

Measuring Consumer Expenditures with Payment Diaries

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Abstract:

As the 2012 Diary of Consumer Payment Choice (DCPC) illustrates, there are advantages to measuring consumer expenditures by tracking the authorization of payments by instrument type (cash, check, debit or credit card, etc.). The main advantages of payment diaries appear to be the following: 1) the ability to measure expenditures by payment instrument aggregated into lumpy purchases (“shopping baskets”), 2) relatively low respondent burden, and 3) effective random sampling. Three notable results emerge from comparing the 2012 DCPC estimates with estimates from other reputable estimates of the current value of consumer expenditures: 1) DCPC *payments* estimates are 75 percent higher than Consumer Expenditure Survey estimates; 2) DCPC *consumption* estimates are 17 percent higher than personal consumption expenditures estimates in comparable expenditure categories (about half of the categories are comparable); and 3) DCPC payments roughly equal comparably adjusted national income and product accounts disposable income.

Keywords: payments, consumer expenditures, consumption, income, diary survey

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1. Introduction

Obtaining the best possible estimates of consumer expenditures is crucial to proper construction of consumption data and applied economic research on consumer behavior. Measuring consumer expenditures well is complex and difficult, as is evident in the comprehensive volume by Carroll, Crossley, and Sabelhaus (2015). The challenges, which are manifest in discrepancies between microeconomic and aggregate estimates of consumption and related data, as documented by Cynamon and Fazzari (2015) and Fixler et al. (2016) among others, confound efforts to understand households' responses to the recent financial crisis. One basic problem is that the leading U.S. data source, the Consumer Expenditure Survey, covers only about three-fifths of personal consumption expenditures. However, in a potentially promising development, Bagnall et al. (2016) report that aggregate payment values from individual consumer diaries conducted during the 2009–2012 period in seven industrial countries amounted to between 72 and 111 percent of national income estimates of consumption, suggesting that payments data might contribute to a solution.¹ Though imperfect, these relatively high estimates merit further investigation.

This paper uses the Boston Fed's 2012 Diary of Consumer Payment Choice (DCPC) to describe and quantify the advantages of collecting consumer expenditure data using payment diaries that record daily authorizations by the type of payment instrument (cash, check, money order, debit or credit card, online banking, etc.) at the point-of-sale (POS), for bill payment (BP), and for all other payments. The DCPC was implemented daily in October 2012, with a representative sample of U.S. consumers in conjunction with the Boston Fed's annual, recall-based Survey of Consumer Payment Choice (SCPC), which does not collect expenditure values. According to the 2012 DCPC, the average U.S. consumer made 1.9 payments per day (58 per month) worth \$124 daily (\$3,869 per month or \$46,428 per year). Cash accounted for 41 percent of consumer payments (the most) by number, but for only 12 percent by dollar value, because the dollar value of the average cash payment was lowest (\$19) among the payment instruments.

In theory, measured properly, consumer payments represent a nearly comprehensive distribution of personal income, comprising: 1) consumer expenditures for nondurable goods and services plus investment in durable goods, 2) all taxes, and 3) the part of personal saving associated with payments that transfer money from cash or deposit accounts to other assets (an

¹ This cross-country comparison of consumer payment diary surveys shows that consumer expenditures are remarkably similar across developed countries, especially the number of payments per day and the daily value of expenditures (the latter adjusted for income differences), although choices of payment instruments vary more across countries.

asset transfer) or liability accounts (such as loan repayments).² In practice, however, payment diaries typically measure only expenditures made directly by consumers for themselves. Thus, diaries typically exclude the expenditures made on behalf of consumers by third parties such as employers, although these third-party expenditures could be tracked with more-comprehensive diary surveys or other data sources.

Consumer payment diaries have several advantages for collecting expenditure data. Like other diary surveys, the DCPC asks respondents to record their expenditures each day. In most cases, recording is done at the point of payment throughout the day, although in some cases it may not occur until the end of the day. Daily recording of payments data involves less measurement error from memory loss than typically occurs with recall-based surveys, which rely on respondents' recollections of past expenditures after the passage of more than a day, typically a week, month, or longer period of time. Moreover, *payment* diaries achieve better coverage of all types of consumer expenditures than *product* diaries because they increase coverage and recall by aggregating expenditures into lumpy purchases ("baskets") by payment instrument rather than tracking or attempting to track every single individual good and service purchased.³ By tracking all payments authorized, by instruments (a small number relative to the number of individual items purchased), payment diaries also achieve broader coverage of household economic activity than typical consumer surveys that focus on a narrower range of expenditures or more-highly aggregated survey categories that combine easily forgotten smaller expenditures. Combined with properly designed, high-frequency sampling strategies, payment diaries require relatively short participation periods (three days) and a lower respondent burden. Together, these advantages significantly improve estimates of aggregate expenditures, but they also involve at least two non-trivial costs: 1) payment diaries cannot identify the amount spent on individual goods and services (or their quantities and per-unit prices) and 2) short participation periods are not accurate reflections of consumer expenditures over more-relevant longer periods like units tracked in budget cycles (week, month) or income frequencies (weekly, bi-weekly, monthly).

This paper evaluates the ability of the 2012 DCPC to estimate U.S. consumer expenditures and income by comparing and contrasting DCPC aggregate estimates with estimates from other leading surveys and data sources. The primary focus is on comparing the DCPC estimates with estimates from the Consumer Expenditure Survey (CE), the leading U.S. data source that has both a recall-based survey (CE-S) and a recall-based product diary (CE-D) instrument. Also included in the analysis are consumer expenditure estimates from the Financial Crisis Surveys

² For a more comprehensive treatment of integrated financial accounts see Sampranathak and Townsend (2010), and for a more detailed application to payments data, see Sampranathak, Schuh, and Townsend (2017).

³ When a consumer buys 50 items at a grocery store and pays \$200 for the entire shopping basket with a debit card, the \$200 debit card payment equals the nominal value of all 50 consumption goods in the basket.

(FCS) of Hurd and Rohwedder (2010) and the Survey of Consumer Finances (SCF). Aggregate DCPC estimates of consumption expenditures and total payments are compared with data from the U.S. National Income and Product Accounts (NIPA) on personal consumption expenditures (PCE) and disposable personal income.

The overall conclusion of this study is that the October 2012 DCPC produces estimates of consumer expenditures that are surprisingly better than other leading data sources. Three notable results emerge from the analysis. First, DCPC payments are 75 percent higher than CE estimates. Second, DCPC consumption is 17 percent higher than NIPA estimates in comparable expenditure categories (which, taken together, represent about half of PCE). And third, DCPC total payments roughly equal NIPA disposable income, adjusted for comparability.

Given its relative success in estimating consumer expenditures and income, the DCPC appears to merit use for research on income, consumption, and saving at the micro and macro levels. For example, daily consumer payments in the DCPC are highest near paydays and dates of other income receipt, a result consistent with findings of Stephens (2003, 2006), Parker et al. (2013), Gelman et al. (2014, 2015), Baker (2016), Parker (2016), and Pagel and Vardardottir (2016). Schuh and Tai (2016) use the DCPC to document changes in the value and composition of consumer payments in responses to Hurricane Sandy, and Samphanathak, Schuh, and Townsend (2017) show how the DCPC tracks cash flow dynamics more effectively than other surveys do. Overall, payment diary data are essentially the same as transaction records from banks and other financial institutions, such as those used by Ganong and Noel (2016) among others, but the payment diaries offer distinct advantages described later.

The remainder of the paper proceeds as follows. Section 2 describes the leading surveys and methods used to collect U.S. consumer expenditure data, and Section 3 describes the Boston Fed's DCPC in more detail. Section 4 explains the conceptual relationship between consumer payments and expenditures. Section 5 compares estimates of aggregate consumer payments (DCPC) with aggregate consumer expenditures from other surveys (CE, FCS, and SCF), and with consumption (PCE) in comparable expenditure categories. Section 6 compares estimates of aggregate consumer payments (DCPC) with estimates of aggregate personal disposable income. Section 7 concludes.

2. Surveys of consumer expenditures and payments

The success of measuring consumer economic behavior depends crucially on the design and implementation of the survey instrument(s) used to collect data. This section compares leading U.S. surveys that measure consumer expenditures or payments and focuses on three issues identified by Crossley and Winter (2015): 1) survey modes; 2) methods of data collection

(recall versus recording); and 3) the scope and aggregation of expenditure categories. It also briefly addresses other issues cited by Crossley and Winter: the format of questions, response unit of the survey, reference period of measurement, role of incentives, and the strategy for reducing or correcting response errors in real time.

2.1 Overview of Surveys

Table 1 provides details of the U.S. surveys, two of which include a diary survey (“diary” for short), listed in chronological order of origin. Rows are grouped into sections with information about questionnaires, measurement, and sampling. Four sponsors collect data for disparate reasons:

- **U.S. Bureau of Labor Statistics (BLS)** – The BLS sponsors the Consumer Expenditure Survey (CE), which “consists of two surveys—the quarterly interview survey and the diary survey—that provide information on the buying habits of American consumers, including data on their expenditures, income, and consumer unit (families and single consumers) characteristics.”⁴ “As in the past, the regular revision of the Consumer Price Index (CPI) remains a primary reason for undertaking the Bureau’s extensive Consumer Expenditure Survey. Results of the CE are used to select new ‘market baskets’ of goods and services for the index, to determine the relative importance of components, and to derive cost weights for the market baskets.”⁵
- **Federal Reserve Board** – The Board sponsors the Survey of Consumer Finances (SCF), which “is normally a triennial cross-sectional survey of U.S. families. The survey data include information on families’ balance sheets, pensions, income, and demographic characteristics. Information is also included from related surveys of pension providers and the earlier such surveys conducted by the Federal Reserve Board.”⁶ Although it does not collect all consumer expenditures directly, the SCF can be used to derive an estimate of total expenditures from estimates of income and wealth, and it does collect some expenditure data directly.⁷
- **RAND Corporation** – RAND sponsors the monthly ALP Financial Crisis Surveys (FCS), which are “dedicated to tracking the effects of the financial crisis and great recession on American households” by collecting data on consumer expenditures, balance sheets, labor market conditions, expectations, and other variables (for more details, see Hurd and Rohwedder 2010).
- **Federal Reserve Bank of Boston (Boston Fed)** – The Boston Fed sponsors the annual Survey of Consumer Payment Choice (SCPC) and the occasional Diary of Consumer Payment Choice (DCPC), which measure consumer adoption of payment instruments and deposit

⁴ See <http://www.bls.gov/cex/> and <http://www.bls.gov/cex/csxovr.htm>.

⁵ See BLS Handbook of Methods, <http://www.bls.gov/opub/hom/cex/pdf/cex.pdf>.

⁶ See <https://www.federalreserve.gov/econresdata/scf/aboutscf.htm>.

⁷ For more details about the SCF, see <http://www.federalreserve.gov/econresdata/scf/scfindex.htm>.

accounts and use of instruments. Originally, the SCPC and DCPC were not integrated like the CE but were developed independently and are now being integrated. The SCPC collects only the number of payments, while the DCPC also tracks the dollar values. Both provide data on cash and (in later years) checking accounts and revolving credit; the SCPC contains limited information about household balance sheets.

