diarists.

Table II-b. Member-level characteristics (percentages) by CU's diary type

	Diary type within ID Sample CU			RP Sample (Paper)
	Mobile only	Desktop only	Mix (Mobile and Desktop)	
No. of persons (N; total=946)	153	226	61	506
Age group (years)				
Unknown	.	.	.	2.5
16-20	8.4	6.0	10.2	9.5
21-34	32.7	18.5	14.3	17.8
35-49	35.5	19.0	28.6	28.4
50-64	15.9	35.5	36.7	27.6
65+	7.5	21	10.2	14.1
Education attainment				
Less than high school	13.1	7.0	8.2	11.1
High school grad	15.0	21.5	12.2	22.4
Some college	17.8	32.5	42.9	25.6
College grad	54.2	39.0	36.7	38.4
Unknown				2.5
Race				
White	81.3	76.0	81.6	74.1
Black	6.5	7.5	4.1	8.5
Other	12.1	16.5	14.3	17.3
Hispanic origin	15.0	8.0	12.2	11.6
CU size				
Single person	8.4	9.0	.	12.1
2-3	54.2	61.0	55.1	51.0
4+	37.4	30.0	44.9	36.9
Own dwelling unit	72.0	76.0	73.5	64.6
Area: 20%+ in poverty	11.2	2.0	.	9.0

N = diarists age 16+ from 354 double-placed CUs completing both weeks, excluding total recall CUs (164 ID, 190 RP).

III. Findings

Highlights of findings of the feasibility test's 7 research questions are presented in this section. Comparisons between the ID sample and RP sample were performed by aggregating data to the *CU-level*. In addition, there were also comparisons made within the ID sample by web diary mode at the *person-level* (CU member level). A distinction is also made between analyses at the *case level* (where a CU's 2 weekly diary outcomes and reports are aggregated for analysis) versus at the *weekly diary level* (where a CU's weekly diary outcome and reports are treated separately by week for analysis). Most of the results in this report pertain to the *case level*.

1. Feasibility

A primary objective of the feasibility test was to learn about the operational issues that arise in fielding individual web diaries for a household according to the test protocol. Knowledge of these issues will inform modifications to future test protocols or identify the resources and actions needed to make the protocols work as intended.

1a. Adherence to Protocol

Reporting in multi-member CUs
Although the goal of the test was for each eligible member to have an individual diary in which to report, many interviewers reported that there was a 'central person' in multi-member households who ended up completing the individual diaries. This belief was borne out by the data showing partial within-CU participation (see Table III-4d). Many interviewers cited this limited within-CU participation as a reason for low counts of expenditure reports and/or blank diaries.

Interviewer monitoring of diary logins
Interviewers did not consistently follow the monitoring protocol to make tailored follow-up calls to respondents who had not logged into their diary for 3 days. From debriefings with interviewers, they suggested they did not always receive notifications to do so (Census, 2015). Only 9 percent of CUs flagged for tailored follow-up calls were indicated to have received them, based on interviewer records of contacts. Interviewers were also instructed to make routine follow-up contacts with a CU 3- and 8-days after diary placement, for all CUs with placed diaries. Compliance was poor: only 58 of the 415 ID sample CUs[1] (14 percent) involved interviewers recording their follow-up contacts (Table III-1a).[2]

Table III-1a. Proportion CUs with routine follow-up contact by regional office

	N	**% with follow-up attempt**
PHI	88	5%
CHI	152	31%
LA	175	4%
Average:		14%

N = 415 double-placed ID CUs

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[1] Including CUs that never made entries by diarists or by recall/receipts.

[2] For each contact, interviewers were supposed to enter 'IDT' in a variable field in the Contact History Instrument (CHI); this analysis also captured interviewer entries of things like 'day 3, 3rd day, day 8, idft followup call', it does not capture if interviewers made follow-up contacts without identifying them in CHI.

To determine the effect of contact on respondent behavior, we focused on interviewer follow-up contacts that actually reached a sample member (43 of the 58 CUs with follow-up attempts in Table III-1a, or 10 percent of CUs) (Table III-1b).

Table III-1b. Impact of routine follow-up contacts on diary completion

	N	Did not receive (n=372)	Received (n=43)	Diff (No contact - contact)	% Difference
2-week	211	49%	70%	-21%	-30%
1-week only	27	7%	5%	-2%	-40%
No complete	177	45%	26%	-19%	-73%

N = 415 double-placed ID CUs

CUs that received a follow-up contact were significantly more likely to be 2-week completers than those that were not (70 percent versus 49 percent, respectively)[3]. They also recorded more expenditures in their diaries (Table III-1c).

Table III-1c. CU entries by whether CU member received a follow-up contact

	N	Mean	Median
Did not receive	331	25.2	0
Received	39	52.1	44
Diff (no contact – contact)	-	-26.9	-44
% Difference	-	-50%	-

Note that part of the difference in the table above is due to the fact that many who did not receive a follow-up contact did not complete diary entries, bringing down that average to 25.

1b. Obstacles to accessing the web diaries for respondents

A major selling point of web diaries over a paper diary is that they are more convenient to carry, and thus more easily accessible. There were two main barriers to accessing the web diary in the test that did not exist for paper diaries.

One barrier involved entering the URL, which, for the desktop diary was https://respond.census.gov/ced, into the device browsers. A simple, easy-to-type URL for web diaries would have facilitated easy access to the web diary; unfortunately the Census Bureau was unable to implement this due to time constraints. Instead, respondents were encouraged to set up shortcuts to the diary in their web and mobile browsers, and step-by-step instructions were included on the back of the User Guides (BLS, 2014). The extent to which these shortcuts were set up by respondents was unclear, however.

Another barrier involved the credentials – a username and password – respondents had to use each time to access their individual diaries. Interviewers across the 3 regional offices participating in the test consistently reported that respondents had difficulty with login passwords, and difficulty getting through to the Help Line (Census Interviewer Debriefing Report, 2015). Onerous password requirements can be a deterrent to diary recording. As highlighted in Figure III-1a, the CE web diary's minimum password strength requirements were more stringent than other private and public organizations. Bringing password

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[3] Mann-Whitney H=3.72, p=0.0002.

requirement in line with respondents' expectations from their sign-on experience with other entities is expected to facilitate use of web diaries.

Figure III-1a. Minimum password strength requirements for select websites.
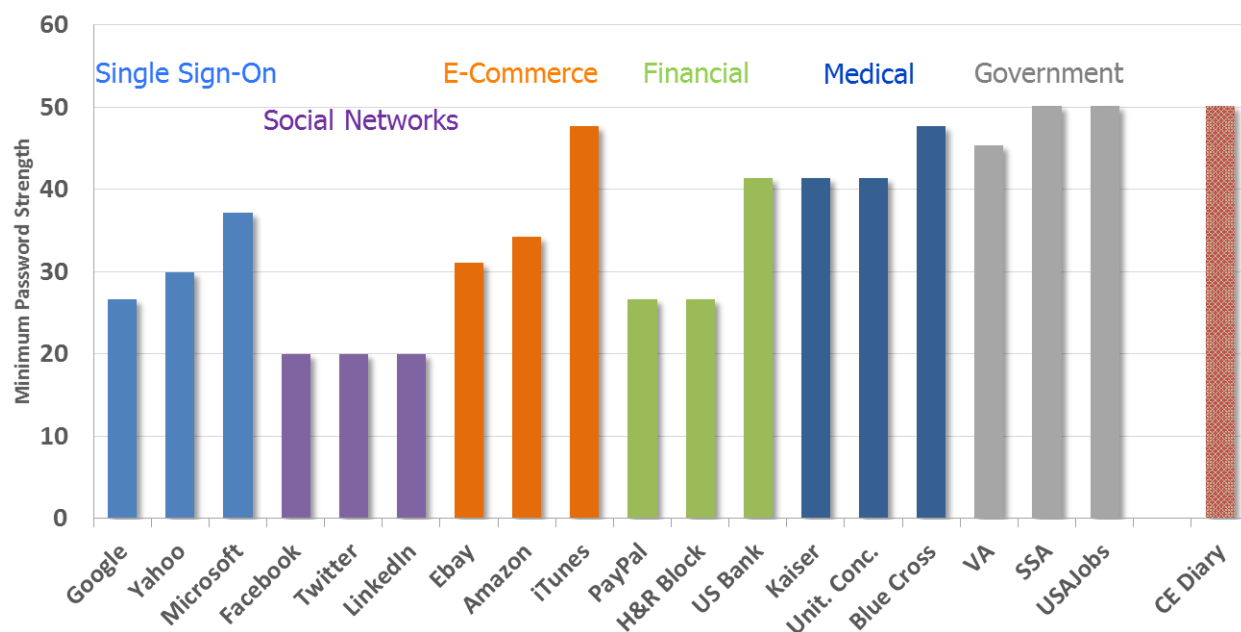
Notes to Figure III-1a: the values in the graph were calculated based on password requirements at these sites in May 2015. The websites are grouped by type based on the type of business they conduct. The Y-Axis is minimum strength requirements as calculated using this equation (Florencio & Herley, 2010): *Minimum Allowable Password Strength = (Minimum Length) X log₂ (Number of Possible Characters)*. In this equation, the number of required characters is multiplied by the log of the number of possible characters that could be placed in each position. That is, if a website requires lowercase letters and numbers, each character in the password could be one of 36 possibilities (a-z or 0-9). If capital letters are also included as a requirement, this could be 62 possibilities (A-Z, a-z, or 0-9).