The CE surveys are oldest, having been in continual use since 1980, while the SCF began in 1983.⁸ The other surveys are more recent, having originated in the wake of the financial crisis in 2008. Although each survey except the SCPC collects data on the dollar value of consumer spending, the motivation varies across surveys, so they should not be expected to produce the same type or value of estimates. To the extent possible, this paper focuses on comparisons of similar types of consumer spending.

2.2 Questionnaires

The unit of observation (or measurement) for diaries (CE-D and DCPC) is a consumer, while surveys also ask questions pertaining to the entire household. Ideally, spending data would be collected for each individual consumer within a household and for joint household expenditures from the most reliable data source—in other words, by conducting a “census” of households—which would enable accurate measurement of intra-household spending and transfers. While preferable in most cases, this ideal approach is more time-consuming and expensive than measuring randomly selected individuals, but it may yield better representation of households and more-accurate estimates of joint household expenditures than surveying random individuals. The DCPC observes only spending for individual consumers, to minimize costs. Also, some payment behavior, such as cash spending, is relatively difficult for a respondent—even the “head of household” to report accurately on behalf of other household members to come up with an accurate estimate for the entire household.

The mode and method of collecting data also differs between diaries and surveys. Survey questionnaires rely primarily on respondent *recall* to answer retrospective questions about spending. The CE-S and SCF conduct interview surveys, so respondents have assistance in interpreting questions, whereas the FCS and SCPC use unaided, Internet-based, online questionnaires, which may be susceptible to more recall and measurement (misinterpretation) errors despite being shorter and more convenient. In contrast, the diaries (CE-D and DCPC) use memory aids to collect data based on daily *recording* of spending, supplemented by an interview (CE-D) and Internet survey (DCPC). Both diaries use paper memory aids, but the DCPC offers multiple options: a long-form or short-form paper memory aid, receipt bag, or other method

⁸ The CE originally began in the 1800s and was implemented about every 10 years until 1980. For more details, see <https://www.bls.gov/cex/ceturnsthirty.htm>.

comfortable for the respondent.⁹ No consensus has emerged on the relative benefits of the modes and methods of data collection. Bee, Meyer, and Sullivan (2015) conclude that the CE-S interview survey performs better than the CE-D recording, but the National Academy of Science’s committee on redesigning the CE thinks the diary recording is better and recommended expanding its use in the CE products (Dillmon and House 2013).

Respondent burden is generally lower for the newer surveys (FCS, SCPC, and DCPC), which are shorter per survey and pay higher incentives on a per-minute basis. In particular, the SCF is relatively long and complex (and sometimes requires very high incentives), while the CE pays no incentive. The Internet surveys and diaries tend to enjoy remarkably high participation, response, and retention rates, typically about 90 percent or better, perhaps because of the lower net burden.

2.3 Measurement

Most survey instruments measure *expenditures* as the total dollar amount spent in a category of consumer goods and services. In contrast, the SCPC measures *payments* as the number of transactions in a category of consumer goods and services, while the DCPC measures the number and value of payments. A payment in the DCPC refers to the total dollar amount spent for one transaction (or purchase), which may include multiple products (goods or services). For example, the total bill for all items in a grocery cart purchased during one shopping trip to the store includes 50 grocery items, but it counts for only one payment in the groceries expenditure category. Surveys that measure expenditures generally do not track payments.

Another distinction between expenditures and payments is related to the unit of measure in surveys versus diaries. Surveys (CE-S, SCF, FCS, and SCPC) obtain estimates of total expenditures or payments in an entire expenditures category summed over all items purchased or payments made. This method may involve summation errors (mathematical computation) or recall errors (omission of items and payments) over products and payments or over time, and thus yields underestimates of aggregate expenditures and payments in a category.¹⁰ In contrast, diaries (CE-D and DCPC) obtain estimates for each individual product (CE-D) or payment (DCPC) in a category and thus track an essentially unlimited number of entries within categories. This latter point illustrates the fact that the DCPC measures spending at a higher level of aggregation than the CE-D (payment versus product). These factors are interrelated with expenditure category definitions, which are discussed in detail later.

⁹ Foster (2016) shows that respondents are more likely to carry paper memory aids when given financial incentives, but the number of payments per datum was not statistically different for respondents who carried a paper memory aid.

¹⁰ For examples of this phenomenon applied to consumption expenditures, see Dillmon and House (2013, pages 5, 77, and following) and Gibson and Kim (2007).

The period during which consumer spending is measured also influences the quality of the data, and period differences are related to methods of data collection. Recall-based surveys measure spending that occurred during a “usual” or “typical” time period, which varies across surveys from one week to one year.¹¹ Presumably, longer periods of recall involve greater recall (memory) errors for expenditures.¹² The CE-S and FCS give respondents a specific time period (usually a month or quarter), whereas the SCPC allows respondents to choose their own time period (week, month, or year), depending on the payment situation. While daily recording in the diaries (CE-D and DCPC) likely reduces recall error, some recall is required even for diaries. The DCPC respondents perform their own data entry in an online survey each night, which entails recall unless they used a memory aid, and some questions in the DCPC Internet questionnaire also require other types of recall. However, results from the 2010–2011 pilot DCPC show no evidence of statistically or economically significant data-entry errors (Foster 2016).

Finally, all surveys and diaries include some strategies to reduce reporting errors in real time. Surveys with interviews provide the opportunity for interviewers to verify answers or to answer respondent questions, both of which may reduce errors. Internet surveys include various types of automated range checks, arithmetic verification, and other types of screen checks in anticipation of erroneous answers. Respondents are prompted to re-answer or correct their answers, but unaided Internet surveys may not be as effective as interviews in reducing errors.

The precise methodology of collecting consumer spending data determines the ultimate success of measurement. Appendix Exhibits 1–4 provide snapshots of the data collection techniques from the four main surveys that collect the dollar-value spending data studied in this paper. Two are recall-based surveys (CE-S and FCS), and two are recording-based diaries (CE-D and DCPC). The exhibits illustrate the measurement characteristics described in Table 1.

2.4 Sampling

All of the surveys and diaries included in this study are designed to produce representative estimates of U.S. consumer expenditures or payments. With the exception of the Internet-based surveys (FCS, SCPC, and DCPC), which limit the population to adult consumers ages 18 years and older, they all target the total non-institutional population. However, sampling frames and

¹¹ The adjectives “usual” and “typical” may also evoke different responses. Angrisani, Kapteyn, and Schuh (2015) found differences in the number and value of payments measured by “specific” (day, week, or month) versus “typical” periods.

¹² However, measuring the number of infrequent payments at lower frequencies in the SCPC can avoid measurement errors due to rounding at higher frequencies. For example, reporting at a point in time for the entire month, one check payment per month is about 0.25 checks per week, so 0 per week = 0 per month, while, reporting at a point in time for a week, 1 per payment week = 4 per month.

sample sizes differ substantially, which affects the relative accuracy and efficiency of the national estimates.

The older surveys and diary have larger sampling frames and samples. The CE frame is the Census Bureau's Master Address File, which contains information on essentially all U.S. residents and is likely the most comprehensive list available. Other surveys and diaries rely on much smaller frames that have been selected from the U.S. population. The SCF frame from the National Opinion Research Center (NORC) is the largest, at about 3 million households, covering about 99 percent of the population, and is supplemented by IRS administrative data on high-income households. The actual samples drawn from these frames number about 6,000 to 7,000 individuals or households. The size and representativeness of these frames and samples are advantages that may be offset by relatively high costs and lower response rates.

In contrast, the newer surveys and diary have much smaller sampling frames and samples. For these newer surveys, the sampling frames are "Internet panels" of respondents who agree to take surveys regularly over time. As described in Hays, Liu, and Kapteyn (2015), Internet panels may be constructed as convenience samples or may be probability based and representative of the target population. In the latter case, they are usually drawn by random digit dialing (RDD) or address-based sampling (ABS). The main Internet panels are RAND Corporation's American Life Panel (ALP) and the University of Southern California's Understanding America Study (UAS), each of which contains about 6,000 respondents. The ALP includes convenience and probability samples, while the UAS is an ABS sample only. Actual samples drawn from these frames are roughly one-third as large (2,000 to 2,500) as the other samples.

Internet panels have relatively low costs, very high response rates, and generally good quality data, but their size and construction raise concerns about representativeness. One concern is the use of convenience samples and RDD methods using landline telephones that are no longer universal. Another (waning) concern is that some consumers may have limited access to, or experience with, information technology, although panel vendors take steps to address this constraint by giving respondents computers or tablets and training. A third concern is potential sample selection bias, of which there may be multiple types. The most troublesome type of selection bias is one that occurs when panelists are not representative due to unobservable characteristics at the time of their selection. Other types of selection bias are observable, such as the finding in Heffetz and Rabin (2013) that survey respondents who are easy to reach (that is, who readily agree to participate with few invitations) report different degrees of subjective happiness cooperation than respondents who are harder to reach (require many invitations). The ALP contains some members who agreed to join when solicited after having participated once in the Michigan Survey of Consumers; roughly half agreed, and these members may have been easier to reach than the half who did not. Finally, selection effects may develop from

learning and experience that occurs during repeated survey-taking over time, as in the SCPC (multiple years of annual surveys) and DCPC (three consecutive days). As a counterpoint to concerns about selection, Gutsche and Weerman (2013) argue that “practicing involved panel management techniques” makes Internet access panels more successful in measuring economic behavior, as exhibited by higher rates of participation and response as well as greater diligence in participating and responding to questionnaires.

For reasons described earlier, an additional concern may arise with estimation of U.S. consumer spending using samples of respondents that are not drawn from representative households or do not contain all individual consumers within each household. In theory, consumer-based statistical sampling could produce unbiased estimates of U.S. spending, provided that: 1) consumers are randomly selected and sufficiently representative of all consumers within U.S. households and 2) consumer spending within households is uncorrelated across consumers. Unfortunately, neither condition likely holds in the Boston Fed surveys. Hitczenko (2015b) found that the SCPC has a disproportionately large number of consumers with relatively high financial responsibility within their households, which may bias estimates of the number of payments upward by about 10 percent. Furthermore, household spending is most likely correlated across consumers within households for various reasons, such as shared expenses (rent or utilities) and similar preferences. DCPC respondents are asked to report only their own payments, but failure to do so would cause measurement error. Some payments may occur strictly between consumers within households and thus may not be recorded properly.¹³

Despite potential sampling limitations and obvious room for improvements, the DCPC produces reasonably reliable estimates of U.S. activity. Table 2 reports demographic characteristics and selected economic statistics for the DCPC and compares them to reliable benchmark estimates (mostly the Current Population Survey, CPS). The 2012 DCPC-weighted estimates of demographic shares of consumers do not exhibit major differences from their benchmarks, and U.S. estimates of selected economic variables are encouraging. The employment-to-population ratio differs by less than 1 percentage point from its benchmark, as does the rate of adoption of checking accounts; the median primary home price differs by only about 10 percent; and average payment-card transaction values are relatively close. These results lend credibility to the consumer spending estimates reported later.

2.5 Expenditure categories

The definition of expenditure categories impacts the measurement of consumer spending in at least two ways. First, the scope of expenditures included influences spending estimates, with

¹³ The SCPC and DCPC include a relative small subsample of adults living in the same household that can be used to characterize some of these issues. See Hitczenko (2015b, 2016) for examples of research on within-household payment choices based on this subsample.

broader definitions that include more types of expenditures on goods and services likely to produce higher estimates. Second, the level of aggregation across products influences spending estimates, with more distinct subcategories and products likely to produce higher estimates—provided disaggregation does not reduce coverage within categories.

Table 3 reports the number of subcategories within each of nine relatively homogeneous expenditures categories for the two surveys (CE-S and FCS) and diaries (CE-D and DCPC).¹⁴ All four data instruments have similar scope, and all but three categories have multiple subcategories. For the surveys, the number of subcategories indicates potentially important differences in the level of aggregation (a lower number of subcategories indicates higher levels of aggregation, and vice versa). For diaries, however, the number of subcategories is not relevant for aggregation because the diaries obtain essentially unlimited estimates of spending on each product (CE-D) or payment (DCPC). Instead, the number of expenditure subcategories is relevant for respondent classification of expenditures or payments, with more subcategories providing more flexibility for respondents to classify their expenditures and payments.

Among surveys, the CE-S has many more subcategories than the FCS (429 versus 45).¹⁵ If precision is lost in aggregation, then the CE-S (with more subcategories) might obtain more accurate estimates than the FCS. However, this supposition assumes that the detailed CE-S categories provide an exhaustive decomposition of more aggregate categories, which may not be correct. For example, Appendix Exhibit A.3 (the CE-S food questionnaire) shows that the CE-S subcategories are often very narrow, such as cigarettes, a very specific product comparable to items in the CE-D, but this same survey does not ask for other detailed products or subcategories of products similar to cigarettes. However, there is some overlap among CE-S subcategories, such as “grocery shopping” and a follow-up question about the subset of nonfood expenses in grocery shopping, so the net effect of each category’s disaggregation on measurement is uncertain.

Among diaries, the CE-D has many more categories than the DCPC (261 to 45). However, the number of categories is less important for diaries because they record an essentially unlimited number of expenditures or payments within each subcategory. Still, respondents use

¹⁴ See the Appendix for a full list of the 45 detailed “merchant” categories in the DCPC. These categories were defined in part to reflect the standard consumer expenditure categories. However, they were also designed to match unique and detailed (3- or 4-digit level) NAICS industry categories, for two reasons. First, unique identification of data by industry category permits benchmark comparisons with other data that are also organized by NAICS industry. Second, research on payment choices takes into account the nature of the payee in studying consumer demand for payment instruments, so it is helpful to be able to classify data in a manner consistent with the supply-side acceptance classification of payment instruments.

¹⁵ The FCS expenditure categories are similar to those in the Consumption and Activities Mail Survey (CAMS), produced by the University of Michigan. For more information about the 2013 CAMS, see <http://hrsonline.isr.umich.edu/index.php?p=shoavail&iyear=9F>.

expenditure categories to classify expenditures or payments, so having more categories can help respondents find the “right” classification, although it may also increase respondent burden (time and complexity). The DCPC has fewer categories than the CE-D because payments often contain a broad range of heterogeneous individual products, such as items sold by general merchandise stores (Walmart or Target), so it is difficult for respondents to choose one category for the entire shopping basket. Although expenditure categories may affect respondents’ classification of spending, they likely do not affect respondents’ recording of the actual value of payments.

Tracking essentially unlimited numbers of expenditures or payments within a category gives diaries an important advantage over surveys. Universal coverage (inclusion) of all products or payments enables diaries to measure a greater proportion of total consumer spending, and may possibly facilitate more accurate estimates as well. However, over the course of a month, the number of products purchased by consumers (perhaps hundreds per month) is far greater than the number of payments made by consumers (about 60). Therefore, the CE-D imposes a much higher respondent burden to record product details than the DCPC imposes on respondents to record payments (to see this, compare the CE-D and DCPC memory aids in Appendix Exhibits 1–2). The CE-D might underestimate consumer spending by missing some products, whereas the DCPC is more likely to record essentially all payments and thus estimate total spending more accurately.

2.6 Relation to similar data sources

In recent years, the frontier of collecting consumer expenditure data has expanded to include an array of electronic-based methods that tap into databases of transactions from financial institutions and merchants. Survey and diary estimates of consumer spending are closely related to these electronic transactions data. The DCPC, in particular, contains essentially the same information but offers additional advantages and could be combined with transactions data to produce even better measures.

Financial records

Most spending by consumers is tracked in electronic account transaction records from their depository institutions (banks and such) and other financial institutions, including non-banks (such as PayPal). Checking accounts track payments by debit card, check, online banking bill payments, and bank account number payments, as well as cash withdrawals (although not cash payments). Banks also record credit card payments, although consumers often may hold credit cards from a bank different from the one where they have their checking account. Like the DCPC, these transactions data include identification of the payee (such as a merchant) in a classification system, but they do not reveal the specific products purchased during the transaction. Overall, the DCPC obtains essentially the same information contained in the

records of a checking or credit card account, albeit with potential errors from consumer reporting.

When consumers have multiple accounts at different financial institutions or use cutting-edge payment instruments such as checks written against a home equity line of credit, collecting financial transactions data in a manner that ensures coverage of all transactions is more difficult. Personal financial management (PFM) tools (also called “data aggregators”) have emerged, making it easier to collect disparate financial transactions data by utilizing electronic “back-end” processing platforms that interface with financial institutions and populate consumer data into software or mobile apps. To a degree, the DCPC obtains data similar to that gathered by PFMs, except that the DCPC does not collect much household financial data beyond payments and deposit accounts. However, PFM data may not be representative of the finances of U.S. consumers. The 2015 SCPC reveals that only 7 percent of consumers have PFM tools, which often require consumers to give permission and confidential information (such as passwords) to third parties for data access, raising questions about selection bias.

Although transactions data from financial institutions are very difficult to obtain due to their proprietary nature and privacy concerns, some of these data have been obtained and used in research. Ganong and Noel (2016) use bank account data from the JPMorgan Chase Institute.¹⁶ Agarwal et al. (2013) use a “unique panel database on the near universe of credit card accounts held by the eight largest U.S. banks” (p. 2). And Stango and Zinman (2009) use data from Lightspeed, a company that solicits permission from consumers to access their financial accounts. Other research has obtained data from PFM tools: Baker (2016) uses Intuit’s Mint.com, Gelman et al. (2014) use Check Me, Pagel and Vardardottir (2016) use data from Iceland’s Meniga, and Gelman et al. (2016) use a financial aggregator and bill-payment software from an unidentified mobile app. Government regulators, such as the Consumer Financial Protection Bureau, have used supervisory authority to obtain financial transaction data for research and policy analysis (see Bakker et al. 2014).

Retail scanner data

The retail sales portion of consumer spending is tracked by scanner data collected at electronic cash registers. Like the CE-D data, retail scanner data contain rich details about the value of products purchased (quantities and per-unit prices). Often these data also include the payment method, making them comparable to the DCPC data as well. Retail scanner datasets are very large because they track spending continuously and can provide detailed geographic information for retail chains with multiple stores.

¹⁶ See Data Assets at the JPMorgan Chase Institute:
<https://www.jpmorganchase.com/corporate/institute/our-data.htm>.

However, retail scanner data have two key limitations. One is the scope of expenditures. Klee (2008) uses data from a grocery store, and Wang and Wolman (2016) uses data from a national discount store. Another, more important limitation is that most retail scanner datasets do not contain information about the specific consumer making the transaction. This anonymity makes scanner data less confidential and more accessible than financial records, but it greatly limits inference about the relationship of consumer characteristics to spending and identification of customers who are not consumers (such as businesses). Thus, research with retail scanner data must use average consumer characteristics by geographic region instead. However, some retail scanner datasets are supplemented by surveys of consumers who re-scan their products at home and provide information about themselves for use in research, as in Cohen and Rysman (2013).

Advantages of the DCPC

The data sources for consumer expenditures or payments have many similarities. Each has its own particular strengths, but the DCPC offers several advantages over the financial and retail alternatives, and overall the DCPC dataset provides generally better estimates of total consumer spending. For one thing, the DCPC data are drawn from samples that are more representative of U.S. consumers than the samples that are drawn from the alternative data discussed in this paper. Also, by tracking all consumer payments, the DCPC dataset includes spending from a more comprehensive set of underlying liquid asset and liability accounts from which each individual consumer's (or household's) payments are drawn, even compared with PFM data.

For any particular payment account, the DCPC also offers more detailed information about consumer spending. For example, bank checking accounts include data on cash withdrawals but not cash payments, whereas the DCPC has both. Also, each DCPC payment is recorded electronically and followed by a "mini survey" about a range of important details concerning that specific transaction, providing much more information and hence allowing more flexibility in the approach to measuring consumer economic behavior. For each payment, the DCPC obtains more detailed or precise information about the types of consumer products purchased from each payee, the characteristics of the payees (name, business, payment acceptance, and cash discounting), the characteristics of the consumers (cash in wallet, carrying of payment cards), and consumers' attitudes (payment preferences, reasons for spending, financing decisions).

Finally, the DCPC dataset enables more flexibility and applicability than alternative data sources, which are essentially provided "as is." The DCPC can be used to conduct field experiments that measure differences in consumer behavior resulting from differences between control and trial groups, such as the information known to consumers in each group before making decisions. The DCPC can also be used to measure the specific effects of natural

experiments, such as randomized tax rebates or hurricanes, on consumer behavior. Perhaps most importantly, payment diaries produce data with strong consistency between micro and macro estimates, which is lacking in prior research with other data sources.

It is important to point out that the choice of data source on consumer spending does not have to be mutually exclusive. Each one has relative advantages that, if combined, could produce more and better data on consumer spending collectively, as in the case of supplementing scanner data with surveys (Cohen and Rysman 2013). Furthermore, the use of PFM tools integrated with surveys or diaries also could improve data quality, or the PFM tools could be used instead of surveys and diaries for consumers who already have them to reduce costs and respondent burden. Likewise, scanner data could replace diary recording for some types of transactions. These and other improvements in data collection may be worth pursuing, but they are outside the scope of the current paper and reserved for future research.

3 More information about the 2012 DCPC

3.1 Background

Electronic networks emerged in the 1970s and facilitated a transformation of money and payments from being paper-based (currency and checks) to being based on electronic payment means. Visa replaced its paper receipt system for credit cards with electronic card processing in 1974 and MasterCard followed shortly thereafter.¹⁷ The Electronic Funds Transfer Act of 1978 facilitated electronic payments from bank accounts and established a centralized Automated Clearing House (ACH) network. ATM cards (1980s) turned into debit cards (1990s) when terminals at the point of sale in stores were configured to accept PINs.¹⁸ From 1995 to 2000, the aggregate number of paper checks cleared in the United States declined 3 percent annually (Gerdes and Walton 2002), finally demonstrating that a long-predicted demise of checks had begun.¹⁹ More recently, payments are made through online banking and the Internet, via cellular networks with mobile phones, and even exclusively on the Internet with private currencies like Bitcoin.²⁰

One response to this transformation of payments has been that central banks in certain industrial countries have begun to collect high-quality data on payments. A leading example is the Federal Reserve Payment Study (FRPS), a triennial survey of financial institutions and other

¹⁷ Evans and Schmalensee (2005), page 74.