2. Participation

We sought to identify whether providing individual web diaries improved survey cooperation compared to only proving one paper diary for a household. Asking one member of a household to complete a diary for all members of that household may seem like an unreasonable request to the potential diarist. One might expect an individual to be more amenable to do the survey if they do not need to record all expenses for the household. Or, they may find the ability to record expenses using their own portable devices to be preferable to using a paper-and-pencil method.

To shed light on whether individual web diaries improved survey cooperation, we examined cooperation rates by the type of diary provided. This is not an ideal test of the research question since respondents were not randomly assigned to each condition, resulting in the need to establish comparable groups – the ID and RP samples. We calculated cooperation rates according to the American Association for Public Opinion Research (AAPOR) cooperation rate formula 2, which includes partially completed diaries among the counts of completed interviews. An explanation and chart of how the outcome rates were calculated appears in Appendix B.

Table III-2. Case-level outcome rates by group.

	ID	RP	Diff	% Diff
Screen-out rate[4]	25%	31%	-6%	-19.4%
Contact rate	96%	95%	1%	1%
Cooperation rate	23%	28%	-5%	-17.9%
Response rate	22%	27%	-5%	-18.5%
'Non-response' rate (or non-placement rate)	59%	64%	-6%	-7.8%

N = 1,216 CUs (ID test), 2,814 CUs (RP control). For definitions of rates shown, see Appendix B.

Table III-2 indicates that CUs in the RP sample had 18 percent higher cooperation rates than those in the ID sample (28 percent and 23 percent, respectively). The higher 'non-response' and screen-out rates in the RP sample may be attributed to the way the sample was designed for the IDFT. The ID sample targeted PSUs with high internet rates and a higher prevalence of English speakers, so that the ineligible CUs would be effectively screened out of the ID frame prior to contact, whereas those CUs remained in the production frame and had to be 'screened out' during the analysis stage in order to get a similar RP subsample with which to compare ID outcome rates. Thus, we classified some of the RP cases as 'screen out' CUs for the calculation of outcome rates even though they responded to the survey, because they did not have internet access (or other ID eligibility criteria) and thus would have been non-respondents if in the ID sample. Since this 'non-response' group also includes non-contacted CUs, they could also be considered non-placement CUs. From interviewer debriefings, we learned that households who screened out were comprised mainly of members over the age of 55 for whom the expense of internet access was prohibitive (Census, 2015). It did not appear that offering individual diaries (or offering desktop and mobile web diary options) led to more households completing the survey; a higher percent of the CUs in the RP sample that were placed with diaries completed diaries (73 percent) compared to the rate in the ID sample (55 percent)[5]. Interviewers expressed that CU members with whom interviewers spoke personally were more likely to cooperate with the survey request (Census, 2015).

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[4] 86 percent of the screen-out rate in the ID sample is attributable to respondents reporting no home internet access.
[5] Completion for the ID sample was defined by the presence of an expenditure entry (regardless of source) for at least one CU member.

3. *Contemporaneous reporting*

One major benefit of web diaries over paper diaries was their facilitation of real-time data capture, a recommendation made for the CE survey as part of the Gemini Redesign proposal (Edgar et al., 2013). When on a mobile device, web diaries can be present with individuals throughout the day. If respondents have access to a diary and internet connection, they can record their expenses at the time of the expense, rather than having to wait until they return home. This limits the risk that they will forget to record expenditures. Unlike paper diaries, web diaries have the capability of tracking when an item was recorded in the web diary and the item's reported date of purchase. Despite this capability, data limitations in the IDFT prevented us from linking logins with the specific expenditure entries with which they were associated. Therefore, we estimated the extent of contemporaneous reporting by analyzing the distribution of diarist logins throughout a 24-hour period. If diarists made entries as they incurred various expenses (e.g., lunch, clothing purchases, movie tickets), we would expect to see a fairly constant pattern of diary logins throughout the day. Although the actual time distribution of the expenses incurred by respondents is unknown, the pattern in Figure III-3 suggests that CU members in the ID sample were engaged in contemporaneous reporting. On average, half of web diarist logins occurred during the day, between the hours of midnight and 3pm.

Figure III-3. Average proportion of diarist logins by time of day by web mode
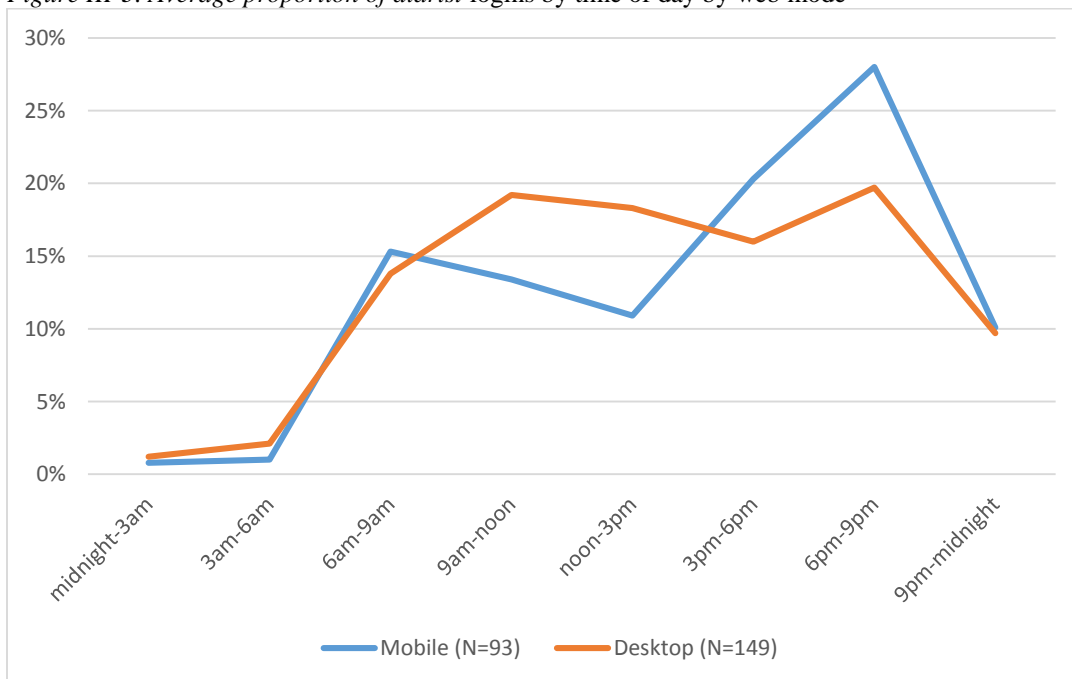
N = 242 diarists making 1+ login from 163 CUs, excluding total recall CUs

Between the two modes, we expected diarists using desktop web entry (the line in orange) might have had more of a spike in reporting toward the end of the day (e.g., when they returned from work). Instead, it was diarists using mobile diaries (the line in blue) who had a peak of an average of 28 percent of entries occurring between 6pm and 9pm (the comparable peak percent being 19.7 percent of desktop diarists in that time period).