¹⁸ Visa and MasterCard also created signature-based debit cards that did not require a PIN and provided short-term settlement credit similar to credit cards.

¹⁹ For more information, see Benton, Blair, Crowe, and Schuh (2007), Gerdes (2008), and Schuh and Stavins (2010).

²⁰ For more information and analysis about mobile phones, see Crowe, Rysman, and Stavins (2010) and Federal Reserve (2016); for Bitcoin, see Velde (2013), Böhme et al. (2015), and Schuh and Shy (2016). See also Rysman and Schuh (2016) and Chakravorti (2016) for more comprehensive treatments.

companies in the payments industry (see Federal Reserve 2013). However, the FRPS does not include cash (currency) and, until recently, was available only for the entire U.S. economy and did not identify payments by sector (household, business, and government).²¹ Therefore, central banks also began collecting data on consumer payments and especially cash, for which there had been little or no data (see Bagnall et al. 2016).²² Another motivation was the lack of satisfactory data on consumer ownership and use of deposit accounts and payment instruments (see Schuh and Stavins 2009). While financial institutions, non-financial companies, and consultants had lots of high-quality data on consumer payments, the data were typically proprietary or exceedingly costly. The limited amount of affordable data typically did not reveal or meet satisfactory standards of sampling and statistical analysis. The focus on consumer demand for payments was motivated by the need to estimate consumer welfare and determine the structure of an optimal electronic payment system and related policy implications.

The Boston Fed's first contribution to data development was the SCPC, a 30-minute online questionnaire focused mainly on two concepts: 1) adoption of bank accounts and payment instruments (including cash holdings), and 2) recall-based use of payment instruments defined as the number of payments made with each instrument from those accounts. The SCPC has been implemented annually using the RAND Corporation's American Life Panel (ALP) from 2008 to 2014 and the University of Southern California's Understanding America Study (UAS) from 2014 onward. See Schuh and Stavins (2014) and Hitczenko (2015a) for more information about the 2012 SCPC.²³

Over time, it became apparent that collecting the dollar value of payments was also an important part of understanding consumer payment choices. The previously discussed scanner data and research revealed unconditional correlation between payment instrument choices and the dollar values of payments (which the SCPC does not collect). In retail payments, cash is used most often for small-value purchases, debit cards for medium-value purchases, and credit cards for larger-value purchases; Briglevics and Schuh (2016) provide complementary evidence for bill payments. Briglevics and Schuh (2016) show how the payment choice correlation changes after conditioning on cash in the consumer's wallet at the time of purchase and the number of payments per day, using a dynamic structural model that extends Koulayev et al. (2016).

²¹ In 2012, the FRPS began collecting data by type of deposit account, separating payments by household accounts from non-household accounts. See Federal Reserve (2013) for more details.

²² One exception is the 1984 and 1986 Survey of Currency and Transactions Account Usage, implemented by the Federal Reserve Board.

²³ The 2012 SCPC questionnaire and data are available here: <http://www.bostonfed.org/economic/cprc/data-resources.htm>.

Consequently, the Boston Fed implemented the DCPC in 2012 to complement its annual SCPC, with assistance from the Richmond and San Francisco Federal Reserve Banks, and implemented it with the ALP.²⁴ One key objective was to compare and contrast recall-based (SCPC) and recording-based (DCPC) estimates of the number of payments by payment instrument. A second objective was to collect data on the dollar value of payments. The SCPC and DCPC are broadly similar to payment surveys and diaries fielded by other industrial countries, such as Australia, Austria, Canada, France, Germany, and the Netherlands (see Bagnall et al. 2016). A substantially revised DCPC was implemented in the fall of 2015.

3.2 Questionnaire content

In contrast to the SCPC, which collects data on the total number (but not value) of consumer payments over a period of time, the primary goal of the 2012 DCPC was to collect data on each separate value of every individual consumer payment authorized by payment instruments, plus the management of cash (notes, bills, and coins), which also is a payment instrument. In the online questionnaire, seven core variables are collected for each non-bill payment every day: time and date of payment, dollar amount, payment instrument, payment location, merchant type, and merchant name (see the “Daily Payments and Cash Activity” screen shot in Appendix Exhibit A.2). Later, the DCPC online questionnaire also collected recurring and occasional bill payments using these standard entry boxes. Similar core variables were collected each night for cash holdings (in wallet, purse, or pocket) by currency denomination in a separate screen, as was all other cash management activity (withdrawals, deposits, cash gifts received and given, and other cash activity).

The 2012 DCPC also collected data on many other concepts that are less central to this paper and thus mentioned briefly here. These include consumer preferences over payment instruments, details of each specific payment opportunity (such as discounts received for cash payments or surcharges for credit cards), carrying of payment instruments, and other matters.

3.3 Diary modes

The 2012 DCPC survey consisted of two modes. The first mode comprised a number of voluntary memory aids, and the second was an online questionnaire, including respondent entry of memory-aid data. Respondents were asked to use memory aids daily, to complete an online questionnaire each night, and to take a brief online survey the night before the diary began. Respondents were provided an instructional video of about six minutes with training materials on how to complete the diary.

²⁴ As of the submission of this paper, the 2012 DCPC questionnaire, data, and official results have not yet been published, but eventually they will be available at: <http://www.bostonfed.org/economic/cprc/data-resources.htm>.

The first mode asked respondents to carry with them daily one or more of three memory aids provided by the survey vendor to track their payments and cash management. Two of these memory aids were paper diaries. The long form, eight pages (8-1/2 x 11 inches) folded in half, provided instructions, codes, and room to record three days of payment and cash activity. The short form was a checkbook-sized book of receipts that provided room to record the payment amount and a few details, but no instructions. The third memory aid was a canvas pouch for storing receipts from payment and cash activity. Respondents were urged strongly to carry one of these memory aids, but were allowed to choose their own alternative (including no aid). About 53 percent of respondents carried one of the two paper memory aids (36 percent carried the short form and 26 percent the long).

The second mode required respondents to complete each night an online questionnaire that took about 20 minutes per day and contained two main parts: 1) a daily payments module linked directly to the memory aids; and 2) other related questions that may not have been recorded in any memory aid and required daily recall or other record lookup. The daily payments module asked respondents to enter their data from the memory aids or recollection, while the remainder of the questionnaire collected other information pertaining to respondents' daily payments and cash management activity, including unrecorded details.

3.4 Diary design

Initially, ALP members were recruited to participate in both the 2012 SCPC (designed to take approximately 30 minutes, for a \$20 incentive) and the 2012 DCPC (designed to take approximately 20 minutes per day for three days, for a \$60 total incentive). About 95 percent of invited members who agreed took both the SCPC and DCPC, and many respondents had also completed the SCPC in prior years (2008–2011). After agreeing to participate, respondents were asked to complete the SCPC before the DCPC, and about 85 percent did (compared with about 70 percent within 10 days in prior years); the median completion time was 37 minutes. Most respondents who did not complete the diary were assigned a diary period early in the month of October and had less time than the other respondents between the launch of the SCPC (mid-September) and the DCPC (September 29). The remaining respondents were allowed to complete the SCPC at their earliest convenience, and the vast majority completed the DCPC by early November.

Respondents were asked to participate for three consecutive days during the one out of 31 waves to which they were randomly assigned throughout October (between September 29 and November 2), and to complete a brief (less-than-5-minute) online survey the night before the diary, primarily to obtain estimates of their cash balances at the start of the diary. Diary participants who successfully completed all three days of their online questionnaires (91 percent of selected ALP members) received their incentive payment (\$20 per day). The median

completion time for the online DCPC daily questionnaire was about 13 minutes (the range was 10 minutes for Day 2 to 15 minutes for Day 1), so the incentive also compensated respondents for time spent watching the video, reading and maintaining their memory aid(s), checking their records (if they did), and performing other related tasks.

3.5 Sampling methodology and implementation

The 2012 DCPC sample selection procedure was complicated by the joint selection of respondents who would complete both the SCPC and DCPC, and by the existing structure of the longitudinal SCPC sample. As of 2011, the un-weighted SCPC longitudinal panel was not very representative of the U.S. population; for more details, see Hitczenko (2015a) and Angrisani, Foster, and Hitczenko (2014 and forthcoming). Consequently, the 2012 SCPC and DCPC samples were drawn to increase respondents in underrepresented strata and to improve representativeness of the un-weighted samples. This decision reduced the pool of longitudinal panelists in the SCPC somewhat, but it also reduced the variation of the weights used ex post to stratify the samples.

From the ALP sampling frame of nearly 6,000 members, 2,601 respondents completed the 2012 DCPC. After excluding respondents with incomplete or unreliable diary data, the final dataset contained data from 2,468 respondents. The DCPC participants were selected randomly from the ALP frame to match population shares (measured by the Current Population Survey) of strata defined by three demographic variables: three age categories (19–39, 40–55, 65+), three income categories (<\$30k, \$30–59k, \$65k+), and two categories of race (white, nonwhite).

Daily sampling occurred as follows. Each day from September 29 through October 31, about 75 respondents were randomly selected to begin a three-day diary, forming 33 overlapping waves of about 225 respondents, as shown in Appendix Figure A.1. Thus, each day during October 1–31 about one-third of respondents completed one diary day for each of the three days. In addition to aiming to produce representative samples each day, the sampling strategy and design help to reduce daily seasonal effects that might arise from systematic differences in diary performance across diary days 1–3, such as diary fatigue (declining participation rates, item response rates, or data quality over the diary period), learning effects (improvements in data reporting over time), and strategic shirking (such as advancing or postponing payments to reduce reporting burden).

Overall, the random assignment of diarists worked reasonably well to ensure proper assignment of selected panelists to their official diary periods, despite a significant administrative burden. Appendix Figure A.2 shows that the number of diarists fluctuated between about 200 and 250 per day in most of October, and the startup and shutdown periods worked as expected. The number of panelists who failed to participate in the exact days of their

official diary period was relatively low: at least 87 percent logged in to complete their online survey by the first day, although it is not possible to determine how many of the respondents who logged in for the first time after the first day were reporting data for a period other than the one for which they were assigned. Efforts were made to accommodate respondents who requested date changes or dropped out entirely by replacing them with alternates of similar demographic characteristics, to maintain maximum possible representativeness.

3.6 Aggregation

The DCPC sampling design and implementation produce an important statistical benefit that contributes to the diary's success in estimating aggregate consumer expenditures. Although each diarist provides only three days of longitudinal data for part of the month, the representative sampling is designed to produce a weighted sum of payments that is expected to equal total U.S. payments (for consumers ages 18 and older) in October 2012.

To see this result quantitatively, it is necessary to introduce some notation and algebra. Let p_{igkdt} and q_{igkdt} denote the per-unit price and quantity, respectively, of good or service $g = \{1, \dots, G\}$ by consumer $i = \{1, \dots, N\}$ at payment opportunity (location) $k = \{1, \dots, K\}$ on day $d = \{1, \dots, D_t\}$ of time period (month) t (in this case, October 2012). Then, consumer expenditures for a single payment opportunity k are

$$x_{ikdt} = \left(1 + \tau_{kdt}^C\right) \sum_{g \in k} p_{gikdt} q_{gikdt} ,$$

where τ_{kdt}^C is the (consumption) sales tax rate. The payment opportunity may represent one product ($G_k = 1$), like a cup of coffee, or many products ($G_k > 1$), like a shopping basket full of groceries. In contrast, the CE-D tracks individual goods and services rather than payment opportunities and thus estimates product expenditures:

$$x_{igdt} = \left(1 + \tau_{kdt}^C\right) \sum_k p_{gikdt} q_{gikdt} .$$

In general, the number of goods exceeds the number of payment opportunities ($G > K$), which may have implications for the quality of measurement of consumer expenditures. Note that neither the DCPC nor the CE-D obtains estimates of p or q individually. In any case, payments can be further distinguished by the payment instrument j used to purchase the goods and services at each location. Thus, a payment represents the dollar value of one basket of goods and services:

$$x_{ijkdt} = \Phi_{kdt}(j) \left(1 + \tau_{kdt}^C\right) \sum_{g \in k} p_{gikdt} q_{gikdt} ,$$

where Φ_{kdt} is an indicator variable that takes a value of 1 when the consumer chooses payment instrument j to make the transaction. Now let $w_{it}^m \geq 1$ denote the monthly sampling weight for respondent i , which is based on the full sample of respondents for the month (independent of days) and does not depend on the payment instrument or opportunity. Then aggregate U.S. consumer payments are:

$$X_t = \sum_i \sum_j \sum_k \sum_d w_{it}^m x_{ijkdt} .$$

The monthly sampling weight is constructed for the entire diary sample and provides ex post stratification of the sample results to match the U.S. population. Daily sampling weights, w_{idt}^d , can be constructed for each of the 31 days of the month using a different, but analogous, methodology based on the sample of respondents in each of the three diary waves active on that day. For more information about sampling and weighting, see the DCPC technical appendix by Angrisani, Foster, and Hitzenko (forthcoming).

3.7 Summary of key results

In October 2012, consumer payments averaged \$124 per day with a range of \$66 to \$300, as shown in Figure 1 (solid line), and representing an average of 1.9 payments per day (not plotted in the figure). The peak daily payment (\$300) occurred on October 1 and was followed by a steady decline during the first week of the month. After that, expenditures fluctuated around a steady mean for the rest of the month until reaching their second highest level (\$186) on October 31. The volatility of daily payments and relatively small sample size yield standard errors (dashed lines in Figure 1) that prevent identification of statistically significant differences among days except for a few extreme values.

In contrast, lower-frequency estimates provide better inference about consumer spending at higher frequencies. The daily estimate of monthly payments per consumer (denoted by an overhead bar),

$$\bar{X}_{t,d} = \sum_{s=1}^d (31/d) \bar{X}_{st} ,$$

is less volatile, as shown in Figure 2.²⁵ On October 31, the final estimate of monthly payments per consumer was \$3,869. Multiplying this estimate by 12 gives an annual estimate of consumer payments of \$46,428; multiplying again by an average of 2.04 adults per household gives annual

²⁵ These estimates are constructed using the daily sampling weights rather than the monthly weights.

household payments of \$94,713. Although admittedly a “back-of-the-envelope” calculation, this estimate is notably similar to annual household income estimate of \$87,200 from the 2013 SCF.²⁶

The daily estimates of monthly consumer payments are potentially valuable for their relative timeliness and precision. Estimates early in the month are well above, and statistically significantly different from, the final estimate, due to the seasonally high value on October 1. However, by October 10th the estimate was statistically insignificantly different from the final estimate, and it stayed there for the rest of the month. Thus, the DCPC’s daily estimate of cumulative consumer spending in October 2012 provided an unbiased estimate of its monthly consumer expenditures long *before* the end of the month. In contrast, official government statistics on consumer spending, such as retail sales, are not available until after the end of the month and may be subject to revisions after their initial release.

In addition to seasonal factors for days and weeks within October, the month of October itself may have a seasonal component that would affect inference about the full year, although October was chosen because it has modest seasonality. Hernandez, Jonker, and Zwaan (2015) report seasonal variation of up to about 10 percent in Dutch payments for certain months, although their October seasonal is essentially zero. Furthermore, the U.S. Census Bureau’s nominal retail sales had a seasonal factor of 0.985 for October 2012 and 0.991 for the average October (on a base of 1.000), although retail sales account for only about one-third of personal income and other consumer payments may have larger seasonal factors.²⁷ While the 2012 DCPC is unlikely to contain unusually high payments, October payments generally are not necessarily representative of other months or, when annualized, actual annual payments, so more payments data and seasonal analysis are needed.

4 Theory and measurement

Measurement of consumer expenditures focuses on goods and services that are closely related to the economic concept of consumption, as is evident from the expenditure categories in Table 3. However, payment diaries track all spending and transfers by consumers, not just consumption expenditures. This section examines the theoretical relationship between consumer payments and expenditures, and explains the practical measurement of both concepts in the DCPC.

The analysis applies to individual consumers and thus abstracts from household composition, which may affect measurement. In multi-member households, consumers’ individual incomes

²⁶ See the 2013 Survey of Consumer Finances at <http://www.federalreserve.gov/pubs/bulletin/2014/pdf/scf14.pdf>.

²⁷ Seasonally adjusted and non-seasonally adjusted estimates, from which seasonal factors can be calculated, are available at: <https://www.census.gov/econ/currentdata/>.

and expenditures may be correlated for various reasons and have implications for estimation of aggregate expenditures, as discussed in Section 2. Thus, measurement requires data collection for all consumers in a household, or at least at the household level, which the DCPC does not do, so aggregate estimates may be biased. Nevertheless, the DCPC attempts to measure some of these correlations through methods discussed later in this section.

4.1 Theoretical concepts

This section describes basic accounting identities for personal income and consumer payments, and shows the theoretical relationship between them to provide a simple framework for measurement.

Personal income

Consumers have three ways to allocate their personal income, denoted Y . The textbook equation for this distribution (or accounting) of income is

$$Y = C + T + S ,$$

where C denotes consumption of goods and services, T denotes personal taxes, and S denotes personal saving (or the change in wealth). Subscripts for individual consumers (i) and for time (t) are suppressed for simplicity.²⁸ Consumers make expenditures for consumption and taxes ($E = C + T$). The remainder of income is saved for future expenditures (positive saving), or else assets and liabilities are used to finance expenditures in excess of income (negative saving). In the aggregate and at low frequencies (such as a year) saving typically is positive, but at the individual consumer level and at high frequencies (less than a month) negative saving may be more common.

Consumer payments

Unlike income, there is no economic theory of payments, but the income accounting equation is a logical starting point to use as a guideline. To begin, note that the income accounting identity abstracts from the practical fact that most consumer income is deposited *infrequently* into an account to be spent *continually* between the lumpy receipts of income. Consumers make most payments from their deposit accounts using payment instruments (including cash withdrawn from the accounts) to fund their expenditures.²⁹ Thus, there is an implicit

²⁸ In most macro data, the frequencies of income and its components are typically the same (monthly, quarterly, or annual). In micro data, such as the daily DCPC, it is necessary to account for different frequencies of income (weekly or bimonthly), taxes (quarterly or annual), and consumption (essentially continuous). However, aggregation of high-frequency micro data from the DCPC occurs over all consumers and days and thus all variables can be treated as having a homogeneous frequency (month).

²⁹ One exception is when payments are made directly from consumer incomes by their employer or other income provider on behalf of the consumer. These payments are called a “direct deduction from income” and discussed later.

aggregation of payments over a relevant time period implied in any relation between income and payments, although this detail is suppressed for simplicity.

Consumers have at least three ways to spend their income by making payments, denoted X :

$$X = X^C + X^T + X^S .$$

Consumers make payments to buy consumption goods and services, X^C , to remit personal taxes, X^T , or to make payments related to their management of savings, X^S . Consumers make most payments directly themselves, from a payment (deposit) account or from another asset or liability, but sometimes payments are made by third parties on behalf of consumers, as described later.

The components of the payment accounting identity differ somewhat from their analogues in the income accounting identity due to the nature of payment diaries. Like most consumer expenditure surveys, payment diaries track total spending on consumption expenditures including sales and related taxes, which are not measured separately. Therefore, consumption payments are denoted by

$$X^C = (1 + \tau^C) C ,$$

where τ^C is the sales (consumption) tax rate, and tax payments are

$$X^T = T - T^C = \tilde{T} ,$$

where $T^C = \tau^C C$ represents sales taxes. Finally, saving-related payments represent only part of total saving:

$$X^S = S - \tilde{S} .$$

Consumers make most saving-related payments two ways: 1) directly from consumers' income into asset or liability accounts other than their payment (deposit) accounts; or 2) by asset transfers from a payment (deposit) account to another asset or liability account. The latter payments are authorized using a payment instrument or other means of payment, such as an electronic account-to-account transfer via online banking.³⁰ Saving-related payments are funded by current income and affect net worth, and hence are part of total saving. The residual

³⁰ For simplicity, it is assumed that these transfers occur once per income period. But consumers can make multiple saving-related payments within an income period, in which case the gross payments would have to be netted out appropriately.

component of saving (\tilde{S}) represents all other changes in net worth that are not tracked by payments.³¹

Relation between income and payments

A comparison of the income and payment identities illustrates the relationship between them. The difference between income and payments is

$$Y - X = (C + T + S) - (X^C + X^T + X^S).$$

Assuming that all terms are measured properly, and using the saving identity above, the conceptual difference between income and payments is simply residual savings that are unrelated to payments,

$$Y - X = \tilde{S},$$

which can be positive or negative, like total saving.

4.2 Measurement issues

The preceding discussion of theoretical concepts assumes exact measurement of economic variables. In practice, however, measurement is challenging and never exact because it requires information or details that are unavailable and thus strong assumptions that may not be consistent with reality. For these and related reasons, measurement of consumer expenditures using payments from the DCPC is likely to contain errors. In particular, the measurement of consumer expenditures in the 2012 DCPC is less detailed than in other surveys, so this subsection provides a high-level summary of the broad concepts and measurement issues.

Several issues are important to highlight in evaluating measurement of income and payments. First, each of the data sources is measured differently, and estimates are denoted with a circumflex (hat). Thus, \hat{Y} denotes NIPA estimates of income (and its components), while \hat{X} denotes DCPC estimates of payments. Naturally, each estimate has a composite error,

$$\hat{Y} = Y - \mu^y \text{ and } \hat{X} = X - \eta^x,$$

for one or more reasons, including classical measurement error and sampling error. The composite errors are denoted by different Greek variables because income and payments are not measured identically and thus the types and magnitudes of the errors may be quite different. There is no reason to expect that $Corr(\mu^y, \eta^x) = 0$ but the analytical form of

³¹ Two other savings-related types of payments may occur but are not usually covered in payment diaries and thus are excluded. One type is a pure asset or liability transfer that does not involve payment (deposit) accounts, such as between two investment or liability accounts; these account-to-account (A2A) transfers do not affect household net worth. Another type is a payment funded by an asset or liability for which there is no payment instrument to track.

correlation is difficult (or impossible) to derive, and it is hard to predict the sign or magnitude observed in the data.