4. Individual diarists versus household diarist reporting

A major objective of the feasibility test was to identify whether having CUs report expenditures using diaries for each household member had a discernable impact on measurement error relative to the current production structure, in which one respondent reports for the entire household, via proxy reporting. In this analysis, we assumed that a greater number of reported expenditures signified less measurement error due to underreporting. The thought is that if each household member records his or her own expenses, that items will be recorded that would be missed by a single, household-level respondent. It has been found that proxy reporting results in poorer data quality because an individual who proxy reports may not have observed all of the expenditures made by other household members (Kojetin and Jerstad, 1997).

A limitation in examining this research question was that CUs were not randomly assigned to report via either self-reporting or proxy reporting. As a result, a number of conditions were placed on the two analyses groups to attempt to isolate the effect of individualized reporting from other characteristics of the two groups. We limited the two subsamples to meet the following criteria:
  1) 2-week diary completion,
  2) No total recall CUs,
  3) CUs containing multiple members, and
  4) Multiple assigned and entry-making diarists (in the ID sample)

Several other characteristics may still account for differences. We were not able to control for income, which was not available[6]. We did not control for education since similar proportions in both groups had a member with a college graduate (64.9 percent in the ID sample and 70.5 percent in the RP sample). We did carry out an additional control for CU size, which meant limiting the RP sample to those CUs with an equivalent number of age-eligible members (e.g., over the age of 15, Table III-4f).

Before comparing the two samples, we wanted to know how frequently multiple members of the ID sample actually made entries in diaries when the CU had multiple members assigned to diaries.

Table III-4d. Mean and median number of CU entries by extent of CU member participation

	N	Mean	Median
All Assigned Diarists Participated	48	71.1	58.0
Only One or Some Assigned Diarists Participated	64	59.6	55.5
Diff (All-Some)	-	11.5	2.5
% Difference	-	16.2%	4.3%

N = 112 ID CUs containing multiple members and completing both weeks of diaries, excluding total recall CUs and entries via recall/receipts

There are two major observations we can make from Table III-4d. First, even though the test protocol permitted the option for self-reporting using individual diaries, in a majority of multi-member CUs (64 of 112), only some of the CU members who were assigned a diary actually made diary entries. In 55 of these 112 CUs with multiple members assigned diaries (49 percent), only 1 member made entries. This validates the observations of interviewers from all three regions that getting non-present household members to participate in diary keeping was difficult. One interviewer "was fairly certain that the CU member(s) she was able to speak to were really the only ones who ended up participating in the recording

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[6] Data was not processed through the Edit and Estimation System (EES), where income data is compiled.

process" (IDFT Collection interviewer Debriefing Summary, 2015). The second observation from the table is that, in CUs in which each person assigned a diary did make at least one entry, these CUs had only a 4 percent greater number of median entries than in CUs in which there was partial CU participation (58 and 55.5 respectively).

We next compared ID sample CUs with multiple participating diarists against comparable RP sample CUs that contained multiple members that would have met the age requirements to do an individual diary (age 16 or above)[7]. ID sample CUs with more than one diarist making entries reported over 30 percent fewer median entries in their diaries compared to equivalent RP sample CUs (Table III-4e). There was thus no evidence from this comparison of underreported expenditures resulting from the need to proxy report in the RP sample. One possible explanation was that the barriers to making entries unique to the ID sample (see Section III-1b) outweighed any gains in reporting due to individual diaries.

Table III-4e. Mean and median number of CU entries by group.

	N	Mean	Median
ID	57	70.4	59.0
RP	139	89.4	85.0
Diff (ID-RP)	-	-19.0	-26.0
% Difference	-	-21.3%	-30.6%

N = 196 CUs containing multiple members aged 16+ and completing both weeks of diaries, excluding total recall CUs

To further control for the specific number of CU members in multi-member households, we grouped comparisons by the number of age-eligible members (RP sample) or participating diarists (ID sample) in those households (Table III-4f). We hoped to see whether there was evidence of greater underreporting due to proxy reporting among larger CUs, where the proxy reporter may be less capable of full reporting for the entire household. In Table III-4f, we see that the gap between median ID sample entries and RP sample entries for CUs of size 2 was 25 percent, but for CUs of size 3 or more it was only 4.4 percent. Although this suggests there was some benefit from individual diaries as household sizes increased, there remained a greater number of entries in CUs in the RP sample (with a proxy reporter) than in the ID sample (with individual diarists).

Table III-4f. Count of CU entries by size and group.

	2 diarists/age-eligible members			3+ diarists/age-eligible members		
	N	Mean	Median	N	Mean	Median
ID	47	64.8	57	10	96.8	109
RP	98	82.1	76	41	107.0	114
Diff (ID-RP)	-	-17.3	-19.0	-	-10.2	-5.0
% Difference	-	-21.1%	-25.0%	-	-9.5%	-4.4%

N = 196 CUs containing multiple members aged 16+ and completing both weeks of diaries, excluding total recall CUs

Even with the controls employed here, this was not a clean test of the benefits of individualized reporting, due to the mode differences that existed between the two groups, for which we could not control.

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[7] Here, both subsamples included recall entries, because it is not possible to distinguish these entries from respondent-provided entries in the RP sample.

5. Individual web mode data quality

Taking advantage of improvements in technology, individual web diaries can provide a portable means of recording expenditures, ensure the privacy of individual expenses, and summarize expenditures for respondents, among other advantages. Do these advantages lead to improvements in data quality over paper diaries? Within the web mode, were there differences in data quality between mobile and desktop diaries?

To identify whether providing an individual web diary option led to improvements in data quality, we examined the number of diary entries and the total amount of expenditures made by CUs in the ID and RP samples. We assumed that a greater number of entries and larger expenditure totals indicated a higher level of data quality, when controlling for other factors.

5.i. Number of entries at the CU level

Examining the entry distributions across groups, we found that CUs in the ID sample recorded 31.3 percent fewer median entries than those in the RP sample (Table III-5a). The median number of entries among CUs in the RP sample was 22.5 entries greater than the number for CUs in the ID sample, the RP sample having 72 and the ID sample having 50.5 median entries[8].

Table III-5a. Mean and median number of diary entries per CU by group.

	No. CUs	Mean	Median
ID	164	59.4	50.5
RP	190	79.5	72.0
Diff (ID-RP)	-	-20.1	-22.5
% Difference	-	-25.3%	-31.3%

N = 354 CUs completing both diary weeks, excluding total recall CUs

Since the differences in Table III-5a could be attributed to factors other than the receipt of a web diary, we attempted to control for the CU's size, which may account for some differences in expenditures due to differences in the number of CU members making (and needing) expenditures[9]. When excluding multiple member CUs, the difference was smaller than that seen in Table III-5a, with 9.5 more median expenditure entries among CUs in the RP sample (47) than in the ID sample (37.5)[10].

Table III-5b. Mean and median entries per single-member CU by group

	N	Mean	Median
ID	30	36.1	37.5
RP	51	52.3	47.0
Diff (ID-RP)	-	-16.2	-9.5
% Difference	-	-30.9%	-20.2%

N = 81 single-member CUs completing both diary weeks, excluding total recall CUs

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[8] Mann-Whitney H=-4.43, p<0.0001.

[9] Data was not processed through the Edit and Estimation System (EES), where income data is compiled, to permit for controlling for income.

[10] Mann-Whitney H=-2.25, p=0.024.

We additionally examined whether there were differences in age compositions within the CUs represented in Table III-5b, however these age breaks did not reveal any group in which there were more entries in the ID sample than in the RP sample (see Appendix C for these data tables).

To further examine what may have led to differences in entries, we examined entries by section within the survey. The average number of entries was lower for the ID sample CUs than the RP sample CUs across all four sections (Figure III-5a) – Food and Drinks for Home Consumption (FDB), Food and Drinks Away from Home (MLS), Clothing, Shoes, Jewelry, and Accessories (CLO), and All Other Products, Services, and Expenses (OTH).