Another important measurement issue is the extent to which the data estimates cover (include) all components of the theoretical concepts (“coverage” for short). The main limitation of NIPA coverage is undocumented sources of expenditures and income, some of which may be captured by payment diaries. The main limitation of DCPC coverage is the scope of consumer expenditures, which is essentially unlimited in the NIPA. The DCPC has at least two coverage limitations: 1) payments made by third-parties on behalf of consumers are excluded; and 2) bill payments are not measured well. The remainder of this subsection describes these coverage limitations in more detail.

Undocumented payments and income

Although much effort is made to estimate all personal income, NIPA estimates of \hat{Y} exclude undocumented expenditures and income called the “shadow economy” or “underground economy,” μ^y , which Schneider and Enste (2000) reported to be 8 to 10 percent of U.S. GDP. Shadow economic activity may include: 1) undocumented production and sales of legal goods and services by firms that are not registered with the government, such as home-garage auto repairs or babysitting services, or do not report all sales and wages, perhaps to avoid taxation; and 2) criminal activity that avoids legal restrictions on production and sales, such as activities involving drugs or prostitution. These and other undocumented expenditures and income are not measured in the NIPA and thus are part of.

However, consumers participating in the DCPC may have recorded payments for shadow economic activity due to the focus on measurement by payment instrument rather than by type of expenditure or the payee’s legal status or compliance. In particular, Humphrey, Kaloudis, and Öwre (2004) reported that cash payments play an important role in the shadow economy but are not measured regularly. Although undocumented expenditures are hard to estimate and the DCPC does not attempt to identify them directly, it is possible that recorded (denoted by subscript R) DCPC payments include documented and undocumented (subscripts D and U , respectively) consumption expenditures:

$$\widehat{X}^{C_R} = \widehat{X}^{C_{RD}} + \widehat{X}^{C_{RU}} .$$

All consumer tax payments are assumed to be documented (required by the government), so $\widehat{X}^{T_{RU}} = 0$ by assumption. However, consumers may engage in undocumented saving activity like person-to-person (P2P) payments, which may include personal debt repayments (repaying a colleague for lunch), outright gifts to other persons, international remittance payments, and

the like. Therefore, the DCPC likely includes documented and undocumented saving-related payments:

$$\widehat{X}^{S_R} = \widehat{X}^{S_{RD}} + \widehat{X}^{S_{RU}}$$

Undocumented consumer payments may also occur within households. In some cases, within-household payments may be expenditures shared by household members, for instance, for a share of an electric bill, which would pose measurement problems if not identified separately from consumption expenditures made by other household members who actually pay the electric bill. Payments toward such shared bills may be captured by the DCPC in person-to-person (P2P) payments, and could be removed in empirical analyses to avoid double counting expenditures.³² Other P2P payments within households may represent saving-related activity, such as an allowance given by a parent to a child or other gifts of assets. Such P2P payments underscore the importance of the discussion in Section 2 about the desirability of sampling and surveying all household members to properly measure all payments and produce unbiased household estimates of consumer spending.

Undocumented expenditures have implications for the measurement of income and payments. Total undocumented expenditures, $X^U = X^{C_{RU}} + X^{S_{RU}}$, are part of the composite error in measuring income, $\mu^y = X^U + \widetilde{\mu}^y$. Then, measured income can be re-expressed as

$$\widehat{Y} = (Y - X^U) - \widetilde{\mu}^y,$$

and the difference between measured income and measured payments becomes

$$\widehat{Y} - \widehat{X} = (\widetilde{S} - X^U) + (\eta^x - \widetilde{\mu}^y).$$

Including undocumented expenditures in the DCPC increases the likelihood that payments could exceed income, depending on the magnitude of undocumented expenditures and the extent to which the DCPC respondents report them.

Third-party payments

Total consumer payments include expenditures paid by consumers directly for themselves, which are recorded in the DCPC, and expenditures paid on behalf of consumers by third parties, such as employers, financial institutions, or governments, which are not recorded in the DCPC (denoted by subscript “N”). Thus, payments for consumer expenditures are

³² In the DCPC and SCPC, consumers are asked to report only the bill payments they made and not those made by other household members. However, it is not known how adults in multi-member households view and report their payment to a roommate for part of a shared bill, as opposed to paying the (electric) bill directly.

$$X^C = X^{C_R} + X^{C_N},$$

and likewise for X^T and X^S . Examples of X^{C_N} include various types of insurance (health or life), contributions to flexible spending accounts that pay for child care, and public transit passes. Examples of X^{T_N} include all kinds of federal, state, and local taxes withheld from income. And examples of X^{S_N} include employee-defined contributions to retirement accounts, loan repayments, and direct deposits to an investment account. Some third-party payments are made automatically for consumers, such as standard employment benefits that do not require consumers to choose them, while some third-party payments are optional and consumers willingly choose to direct third-parties to make the payments, perhaps because it is more convenient than making the payments themselves.

The DCPC asks respondents to record only payments that they make for themselves; it does not collect data on consumer payments made by third parties, so $\widehat{X}^{C_N} = \widehat{X}^{T_N} = \widehat{X}^{S_N} = 0$. Because third-party payments are widespread and quantitatively large for most U.S. consumers, especially those made by employers, the DCPC excludes a relatively large portion of total consumer expenditures and income by design.

The DCPC (or other payment diaries) could ask respondents to record third-party payments as well, or even to recall them approximately. The extent to which third-party expenditures are included in consumer spending estimates is determined by the content and methodology of the survey or diary used to collect them. For example, the SCPC clearly asks respondents to record employer-paid payments called “direct deduction from income.”³³ But the 2012 DCPC did not ask respondents to report these third-party payments as clearly as did the SCPC, so respondents had to remember them without specific questions or prompting as to which one(s) should be included. Although this approach may have succeeded in recording some third-party consumer expenditures, it was likely not as successful as directly asking respondents to record third-party payments. However, asking respondents to report third-party expenditures may greatly increase respondent burden.

Bill payments

Most payment diaries only collect data on point-of-sale (POS) expenditures like retail payments, a practice that limits their coverage of consumer expenditures. Of the seven industrial country diaries in Bagnall et al. (2016), only the U.S. DCPC collected data on bill payments like monthly utilities or loan repayments. However, the 2012 DCPC appears to have been relatively

³³ Technically, these third-party payments from income are not defined by the SCPC and DCPC as an official payment instrument. However, they are authorizations of payment that would have been made with a payment instrument if the income had been deposited into the consumer’s account and had been made directly by the consumer.

unsuccessful, estimating only 8 bill payments per consumer per month compared with 22 in the 2012 SCPC. While this gap warrants further examination and development of the collection of bill payments information, the inclusion of bill payments in the DCPC unequivocally increases coverage of consumer expenditures relative to other payment diaries.

Bill payments also pose measurement challenges because the total dollar values of some bills do not correspond exactly to consumption expenditures. Payments like a monthly electricity bill correspond more or less exactly to actual consumption expenditures. However, bills for loan payments contain a mix of expenditure types, requiring extra data collection and respondent burden to identify the components. A leading example is mortgage payments, which may include principal, interest, taxes, and various types of insurance (PITI). Loan repayment of the principal balance reduces a liability (debt) and therefore is saving. Naturally, the property tax portion of the loan repayment is consumer tax expenditure, but the remainder is related to consumption expenditures. Only part of the interest payment is treated as consumption expenditure through a complicated formula in the details of national income accounting.³⁴ And most types of insurance payments are included in PCE as consumption.

Another important example pertains to credit cards. Consumers who use a credit card to pay for consumption expenditures, such as groceries, gas, and clothes, and then pay off the entire balance of the credit card bill at the end of the month are called “convenience users” of credit cards because they do not carry revolving debt. In this case, the end-of-month credit card bill payment equals the sum of the payments made by credit card for consumption expenditures during the month. Therefore, counting the entire credit card bill payment as consumption, in addition to the individual credit card payments, would double count these consumption expenditures.³⁵ Furthermore, not all credit card payments are for consumption. Examples include taxes, cash advances (which also double count consumption expenditures), and balance transfers from one card to another. Therefore, careful measurement of each and every credit card payment is essential to proper measurement of consumer expenditures and their mapping to consumption.

As evident from these examples, the 2012 DCPC did not collect data on the components of loan repayments or other financial bills. Therefore, the individual expenditure components of these repayments and bills cannot be classified accurately in measures of consumption, taxes, or savings. To handle this incompatibility, all payments to financial institutions (merchant code

³⁴ “In personal outlays, PCE is raised by the sum of the imputed service charges for depositor and investor services and for borrower services, and personal interest payments are reduced by the imputed service charges for borrower services, since *a portion of the interest payment is assumed to represent a fee for unpriced borrower services*. [Emphasis added.]” (Bureau of Economic Analysis 2014, p. 139)

³⁵ The situation is even more complicated when consumers revolve some of their prior months’ credit card debt forward to future months, because the credit card bill (current or future) includes consumption expenditures from prior months. It also includes interest payments and possibly fees, both of which are payment for financial services.

M35)—both bills and non-bills—are included in the “non-comparable” category of consumer expenditures. However, the non-comparable expenditures are included in the DCPC total estimate of consumption because some of these financial expenditures belong there. This inclusion may cause total DCPC consumption estimates to be too high for the reasons explained above.

Measured relationship between income and payments

Based on the preceding discussion, measurement of income and payments involves two issues: 1) whether the concepts are recorded in the DCPC or not; and 2) whether the concepts are documented by the government or not. Conceptually, actual total income includes all four components,

$$Y = (Y^{RD} + Y^{RU}) + (Y^{ND} + Y^{NU}) ,$$

and likewise for actual total payments. However, by construction, the measured estimate of income excludes undocumented income and the measured estimate of payments excludes unrecorded payments. Therefore, the difference between measured income and measured payments is:

$$\hat{Y} - \hat{X} = \left(\widehat{Y^{RD}} - \widehat{X^{RD}} \right) + \left(\widehat{Y^{ND}} - \widehat{X^{RU}} \right) .$$

The first term in parentheses represents the difference between measured income and measured payments that are recorded and documented, which should be close to zero if measurement is reasonably accurate. The second term is a difference with less-comparable terms and is unlikely to be zero. Measured income that is documented but not recorded in the DCPC is likely to be large despite the relatively high coverage of the DCPC (about half of consumption, as explained in the next section). Measured payments that are recorded but not documented—the shadow economy described earlier—could be as high as 10 percent of income or close to zero, depending on DCPC respondents’ propensity to record shadow economic activity, which is likely to be higher the more they use cash for payments.