Figure III-5a. Count of average CU entries per section by group.
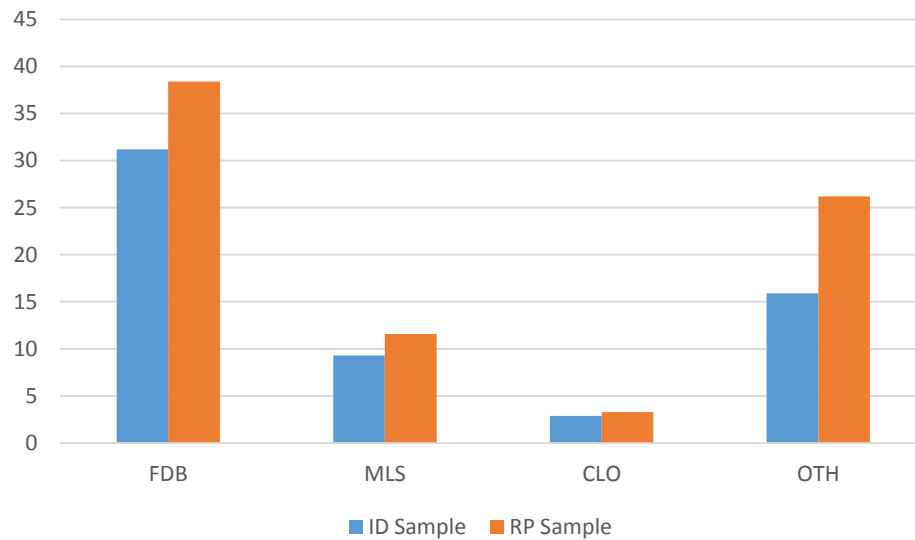
N=354 (ID=164 CUs, RP = 190 CUs)

The largest difference was for the OTH section, where, on average, there were 10 fewer entries for the ID sample (15.9) compared to the RP sample (26.2) (see Appendix C for the corresponding data tables). Examination of the percent of CUs with at least one entry in each section also revealed a difference in the OTH section - 100 percent of CUs in the RP sample made an entry versus 95 percent in the ID sample.

The lower number of entries in the individual web diaries may be due to a number of factors. First, unlike the paper diary, diarists assigned to the web diaries do not have a constant reminder of their participation in the survey (i.e., the paper diary sitting on their kitchen table). Also, the web diaries entail the added hurdle of entering a username and password (and sometimes a URL) each time the diarist wants to enter an expense. This has been shown to be burdensome to respondents in usability tests (see Section III-1b).

5.ii. Expenditure totals at the CU level

As with the analysis of the number of diary entries, there was a 46.2 percent larger median expenditure total entered by CUs in the RP sample than by CUs in the ID sample. RP sample CUs reported almost two times the median expenditure amount as their ID sample counterparts ($2,859 and $1,539 respectively) (Table III-5c)[11].

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[11] All differences were significant at the 0.05 level using Mann-Whitney non-parametric tests.

Table III-5c. Median CU expenditure total by group.

	No. CUs	Median
ID	164	$1,539
RP	190	$2,859
Diff (ID-RP)	-	$-1,320
% Difference	-	-46.2%

N= 354 CUs completing both diary weeks, excluding total recall CUs

Like with entries, we sought to examine the cause of the difference in expenditures between groups. We found that the greater total expenditure amounts entered by CUs in the RP sample was almost entirely due to their reporting greater expenditure totals in the OTH section (Table III-5d).

Table III-5d. Median CU expenditure totals per section by group.

	No. CUs	FDB	MLS	CLO	OTH
ID	164	$186	$99	$37	$584
RP	190	$187	$101	$36	$1,643
Diff (ID-RP)	-	-$1	-$2	$2	-$1,059
% Difference	-	-0.3%	-1.8%	4.3%	-64.5%

The median expenditure totals for the clothing section were actually higher for ID sample CUs by 4.3 percent. In contrast, RP sample CUs entered median expenditure totals in the OTH section that were 64.5 percent higher than the ID sample CUs ($1,643 and $584 respectively). It appears that housing costs or other big-ticket expenses were not captured via individual web diaries as well as through the paper versions. It is possible that adult household members that are mutually responsible for larger expenditures each thought the other member would enter those expenses.

5.iii. Number of entries by diary mode

We first examined differences in reporting by the web diary mode assigned to CU members – desktop or mobile. This analysis was carried out among diarists completing both diary weeks. The analysis differentiated entries reported by diarists from those entries collected by the interviewer using receipts or recall separately from those entered by the two web diary modes (Table III-5e). Desktop diarists reported a greater median number of entries than mobile diarists (31 and 21 entries, respectively). Although only a few diarists provided entries through recall/receipts, they provided more entries in this manner (45) than via the instruments themselves. To the extent that higher reporting represented improvements in data quality, desktop diarists provided better quality data than mobile diarists.

Table III-5e. Descriptive statistics of diary entries by mode.

	No. diarists	Mean	Median	Min	Max
Mobile	87	33.5	21.0	1.0	133.0
Desktop	146	41.9	31.0	2.0	177.0
Recall	16	44.5	32.5	1.0	113.0

N=diarists in 164 ID CUs completing both diary weeks, excluding total recall CUs

5.iv. Prevalence of expenditure entries by recall/receipts

Another aspect to data quality is the timeliness of reporting expenditures. Respondent reporting of expenditures soon after they are incurred avoids the risk of memory decay associated with recalling expenditures after the reporting period has ended. The data quality of web diaries can be compromised if memory decay leads to incorrect estimates or underreports of expenditures. Conversely, if receipts are used, then expenditure amounts are expected to be more accurate. In the absence of data to distinguish whether receipts or recalled expenditures were collected by the interviewer, we assumed that fewer entries collected by recall/receipts after the diary period had ended, and having consistent entry of expenditures across the diary reporting period translated to better data quality.

The proportion of total recall CUs, in which all entries were collected by interviewer in the recall/receipts process, was higher in the ID sample than in the RP sample. There were 21.9 percent of CUs in the ID sample in which respondents made no entries in the diaries compared to 5 percent of CUs in the RP sample (Table III-5f). Respondents reported difficulty in logging-in to access web diaries in the test debriefing, which may account for this relatively larger proportion of total recall CUs in the ID sample. Aside from total recall CUs, an additional 7.6 percent of CUs in the ID sample had at least one entry collected through recall/receipts. An advantage of the individual diary is that it permits identification of specific entries collected by recall/receipts – there is no equivalent indicator in the production diary. In interpreting these findings, it is important to note the operational differences between the two samples. ID diarists had the option to hand receipts to the interviewer to enter for them – User Guide instructions emphasized receipts with 5 or more items (BLS, 2014). This option was not a part of the production sample. Thus some of the entries that were entered by interviewers instead of by respondents may have been in response to that instruction.

Table III-5f. Percentage of CUs reporting expenses through recall/receipts by group.

	No. CUs	At least 1 entry by Recall/Receipts	Total Recall
ID	210	29.5%	21.9%
RP	200	NA	5.0%
Diff (ID-RP)	-	-	16.9%
% Difference	-	-	338%

N = 410 CUs completing two weeks of diary entry, including total recall CUs

Additional analysis indicated that for CUs in the ID sample, an average of 5.5 percent of their entries were collected by recall/receipts (Appendix C). After accounting for total recall, 90 percent of ID sample CUs did not have a single entry collected by recall/receipts. Looking at the debriefing responses of the 16 CUs that had some entries collected by recall/receipts, only a few indicated technical difficulties, suggesting that it was busyness or burden more than inability that led them to give many of their entries to the interviewer by recall or receipts.

5.v. Duplicate entries by expenditure section and diary mode

One potential drawback of an individual diary is that CU members do not see each other's entries and multiple CU members may take it upon themselves to report the same item. This could lead to double-counting of an expenditure. In the following analysis, we examine the prevalence of potential duplicate entries and examine what type of items are susceptible to double-counting.

For this analysis, we denoted a duplicate entry of the same item within a CU if a different CU member reported the same item for the exact same price (the item was matched using the item code)[12]. Recall expenditures were collected in the CAPI instrument at pick-up, and these expenditures were collected at the CU-level due to budgetary limitations. As a result, recall expenditures[13] did not have a member identifier associated with them, in contrast to expenditures entered directly into the mobile and desktop instruments[14], which were associated with specific members. Member-level spending was difficult to accurately analyze due to the fact that we could not associate recalled expenditures to specific members, unless it involved a single-member CU. Since recall is at the CU level, duplicate entries by recall were denoted if the same item was reported at the same exact price (there was no way to determine whether the recall entries were made by a different CU member). The appearance of duplicate entries by recall was not unexpected since the interviewer did not have access to CU member entries in the IDFT; therefore, they were not able to flag duplicate entries like they could in production paper diaries.

Of the total 12,373 items reported in the individual web diary conditions, only 64 items with possible duplicate entries were found, of which more than half occurred in the MLS section (47 items). By diary mode, more than half of these entries (38 items) were reported in the desktop mode (see Table III-5g). The number of potential duplicates is quite small because of the stringent criteria used to identify them.

Table III-5g. Count of possible double reports from multiple-member CUs by mode and expenditure section

	FDB	MLS	CLO	OTH	Row total
Mobile	2	15	0	1	18
Desktop	6	26	0	6	38
Paper	NA	NA	NA	NA	NA
Recall	0	6	0	2	8
Column total	8	47	0	9	64

NOTE: Since the paper diary is completed at the household level, individual members are not identified.

The range of expenditures associated with items that may have been duplicate entries is shown in Table III-5h. Compared to items with non-duplicate entries, expenditures associated with duplicate items were consistently much smaller in value.

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[12] In addition, blanks (i.e., B) and null values (for paper diary and recall) in the member identifier field were treated as a member number as well; meaning that when the same person reported something for the mobile/desktop version and also as part of the recall interview it was treated as duplicate reports by "different household members."

[13] Indicated by MODETYPE=3.

[14] Indicated by MODETYPEs 1 and 2.

Table III-5h. Expenditure range and average of duplicate and non-duplicate entries by mode and diary section

	Non-Duplicate Items				Duplicate Items		
	FDB	MLS	CLO	OTH	FDB	MLS	OTH
Average Item Cost							
Mobile	$ 17.78	$ 9.33	$ 49.19	$ 52.35	$ 1.18	$ 3.59	$ 1.98
Desktop	$ 13.53	$ 7.19	$ 33.05	$ 67.47	$ 9.43	$ 5.48	$ 50.54
Paper	$ 12.72	$ 6.43	$ 31.11	$ 95.83	$ -	$ -	$ -
Recall	$ 16.72	$ 7.31	$ 33.02	$111.15	$ -	$ 7.72	$108.27
Minimum Item Cost							
Mobile	$ 0.02	$ 0.00	$ 0.21	$ 0.04	$ 1.18	$ 0.75	$ 1.98
Desktop	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 7.70	$ 0.66	$ 7.83
Paper	$ 0.00	$ 0.00	$ 0.25	$ 0.00	$ -	$ -	$ -
Recall	$ 0.94	$ 0.16	$ 0.87	$ 0.33	$ -	$ 0.82	$ 1.98
Maximum Item Cost							
Mobile	$ 958.00	$ 299.00	$305.95	$ 965.65	$ 1.18	$ 15.00	$ 1.98
Desktop	$ 188.92	$ 338.14	$507.60	$ 3,150.00	$ 12.10	$ 16.19	$ 214.56
Paper	$ 473.65	$ 3,035.01	$432.00	$18,312.48	$ -	$ -	$ -
Recall	$ 180.00	$ 500.00	$300.00	$ 5,824.28	$ -	$ 16.19	$ 214.56

NOTE: There were no duplicate items for clothing so that column was removed from the table.

5.vi. Item non-response by diary mode

Missing data is a problem with any form of data collection. The following analyses were performed to examine whether the prevalence of item non-response was higher or lower for the web diaries compared to the paper diary. Although both the ID and RP samples had very low rates of missing data for the cost and item description fields, the rate was slightly lower for the RP sample (Table III-5i).

Table III-5i. Percentage of diary entries with item non-response for item cost or item description by group.

	No. Entries	Item Cost	Item Description
ID	12,373	1.7%	1.7%
RP	15,685	0.7%	0.2%
Diff (ID-RP)	-	1%	1.5%
% Difference	-	143%	750%

We additionally examined differences in missing rates for the cost field by mode (Table III-5j).

*Table III-5j. Percentage of diary entries with item non-response for item cost or item description by mode.*

	No. Entries	Item Cost	Item Description
Mobile	3,123	0.7%	1.5%
Desktop	6,481	2.8%	2.5%
Paper	15,689	0.7%	0.2%
Recall	2,769	0.3%	0.0%

There was lower item non-response for cost amounts (which include entries of $0) in the mobile mode than in the desktop mode (0.7 percent and 2.8 percent, respectively). The item description field had the same pattern, with lower item non-response rates in the mobile mode. Additional analysis on item non-response rates for follow-up questions is in Appendix C.

5.vii. *Rounding of reported values by mode*

Rounding of reported expenditure values is an indicator of poor reporting quality. Respondents may enter rounded values because they are easier to type into an instrument, because they believe they are "close enough," or because they do not remember the exact value. Although the counts of rounded values convey the scale of the issue, the percentage of values that are rounded is a more interpretable measure. In Figure III-5b, there are a large number of rounded values in the paper mode, however there were also many more expenditures listed (15,689 for paper vs. 6,481 for desktop, 3,123 for mobile, and 2,769 for recall).

Figure III-5b. Count of expenditure values ending in various cent values by mode of data collection.
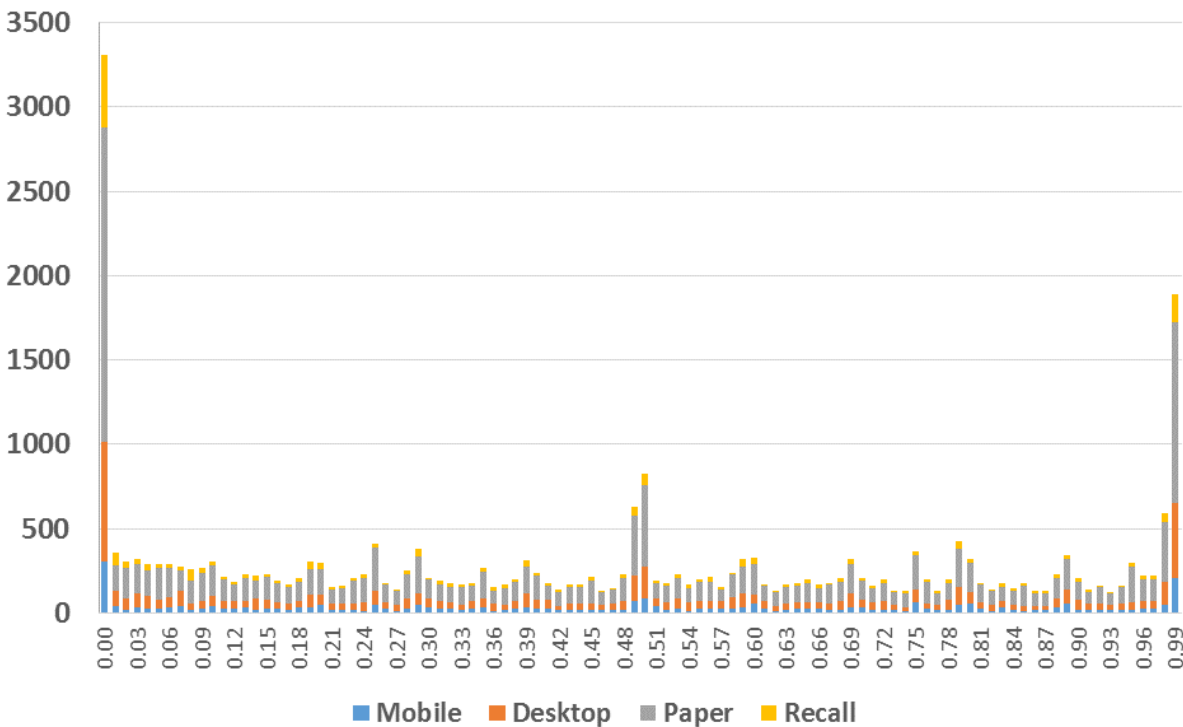
Looking at the percentage of cost values that were rounded shows that only around 10 percent of the reported cost values were rounded to an even dollar value (Table III-5k). The percent of rounded reports was relatively consistent regardless of mode. Only the recall data had a higher percent of rounded values, as would be expected.

Table III-5k. Percentage of expenditure values rounded to nearest dollar by mode.