4.3 Estimating consumption from consumer payments

Originally, the DCPC was not designed to measure consumer expenditures, much less consumption. However, enough details were collected about payments in the 2012 DCPC to enable approximate estimation of consumer expenditures as defined in other surveys. Of course, consumer expenditure estimates from any source (CE, DCPC, or other) require further development to construct proper consumption estimates that can be compared with the NIPA PCE. Moreover, PCE estimates are not exactly comparable to the economic concept of consumption and the measurement of PCE may even have some shortcomings relative to the

DCPC. This subsection describes how the PCE and DCPC concepts of consumption expenditures relate to each other.³⁶

To begin, note that PCE estimates of consumption expenditures, denoted \widehat{C} , are an approximate measure of the economic concept of consumption,

$$\widehat{C} = C - \mu^C ,$$

with the usual composite error, μ^C , that may also include conceptual discrepancies, such as the treatment of durable goods.³⁷ Total PCE includes all documented consumption payments, recorded and not recorded: $\widehat{C} = \widehat{C}^{RD} + \widehat{C}^{ND}$. Likewise, measured DCPC consumption payments are

$$\widehat{X}^C = X^C - \eta^C ,$$

which includes all recorded consumption expenditures, documented and undocumented: $\widehat{X}^C = \widehat{X}^{C_{RD}} + \widehat{X}^{C_{RU}}$. Therefore, the most appropriate comparison of PCE and DCPC consumption is the difference between spending that is both recorded and documented:

$$\widehat{C}^{RD} - \widehat{X}^{C_{RD}} = (C^{RD} - X^{C_{RD}}) + (\eta^{C_{RD}} - \mu^{C_{RD}}) .$$

Unless there are conceptual differences between recorded and documented PCE and DCPC consumption (first term in parentheses), only composite measurement errors should cause the measured estimates to differ. Analogous equations describe the relationships between DCPC consumer payments and consumer expenditure estimates from the CE and FCS. The key measurement challenge for a payment diary is to identify payments that are conceptually equivalent and are measured comparably with estimates of consumer expenditures or consumption from other data sources. The next section provides quantitative estimates of these comparisons.

³⁶ The BLS also constructs a comparable estimate of PCE using the CE, as discussed in Section 5, but that process is not explained here. For more information, see https://www.bls.gov/cex/pce_compare_0203.pdf

³⁷ For example, PCE includes purchases of new cars, whereas economic consumption includes the service flow from the stock of cars. More generally, expenditures and consumption do not always align exactly in time. Consumption of some goods and services, such as canned foods eaten at home or a vacation, may occur after the expenditure. This is especially true of durable goods. Furthermore, in the case of canned foods, for example, a stock of inventory arises when expenditures and consumption are measured at high frequencies, such as daily.

5 Aggregate payments and consumption expenditures

Carroll, Crossley, and Sabelhaus (2015) argue that “...assessing whether the CE [Consumer Expenditure Survey] is comprehensively capturing household spending necessarily begins with comparing aggregates across spending categories and time.” Passero, Garner, and McCully (2015) compare aggregate values of the CE with personal consumption expenditures (PCE) from the National Income and Product Accounts (NIPA). This section extends that work by including the DCPC and FCS and conducting two comparisons: 1) DCPC estimates of consumer expenditures compared with estimates from the CE (survey and diary separately) and the FCS, as collected originally from the respective surveys; and 2) PCE estimates compared with consumption estimates constructed from the DCPC and CE.³⁸

To properly compare aggregate expenditures and consumption estimates, it is necessary to compare the detailed coverage of each data source and to focus on expenditure categories that are comparable across sources. Figure 3 diagrams expenditure coverage for the PCE, CE, and DCPC (FCS coverage is similar to that of the CE). The CE and DCPC cover slightly more than half (54 percent) of PCE. Of the non-PCE portion of expenditures, the DCPC covers essentially all expenditures in the CE plus some not in PCE or CE.

5.1 Estimates of consumer expenditures

Table 4 reports estimates of aggregate consumer payments and expenditures from the DCPC, CE, and FCS for the nine relatively comparable categories in Table 3. The CE estimates are reported in total and separately for the survey and diary (CE-S and CE-D) components to illustrate their relative contributions. DCPC expenditure estimates include confidence interval estimates in brackets, and the CE and FCS estimates include their ratios to the DCPC estimates in parentheses.

In October, 2012, consumer payments in the DCPC were \$11.2 trillion (annual rate), as shown in the first row of Table 4. In contrast, consumer expenditures in the CE were \$6.4 trillion (57 percent of DCPC) and in the FCS only \$4.9 trillion (43 percent of DCPC). The 95 percent confidence interval for the DCPC (\$8.9 to \$13.6 trillion) suggests that the DCPC estimate may be statistically significantly higher than the CE and FCS estimates, provided their confidence intervals are not too large. The first notable result of this paper is that DCPC consumer payments are 75 percent or more higher than consumer expenditure estimates from leading U.S. surveys dedicated to the task of measuring these expenditures, even though the DCPC was not designed for this purpose.

³⁸ I thank an anonymous referee for the suggestion to conduct these separate comparisons and to disaggregate the CE into survey and diary components, which greatly enhanced the insight of the exercise relative to the previous version of the paper.

The magnitude of DCPC payments relative to the CE or FCS expenditures varies considerably across expenditure categories. Nearly 90 percent of DCPC payments occurred in five categories (food, housing, transportation, financial services, and other) that essentially accounted for the entire difference between the DCPC and CE (\$4.8 trillion). The largest absolute difference occurred in food (\$1.8 trillion); the housing and other categories each accounted for \$1 trillion; and transportation plus financial services together accounted for \$0.9 trillion. The DCPC and CE estimates are notably similar in the remaining categories, which are relatively small in value except for transportation (about \$1.6 trillion). Most of the difference between the CE and FCS occurred in three categories where the CE estimates were \$1.2 trillion higher (financial services, transportation, and food).

Regarding CE components, the CE-S accounted for about three-quarters of total CE expenditures (\$4.8 trillion) compared with about one-quarter for the CE-D (\$1.6 trillion). Nearly two-thirds (\$1.0 trillion) of the CE-D expenditures come from the food and related category, whereas the DCPC estimate is three times higher than the CE-D estimate (\$3.0 trillion versus \$1.0 trillion). This result suggests that the survey mode (diary) is not the primary explanation for the DCPC's success. Rather, *payment* diaries like the DCPC are more adept at collecting expenditures comprehensively than *product* diaries like the CE-D.

5.2 Estimates of PCE

Construction of PCE estimates for the NIPA is an arduous task that requires comprehensive data input and careful matching of the data to theory.³⁹ Although PCE may have flaws, it is a reasonable benchmark for comparison to alternative consumption estimates. Neither the CE nor the DCPC has sufficient data, staff resources, or mandate to replicate the PCE entirely, much less improve on it. Both surveys would require extensive expansion to replicate the entire range of PCE, and the CE would need to close the gap between its expenditure estimates and the DCPC payments as well.

However, for the selected expenditures categories with mostly comparable definitions it is reasonable to compare consumption estimates from the DCPC and the CE with the PCE, as shown in Table 5.⁴⁰ This comparison uses CE estimates that the BLS has adjusted to be comparable with PCE as much as possible.⁴¹ The DCPC estimates have been constructed merely by using the expenditure categories most comparable to those in the PCE but have not been adjusted further to match PCE. (Recall that the DCPC was not designed to be a survey of consumer expenditures, much less one to produce consumption estimates.) Furthermore, the

³⁹ For more information on the BEA methodology, see <https://www.bls.gov/opub/hom/cex/home.htm>

⁴⁰ FCS consumer expenditures are excluded from this comparison because they were considerably lower than the CE estimates.

⁴¹ For more information, see Passero, Garner, and McCully (2015).
<http://www.bls.gov/cex/cepeconcordance.htm>

DCPC and CE expenditure categories that were used to construct the respective estimates of consumption are not exactly comparable to each other.

Table 5 begins by reporting in the first column total consumption expenditures and an adjusted total that removes some important but unique categories that are so different that they are not strictly comparable. The remaining rows contain categories with varying degrees of comparability. “Mostly comparable” DCPC categories have reasonably close definitions to PCE and similar measurement, even for seven detailed subcategories. “Mostly non-comparable” DCPC categories may have some rough similarities but also important discrepancies in definitions and measurability. PCE estimates appear in the middle columns to facilitate comparison with each unique CE or DCPC category. As in Table 4, the DCPC column includes the 95 percent confidence interval in brackets, and the CE and DCPC columns include their ratios to PCE in parentheses.

In October, 2012, total PCE was \$11.1 trillion (annual rate), as shown in the first line of Table 5. Although not strictly comparable to PCE, consumer payments were \$11.2 trillion for the DCPC (102 percent of PCE), and consumer expenditures were \$6.3 trillion for CE (57 percent of PCE). The largest strictly non-comparable item pertains to PCE imputed rent (\$1.3 trillion), which the CE estimates closely (\$1.4 trillion or 110 percent of PCE). The DCPC does not attempt to measure or construct imputed rent, but conceptually related payments (mortgages and dwelling expenses) are similar in magnitude to the imputed rent estimates. PCE alone includes goods and services provided by non-profits, and the DCPC alone includes miscellaneous non-PCE payments.

Adjusted total PCE expenditures were \$9.5 trillion, as shown in the middle of Table 5. Adjusted total consumption payments and expenditures for the DCPC and CE were \$8.7 and \$4.9 trillion, respectively (92 and 52 percent of PCE). The 95 percent confidence interval for DCPC consumption payments (\$7.9 to \$9.6 trillion) would be statistically significantly different from PCE only if the PCE confidence interval of PCE were extraordinarily small. Although the DCPC and PCE estimates are roughly the same, recall that adjusted consumption expenditures cover only slightly more than half of PCE and include a non-trivial share of categories that are mostly non-comparable to PCE. The best comparison is DCPC and PCE estimates for the mostly comparable categories, where the DCPC estimate is \$6 trillion (117 percent of PCE). The second notable result of this paper is that DCPC consumption payments are very roughly similar to (about 15 percent higher than) PCE estimates in comparable expenditure categories, even though the DCPC was not designed to measure consumption.

The rough similarity between DCPC adjusted consumption payments and PCE may be coincidental and not robust. Note that DCPC payments estimates in mostly non-comparable categories are much lower than the PCE estimates (\$2.7 versus \$4.4 trillion, or 62 percent of

PCE), whereas DCPC payments in mostly comparable categories are considerably higher (\$6 versus \$5.1 trillion, or 117 percent of PCE). Moreover, the PCE point estimate is outside the 95 percent confidence interval for the DCPC. A similar result occurs in three comparable categories (food, general merchandise, and housing), which are significantly larger than in the PCE. These results suggest that apparent equality between DCPC and PCE may be a statistical artifact, not a robust finding about the ability of the DCPC to reliably estimate PCE.⁴² Thus, the 2012 DCPC requires considerable further development and refinement to estimate PCE well.

5.3 Comparison with the SCF

The SCF provides another data source that supports a methodology for indirectly estimating consumption expenditures, which can be compared with the PCE and DCPC. As noted earlier, the triennial SCF obtains data on U.S. households' balance sheet items (assets and liabilities) and income statement items (primarily the income portion, with limited expense data). Using SCF data on household income and estimating saving as the SCF-measured change in wealth (ΔW) adjusted for unrealized capital gains (CG) over the three-year period, one can derive the level of consumption as described in Sabelhaus and Pence (1999) using the following identity:

$$C^{SCF} = Y^{SCF} - T^{SCF} - (1/3)\Delta^3(W^{SCF} - CG^{SCF}) .^{43}$$

Figure 4 plots the ratio of this derived SCF consumption estimate to PCE consumption (C^{SCF}/\hat{C}). On average over time, the derived SCF consumption estimate equals about 70 percent of total PCE, which is slightly higher than the CE estimate in Table 5 but still notably less than the DCPC estimate.