	No. Entries	Rounded Expenditure Values
Mobile	3,123	9.7%
Desktop	6,481	11.0%
Paper	15,689	11.9%
Recall	2,769	15.6%

5.viii. Drop-off in reporting across the diary-keeping period

We examined the distribution of CU expenditures across time periods – the proportion of all expenditures reported to occur in the second week of diary reporting. There is no reason to expect that respondents would have more expenses in the first week of any two-week reporting period. Therefore, if respondents enter all of their expenditures, we would expect to see, on average, 50 percent of entries coming from Week 2. We calculated the number of expense entries by the week in which they occurred for each household, then derived the average across households in the ID and RP samples (Table III-5l). A limitation of this analysis was the inability to disaggregate entries from recall/receipts from other entries in the paper diaries, resulting in these entries being included for both ID and RP samples. Therefore, it is possible that some of the differences in drop-off may reflect differences in providing entries via receipts/recall by group.

Table III-5l. Percentage of CU entries occurring in Week 2 by group

	No. CUs	Mean Percentage
ID	164	42.2%
RP	190	47.1%
Diff (ID-RP)	-	-4.9%
% Difference	-	-10.4%

N = 354 CUs completing two weeks of diary entry, excluding total recall CUs but including recall/receipt entries

There was a significant difference in the drop-off in entries between the ID sample CUs and the RP sample CUs (42.2 percent and 47.1 percent, respectively)[15]. This greater drop-off among ID CUs may suggest CUs losing interest with the diary-reporting task over time. Additional analysis on drop-off rates by web diary mode is in Appendix C.

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[15] t(df=352)=2.53, p=0.01.

6. Characteristics of ID sample CUs exhibiting higher data quality

Although the analysis in Section III-5 does not suggest that providing a web diary leads to improvements in data quality, we sought to identify whether there might be improvements in quality among some of the CUs who received web diaries. Identifying characteristics of participating households that provide high quality expenditure reports would allow for targeting certain households with an optional web diary, or modifying protocols to promote conditions favoring higher data quality.

On way we examined this research question was by regressing the number of entries made by web CUs on the characteristics of participating CUs and the extent of their interviewer contacts. Table III-6 shows coefficients from two regressions models. The dependent variable in the first model is the log transformed number of entries made including those entered by the interviewer through recall/receipts (which corresponds to the counts in Table III-4a). The dependent variable in the second model is the log transformed number of entries made only by the respondents themselves in the instrument.

Table III-6. Regression of CU characteristics and interviewer contacts on the log of entries for the ID sample

	Model 1		Model 2	
	Coefficient	SE	Coefficient	SE
Intercept	1.161***	(0.284)	1.018**	(0.316)
Two-week completion	1.151***	(0.172)	1.068***	(0.192)
CU Size	0.116*	(0.045)	0.080	(0.050)
Number days with a login[16]	0.062***	(0.017)	0.088***	(0.019)
CU assigned Desktop Diary(s)	0.454***	(0.132)	0.584***	(0.147)
CU assigned Mix of Diaries	0.454*	(0.200)	0.512*	(0.223)
Interviewer made routine contact	0.456**	(0.163)	0.306	(0.182)
CU member highest education: some college	0.342	(0.212)	0.197	(0.236)
CU member highest education: college graduate	0.571**	(0.193)	0.625**	(0.214)
Youngest CU member (>16): aged 36-50 years old	0.197	(0.154)	0.295	(0.171)
Youngest CU member (>16): aged 51 and older	0.068	(0.155)	0.025	(0.172)
	Model R² =	0.40	Model R² =	0.39

*p<.05; **p<.01; ***p<0.001
N = 189 ID CUs completing at least one week of diaries, excluding total recall CUs[17]
Dependent variable in Model 1: number of entries made by both respondents and interviewers.
Dependent variable in Model 2: number of entries made by both respondent only.

Of note in the regressions, when comparing predictors of the overall number of entries (Model 1) and predictors of entries made by the respondents (Model 2), CU size was not significant in Model 2. This is because the 18 CUs in which interviewers entered entries for the CU involved larger-than-average CUs (a majority had 3 or more members), and larger CUs were associated with more interviewer-assisted recall/receipt entries. This suggests that, the larger the household, the more burden may be placed on interviewers to supply entries on behalf of household respondents. Another difference between the two models was that the variable for whether the interviewers made a routine (3- or 8-day) reminder contact was not significant in Model 2. This may be due to CUs having many recall entries among these 28 'reminded' CUs. However the variable for reminder contacts was still close to attaining significance in Model 2 (p<0.1).

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[16] We also examined a separate model using a predictor of the number of times a CU logged-in to an instrument, however this did not affect any of the findings from the models above.
[17] Two CUs with missing values for the number of days with a login were removed from the analysis. The analysis excluded 49 cases in which all entries were the result of recall.

Overall, the models indicated that the more consistently diarists logged in to make entries, the greater number of entries resulted; CUs in which a member had a college degree were associated with a greater number of entries; and in this test, CUs who made entries through a desktop or tablet device were associated with a larger total number of diary entries than those making entries via smartphones. The models also suggested the practice of interviewers making routine reminder contacts could lead to a greater number of overall entries (though this was not significant at the 0.05 level when excluding entries made via recall).

Another correlate of greater web diary entries and higher expenditure totals was respondents who logged in early in the diary keeping period compared to those who did not. Web diarist who first logged in within the first 3 days had a higher number of entries and a higher median dollar value of total expenditures. (Figure III-6).

Figure III-6. Median expenditures and entries by whether a CU member logged in during the first 3 days.
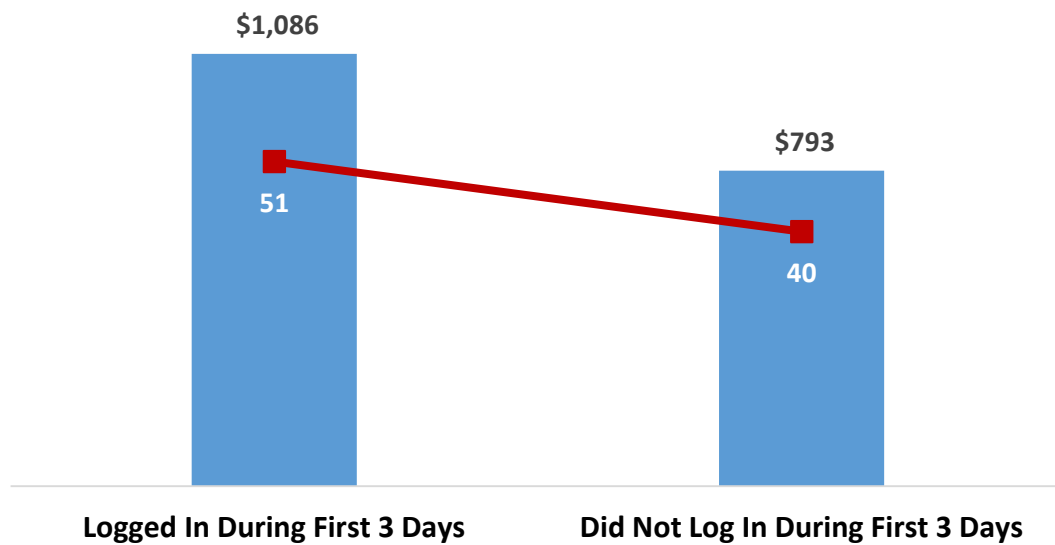
Having a protocol that encourages interviewers to prompt respondents to start logging in early in the reporting period may result in an increase in reported expenditures.

7. Respondent Feedback

Debriefing questions administered at the conclusion of the diary pick-up interview provided ID sample respondents the opportunity to give feedback on their web diary experience. Since respondents may not have been present at the pick-up interview, or may not have completed the diary (questions were asked regardless of whether they entered expenditures in the web diary), we focused analysis on the subset of age-eligible respondents who were assigned a web diary and provided a valid response to the categorical debriefing questions. These respondents reported what they liked about the diary, their perceptions of ease or difficulty of expenditure entry, suggestions for improvements, and perceptions of data security.

We compared responses to the question, "How easy or difficult was it to record your expenses?" between respondents assigned a mobile web diary and those using desktop web diaries (Table III-7a).

Table III-7a. Distribution of diarist responses to ease of recording expenses question by mode group[18]

	Mobile	Desktop	Overall
Very easy	27%	35%	31%
Easy	24%	33%	29%
Neither easy nor difficult	21%	14%	18%
Difficult	11%	9%	10%
Very difficult	16%	10%	13%

N = Diarists from 213 ID CUs providing valid responses (mobile = 135 diarists, desktop = 135 diarists)

Respondents were more likely to indicate that it was easy or very easy to record expenses (50 percent) than difficult or very difficult (23 percent). There was a significant difference in how easy the task was perceived to be by mode[19]. Respondents assigned to the mobile instrument were less likely to report that the task of entering expenses was easy than those assigned to diaries using a desktop. This may be a feature of the test, in that respondents were assigned by default to make entries via a mobile phone if they had one, regardless of their level of comfort with that device. We examined whether there was an association of responses to the debriefing question with reporting (login and entry) behavior (Table III-7b).

Table III-7b. Reporting measures by diarist difficulty of task response by mode[20]

	Mobile				Desktop			
	Hard	Not hard	Diff (hard-not)	% Diff	Hard	Not hard	Diff (hard-not)	% Diff
N	13	65	-	-	12	101	-	-
Logins	8.1	11.5	-3.4	-29.6%	15.3	9.4	5.9	62.8%
Entries[21]	28.7	28	0.7	2.5%	27.3	40.9	-13.6	-33.3%

N = Diarists from 146 ID CUs who had at least 1 login

Overall, web diary respondents who felt that task was 'difficult' or 'very difficult' did not differ in their number of logins. A different pattern emerges when we control by the type web diary respondents used,

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[18] Frequencies of the categorical debriefing questions that include invalid responses are included in Appendix 3.
[19] Mann-Whitney non-parametric tests: H=2.4, p=0.016.
[20] 'Hard' includes 'difficult' and 'very difficult'; 'Not hard' includes 'neither easy nor difficult,' 'easy,' and 'very easy.' Mode group refers to mode in which respondents actually made entries.
[21] Excludes entries from recall/receipts

however. Respondents who assessed the task as hard and used the mobile instrument had 29.6 percent fewer logins than those who did not find it hard. Respondents who assessed the task as hard and used the desktop instrument had 62.8 percent *more* logins than those who did not find it hard[22]. Respondents using the mobile instrument had no difference in entries based on their assessment of task difficulty. Respondents using the desktop instrument and assessing the task as hard had 33% fewer entries than those who did not assess it to be hard. One hypothesis is that the response to the task difficulty question meant different things for respondents using different modes. Respondents using the mobile instrument may have been expressing that the process of logging-in to the instrument was difficult when answering that question, whereas respondents using the desktop instrument may have been referring to the process of entering expenditures in the instrument.

Another debriefing question dealt with the perceived security of the instruments, "When using the application to record your expenses, how secure do you feel that your data is?" (Table III-7c).

Table III-7c. Distribution of diarist responses to perceived security question by mode group[23]

	Mobile	Desktop	Overall
Completely secure	44%	53%	49%
Secure	29%	21%	25%
Neither secure nor unsecure	16%	17%	17%
Somewhat unsecure	4%	5%	5%
Completely unsecure	7%	3%	5%

N = Diarists from 213 ID CUs providing valid responses (mobile = 135 diarists, desktop = 135 diarists)

Regardless of the mode they were assigned[24], respondents reported that their data was secure or completely secure (74 percent) with only a few expressing security concerns (10 percent). We examined whether there was an association of responses to this debriefing question with reporting (login and entry) behavior (Table III-7d).

Table III-7d. Diarist reporting measures by perceived security

	Unsecure	Not unsecure	Diff (Unsecure-Not)	% Diff
N	10	181	-	-
Logins	10.5	10.4	0.1	1.0%
Entries	33.8	34.9	-1.1	-3.2%

N = Diarists from 146 ID CUs with at least 1 login

We see in the table above, that there were no major differences in respondents' login or entry behaviors based on their perceptions of data as somewhat or completely unsecure[25].

Respondents also were asked two open-ended questions about the instrument. The first regarded aspects of the individual diaries that they liked, "What did you like about this application?" (Table III-7e).

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[22] The later difference only approached significance [Mann-Whitney, H=1.4, p=0.168]. No other differences were found to be significant.

[23] Frequencies of the categorical debriefing questions that include invalid responses are included in Appendix 3.

[24] No significant difference was found. Mann-Whitney tests: H=1.4, p=0.17.

[25] Breaking out mode in the table also revealed no significant differences.

Table III-7e. Frequency of things diarists liked about diary by mode group

	Mobile	Desktop	Overall
User friendly/self-explanatory	49%	53%	51%
Informative about spending	9%	5%	7%
Easier than paper/offline	0%	8%	5%
Navigation/organization	3%	6%	5%
Liked ability to use smartphone	10%	0%	4%
User Guide	3%	1%	2%
Quick	3%	2%	2%
Other/non-interpretable	10%	13%	12%
Nothing	6%	6%	6%
Didn't use/negative response	8%	5%	6%
Total	100%	100%	100%

N = Diarists from 146 ID CUs with at least 1 login (mobile = 78 diarists, desktop=113 diarists)

In their own words, respondents who had at least one login volunteered that the instrument (whether the mobile or desktop version) was easy to use and self-explanatory (49 percent of mobile responses, 53 percent of desktop responses).

The three most frequently-mentioned favorite aspects of each mode are listed below.

Mobile:
1. Ability to use a smartphone (10 percent)
2. Ability to see information about their spending in the application (9 percent)
3. The ease and speed of navigation (6 percent, combined)

Desktop:
1. It was easier to use than a paper diary (8 percent)
2. It was easy to navigate and well-organized (6 percent)
3. Ability to see information about their spending in the application (5 percent)

These responses can be cited as selling points for the diary during placement attempts.

The second open-ended debriefing question asked, "How could we improve the process of recording your expenses?" and elicited a wide range of responses. Table III-7f includes responses from diarists who had at least one login and provided a substantive response to the debriefing question[26].

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[26] Almost 50% of responses were 'nothing' 'don't know' or uninterpretable.

Table III-7f. Frequency of things diarists felt could be improved for recording expenses by mode group

	Mobile	Desktop	Overall
Change in CE survey practices[27]	26%	17%	21%
Scanner/photo functionality	15%	15%	15%
Logging in (make easier)	13%	9%	11%
Have access via other/multiple devices	20%	2%	10%
Improved instructions[28]	9%	9%	9%
Make it easier to enter many items (receipts)	4%	9%	7%
Faster connection	0%	9%	5%
Ability to change username/password	4%	4%	4%
Help Desk	4%	4%	4%
Better organized	0%	6%	3%
Date default/date function didn't work on Mac	0%	4%	2%
Don't let user time-out	0%	4%	2%
Ability to move entries across sections	0%	4%	2%
Have memory of entered items	2%	0%	1%
Add clickable calendar	2%	0%	1%
Allow multiple simultaneous users	0%	2%	1%
Daily reminders	0%	2%	1%
Ability to download data into diary	0%	2%	1%
Total	100%	100%	100%

N = Diarists with at least 1 login, excluding non-substantive responses (mobile = 46 diarists, desktop=54 diarists)

Many diarists suggested changing something that was a current CE requirement. Among changes that could be implemented in future tests, many respondents suggested providing an ability to scan or take photos of receipts, and relatedly wanted entry of multiple items (e.g., grocery purchases) to be easier. Respondents also felt the log-in process could be simplified (especially in the mobile mode, which may explain the mobile login findings in Table III-7b). Those in the mobile mode wanted to be able to also use the desktop mode. These responses indicate that some features of the test may not have been fully explained to respondents, such as the ability to change their password, and other features of the test were not appreciated, such as the need to log back in after a period of inactivity. Individual responses suggested having the diary be able to auto-recall a previously-entered expenditure description or vendor, having a calendar display that could be clicked to get to a certain date, allowing for simultaneous entries by multiple diarists, receiving a daily reminder about the diary task, and having the ability to download expenditure information from a bank account directly.

Although there is not a clear explanation for why respondents assigned to the mobile diary entered fewer entries than those assigned to the desktop diary, their responses to the debriefing questions suggest mobile diarists had more difficulty with the log-in process (even those who had logged in at least once), and wanted to be able to use a desktop diary as well as their smartphones when making entries.

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[27] For Mobile: redefining how expenditures are classified, simplifying requirements (e.g., remove need to specify bottled/canned, remove need to itemize groceries); for Desktop: having more categories, simplifying requirements
[28] For Mobile, defining how to enter expenses for those on vacation, how to classify grocery items as bottled or fresh; For Desktop: provide more examples of how to categorize items, how much detail to include

V. Discussion and Conclusion

The motivation for the CE Program to consider offering individual web diaries as a mode option was that they have the potential of directly addressing two limitations with the current CE Diary design: a single paper diary for each responding household, and a paper diary that is not likely to be present on the respondent throughout the day. Specifically, the advantages that the CE Program hoped to reap from individual web diaries were:

1. facilitate respondents' "real time" recording of expenses since the web diaries utilized by this test (smartphone, tablet/desktop computer) would be more portable than a 8½" by 11" paper diary;
2. take advantage of the ability (technically) to monitor respondents' use of the web diary during the diary keeping period, in order to provide reminders/prompts to respondents *during* the diary keeping period as needed;
3. the ability (technically) to measure the lapse in time from when an expense was incurred and when it was recorded in the web diary. This would indicate the extent to which contemporaneous reporting was occurring, something not possible with paper diaries; and
4. minimize omissions of incurred expenses to which a single diarist proxy reporting for all eligible household members would be susceptible.

We report on the extent the individual web diary test protocol was implemented as designed, as well as the extent to which the potential technical strengths of web diaries were realized.

From the feasibility test, we learned the following:

1. There were challenges implementing the test protocol as designed.
   - The data indicated a lower than expected prevalence of all eligible household members cooperating with the survey request in multi-member CUs. Other measures beyond offering individual diaries, such as the offering of incentives, may be needed to maximize within-CU participation.
   - The need to enter a long web site address and the complexity of password requirements made logging in to the web diaries a difficulty for many respondents.
   - The CE Program needs improvements in the infrastructure supporting web diary monitoring to be able to take advantage of the full functionalities of web diaries.

2. There was no improvement in household cooperation rates for the ID sample compared to the RP sample. Within-household participation rates in the ID sample were also low; in almost half of CUs where multiple members were assigned diaries, only one member made entries. This mitigated an intended advantage of individual diaries – that more members would be participating in recording expenditures.

3. The examination of contemporaneous reporting of expenses for respondents with web diaries was hampered by data limitations. Specifically, we did not have a linking identifier that permitted the association of when an item was recorded in the web diary and the item's reported date of purchase. To deal with this constraint, we examined the distribution of logins among those given web diaries, and found steady login rates throughout the day, providing evidence of real-time reporting of expenditures. On average, half of diarists' logins occurred between the hours of midnight and 3pm.

4. Single proxy respondents using paper diaries reported more median entries than diarists assigned individual web diaries, among multi-member CUs. Some of this difference may be accounted for by the low within-household participation in ID sample CUs. There was some suggestion that individual web diaries may have limited underreporting associated with proxy reporting; as household sizes increased (and as more diarists participated in making entries), the gap in entries in favor of household paper diaries was reduced.

5. There were fewer entries and lower median expenditure totals among the ID sample CUs compared to the RP sample CUs. Both groups had a drop-off in diary entries in the second week of the diary reporting period, although this was more pronounced in the ID sample. There was a higher prevalence of the less preferred total recall CUs in the ID sample, as well as slightly higher item non-response rates (e.g., for expenditure values and item descriptions). The extent of rounding of expenditures was relatively consistent across diary modes, and there was evidence of some duplicate reporting of items in multi-member ID sample CUs. Overall, we conclude that the reporting behavior of individual web diary CUs did not represent an improvement over that of the production paper diary CUs, likely due to the challenges described in point 1.

6. We identified characteristics that were associated with a larger number of entries and higher expenditure amounts among CUs given web diaries. A design that focuses on CU members with higher education levels, that emphasizes and supports interviewer monitoring to ensure compliance with the diary-keeping task, and that encourages respondents to log in early in the reporting period is expected to result in higher expenditure reporting among web diarists.

7. Feedback from diarists in the ID sample who responded to debriefing questions was largely positive regarding the ease of recording expenses and the security of their data. Some respondents in the mobile mode noted that they liked the ability to use a smartphone and see summaries of their expenditures; desktop mode diarists mentioned preferring that mode to a paper diary. However, respondents in the mobile mode who indicated that the reporting process was difficult were associated with 30 percent fewer logins. Suggested improvements for the web diaries included providing scanner functionality, making the login process easier, and permitting access via multiple devices.

We did not have access to cost information for tasks related to the actual implementation of the field test at a sufficient level of detail. Therefore we were unable to estimate the cost impacts of individual web diaries compared to production diaries.

Despite suggestions individual web diarists engaged in contemporaneous reporting and limited proxy reporting in larger CUs, we conclude that overall, providing CUs with individual web diaries did not represent an improvement over having CUs report by a single proxy diarist using a paper diary. This may in part be attributable to the obstacles in implementing the test protocol as designed.

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Appendix A. Individual Diaries Protocol

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Appendix B. Case-level Disposition Chart

Chart A. Case-level disposition chart

1. RP sample				
Sample Frame* (F=2,814)	CE Ineligible (NE=457)			
	Screen-Out (S=876)			
	Comparison Eligible (E=1,481)	Non-contact (UC=109)		
		Contacted (C=1,372)	Refusal (passive or explicit; RF=520)	
			Placed (PL=852)	Not completed (NR_RF=226)
				Completed (INTV=626)
2. ID sample				
Sample Frame (F, 1,216)	CE Ineligible (NE, 140)			
	Screen-Out (S, 302)			
	Test Eligible (E, 774)	Non-contact (UC, 43)		
		Contacted (C, 731)	Refusal (RF, 294)	
			Placed (PL, 437)	Not completed (NR_RF, 196)
				Completed (INTV, 241)

Notes on Control sample:
- *Sample frame: represents production CUs in the Philadelphia, Chicago or Los Angeles ROs.
- CE Ineligible: (Type B/C definition currently used in production)
- Screen-Out (RP sample): CUs screened out due to sample unit not meeting criteria for comparison with test group. This includes some CUs that were placed with diaries - but because of need for comparability (e.g., CUs with Internet access) were not included among placed CUs ('PL').
- Completed (RP sample): for comparability with ID sample response rates, this includes 'test eligible' CUs (e.g., had Internet access, weren't spawned, English speaking) that were completes but were not double-placed [in the report analysis, only the 205 completes that were double-placed, out of the 626 total completes, were analyzed].

CU-Level outcome rates (defined with respect to Chart A):
1. Screen-Out rate
=S / F
Control: 876 / 2,814 = 31%
Test: 302 / 1,216, 25%
- No internet =261/302 =86%
- Language issues = 32/302 = 11%
- Spawned CUs = 9 / 302 =3%

2. Contact rate
=[C + S] / [E + S]
Control: [1,372 + 876] / [1,481 + 876] = 2,248 / 2,357 = 95%
Test: [731 + 302] / [731 + 302 + 43] = 1,033 / 1,076 = 96%

3. Cooperation Rate[29]
=INTV (for at least one CU member) / [C + S]
Control: 626 / [1,372 + 876] = 626 / 2,248 = 28%
Test: 241 / [731 + 302] = 241 / 1,033 = 23%

4. Response Rate (at least 1 member in the CU; equals Contact rate x Cooperation rate)
= INTV (for at least one CU member) / [C + UC + S]
Control: 626 / [1,372 + 109 + 876] = 626 / 2,357 = 27%
Test: 241 / [731 + 43 + 302] = 241 / 1,076 = 22%

5. 'Non-Response' Rate (note: for comparison purposes)
= [E + S – PL] / [E + S]
Control: [1,481 + 876 – 852] / [1,481 + 876] = 1,505 / 2,357 = 64%
Test: [774 + 302 – 437] / [774 + 302] = 639 / 1,076 = 59%

Among 437 placed CUs (ID Sample):

Placed 1 week (22)	
Double-placed (415)	Not completed (177)
	Completed 1 week (28)
	Completed 2 weeks (210)

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[29] AAPOR Cooperation Rate 2 includes some who are unable to do an interview (e.g., due to language/lack-of-internet screen-out) as capable of cooperating.

Appendix C. Web Mode Miscellaneous Tables

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Appendix D. Data Issues Log

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