6 Aggregate payments and personal income

This section reports estimates of the relationship between consumer payments and personal income.⁴⁴ As discussed in Section 4, a simple direct comparison of NIPA income and DCPC payments would be inappropriate due to numerous conceptual and measurement differences between the estimates. However, it is feasible to make adjustments to income and payments that makes them approximately equal for comparison. The first adjustment is to remove taxes because they are a large part of third-party payments that are not recorded in the DCPC and it is not possible to identify the sales tax component of payments. Let $Y^d = Y - T$ denote

⁴² I thank an anonymous referee for pointing out this insight from the earlier version of the paper.

⁴³ See Eika, Mogstad, and Vestad (2016) for an alternative approach to a similar methodology.

⁴⁴ The 2012 DCPC did not collect data directly on the dollar value of consumer income, although it did collect the dates of paydays (most recent and subsequent for any type of income). The 2012 SCPC contains an estimated range of annual income for the consumer's entire household and the ordinal rank of the consumer's income within that household.

disposable income, and $X^d = X - X^T$ denote non-tax payments. Then, estimated disposable income approximately equals estimated non-tax payments after a few adjustments shown in the following expression:

$$\widehat{Y}^d + \widehat{T}^C - \left(\widehat{X}^{CND} + \widehat{X}^{SND} \right) \approx \widehat{X}^d - \left(\widehat{X}^{CRU} + \widehat{X}^{SRU} \right).$$

Sales tax payments are not identified separately from other consumer payments, so they must be added back into disposable income. Non-tax, third-party payments made by employers are not recorded in the DCPC, so they must be subtracted from disposable income. Finally, undocumented non-tax payments are not included in disposable income, so they must be subtracted from non-tax payments. Table 6 reports estimates for these adjusted concepts of aggregate disposable income and payments.

In the fourth quarter of 2012, NIPA disposable personal income was \$12.4 trillion (annual rate). After subtracting estimates of employer third-party consumer payments (supplements to wages and salaries plus Medicare and Medicaid expenses) and of sales taxes, adjusted disposable personal income was \$10.2 trillion. In October 2012, DCPC payments were \$11.2 trillion (annual rate). After subtracting recorded tax payments made directly by consumers and an estimate of undocumented payments (person-to-person payments), adjusted payments were \$10.7 trillion. The third notable result of this paper is that DCPC payments accounted for 105 percent of income, without actually collecting data on personal income directly.

Approximate equality between roughly comparable estimates of disposable income and payments is surprising and encouraging given the simplicity and imperfections of the estimation and adjustments, but much more work is required to obtain a satisfactory correspondence between the DCPC payments and NIPA income. To provide some perspective, note that the actual NIPA personal saving rate was 7.8 percent in October 2012, whereas the difference between adjusted disposable income and adjusted non-tax payments shown in Table 6 was -4 percent. Given the complexity and imperfections of the measurement in the two data sources, it is not possible to identify the components of the 12 percentage point difference or even to establish conclusively whether that difference is accurate.

7 Summary and conclusions

A close examination of consumer payment diaries has revealed their potential to obtain relatively accurate estimates of consumer expenditures and income. In particular, the Boston Fed's 2012 DCPC estimate of consumer payments is 75 percent higher than CE estimates of consumer expenditures, and in the ballpark of NIPA estimates of PCE and disposable income (after appropriate adjustments). This notable result has occurred without an explicit, intentional

effort to design and implement the DCPC with the goal of matching the NIPA data on consumption and income. Originally, the DCPC was intended to provide estimates of the number and value of consumer payments, not consumption and income.

Several features of the DCPC appear to have contributed to its surprisingly good performance in this (in no particular order of importance):

- Measuring expenditures at the level of an individual payment seems to be more effective in covering expenditures than measuring them at the level of individual products (too fine) or at the level of broad categories (too coarse/too aggregated).
- Measuring payments each day seems to be more effective than measuring expenditures at lower frequencies (too much time aggregation).
- Reducing respondent burden (roughly two payments per day for three days) and relying on random sampling with rotating waves seems to be more effective than asking all individual consumers in a sample to report everything they buy in detail over longer periods of time.
- Using representative samples drawn from Internet-access panels seems to produce better rates of participation and response, and more careful data reporting, than using random samples from the broader population that is less inclined to participate and report well; the benefits seem to offset potential sample selection issues.

Except for measurement of expenditures by payment, these features are not unique, neither is any one of them—even the focus on payments—solely responsible for the DCPC’s positive result. Rather, it is the combination of all these features together in one data collection effort that yields success. Therefore, the results presented in this paper suggest that embarking on further refinement and development of consumer payment diaries, done with the intent of contributing to the accurate measurement of consumption, may yield additional notable contributions.

Of course, the DCPC payment estimates are not without flaws and limitations, as might be expected from a methodology used for a purpose other than that for which it was designed. Some of the features of the DCPC that warrant further development and improvement include (in no particular order of importance):

- Sampling and measuring total household expenditures by more consumer members rather than individual consumers randomly drawn from (some) households.

- Identifying consumption (PCE) versus non-consumption expenditures that match NIPA definitions and methodology, including separating bills from other payments.
- Separately identifying the payee from the types of goods and services purchased rather than combining these into one “merchant category” that tries to identify them jointly.
- Collecting more-detailed information about loan repayments and other bills with components that represent economically different types of consumer allocations of income.
- Directly collecting information on receipt of personal income in dollar values rather than indirectly measuring income from payments data.

Improvements in many of these and other features were implemented in the Boston Fed’s 2015 DCPC (conducted from October 16 through December 15), which will be reported in future research. The revisions were designed to follow the methodology of Sampranathak and Townsend (2010), which proposes a complete integration of survey methodology with corporate financial statements as applied to households. More generally, the 2015 DCPC highlights the fact that payment diaries link individual expenditure entries of the income statement with their associated assets and liabilities in the balance sheet through detailed individual cash flow statements. Samphantharak, Schuh, and Townsend (2017) explain how this methodology applies to the 2012 DCPC and provide guidelines for the 2015 DCPC revisions. More research and data collection are needed to realize the full potential of payment diaries for measuring consumer expenditures and for fully integrating the survey methodology with household financial statements.

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TABLE 1

	CE-S	CE-D	SCF	FCS	SCPC	DCPC
Sponsor	BLS	BLS	Federal Reserve Board	RAND Corp.	Boston Fed	Boston Fed
Frequency	Quarterly	Monthly	Triannual	Monthly	Annual	Irregular
Period	1980–present	1980–present	1983–present	2008–2014	2008–present	2012, 2015
<i>Questionnaires</i>						
Observation unit	Consumers and households	Consumers	Primary economic unit	Consumers and households	Consumers and households	Consumers
Mode(s)	Interview (CAPI)	Memory aid & interview	Interview (CAPI)	Internet (unaided)	Internet (unaided)	Memory aids & Internet
Data collection	Recall	Recording & recall	Recall	Recall	Recall	Recording & recall
Minutes	60	235 = (15/day x 14 days + 25)	85	15-20	30	60 = 20/day x 3 days
Incentive	\$0	\$0	\$75–\$300	\$20	\$20	\$60
<i>Measurement</i>						
Unit(s) of measure	\$ amount per category	\$ amount per item purchased	\$ amount per category	\$ amount per category	# of payments by instrument & category	\$ amount per payment; # of payments
Measurement period	“Usual” week, month, or quarter (varies by category)	Daily expenditures	“Average” week for expenditures, past year for income	Last 30 days, last 6 months, or last 12 months (varies by category)	“Typical” week, month, or year (respondent chooses)	Daily payments
Real-time error checks	Range checks for all CAPI numeric entries ⁴⁵	Field reps make informal adjustments	Real-time reconciliation by interviewer	Reconciliation screen at end of survey	Selected range checks	Reconciliation screens for selected data entries
<i>Sampling</i>						
Target population	Total non-institutional	Total non-institutional	Total non-institutional	Age 18+, non-institutional	Age 18+, non-institutional	Age 18+, non-institutional
Sampling frame	U.S. Census Bureau master address file	U.S. Census Bureau master address file	NORC national sampling frame and IRS data	RAND ALP	RAND ALP, USC UAS, GfK Knowledge Networks	RAND ALP, USC UAS, GfK Knowledge Networks
Sample size	~7,000	~7,000	~6,000	~2,500	~2,000	~2,000
Rotation	1 survey per quarter	2 consecutive 1-week periods	1 survey per year	1 survey per month	1 survey per year	3 consecutive days, random assignment
Longitudinal panel	4 consecutive quarters	14 days	None	Voluntary ongoing participation	Voluntary participation since 2008	3-day waves tied to SCPC annual panel
CE-S: http://www.bls.gov/CE/capi/2015/cecapihome.htm CE-D: http://www.bls.gov/CE/ced/2013/cedhome.htm FCS: http://www.nber.org/papers/w17974			SCPC: http://www.bostonfed.org/economic/cprc/scpc/ DCPC: https://www.bostonfed.org/economic/cprc/data-resources.htm SCF: https://www.federalreserve.gov/econresdata/scf/scfindex.htm			

⁴⁵ BLS experimented with cash-flow reconciliation but did not implement it (Fricker and Tan 2012).

TABLE 2

		DCPC	Benchmark⁴⁶
Age ⁴⁷	18–20	2.1	5.4
	21–44	43.8	42.0
	45–64	35.9	34.9
	65+	18.1	17.7
Gender	Male	48.1	49.2
Race	White	76.1	79.8
	Black	12.1	12.0
	Other	11.8	8.2
Ethnicity	Hispanic	17.7	14.6
Household composition	Median (#)	2.95	2.36
	1 member	14.3	27.4
	2 members	34.6	33.8
	3 members	18.8	15.8
	4+ members	32.4	22.9
	With children (<18)	40.4	32.3
	With members 65+	20.8	25.6
Household income	Up to \$14,999	15.1	12.7
	\$15,000–\$34,999	20.7	21.8
	\$35,000–\$49,999	14.2	13.5
	\$50,000–\$74,999	18.3	17.4
	\$75,000–\$99,999	11.6	11.8
	\$100,000–\$199,999	18.0	18.0
	\$200,000 or more	2.2	4.8
Average transaction value (\$) ⁴⁸	Debit	42	38
	Credit	57	76
	Employment-to-population ratio ⁴⁹	55.7	58.8
	Homeownership rate	59.9	65.5
	Median primary-home value (\$) ⁵⁰	160,000	177,000
	Checking account adoption rate ⁵¹	90.4	91.5

**Aggregate Estimates of Demographic and Selected Economic Variables
(percentage of consumers unless otherwise noted)**

⁴⁶ Current Population Survey, March 2012 (unless otherwise noted)

⁴⁷ Of civilian non-institutional population, age 18-plus.

⁴⁸ Federal Reserve Payments Study

⁴⁹ Of civilian non-institutional population, age 20-plus.

⁵⁰ National Association of Realtors

⁵¹ Survey of Consumer Finances

TABLE 3

Categories	Surveys		Diaries	
	(sums of all spending in categories)		(each item/payment in categories)	
	FCS ⁵²	CE-S ⁵³	CE-D ⁵⁴	DCPC ⁵⁵
Total	45	439	262	45
Food, general merchandise, personal care supplies and services	5	50	193	9
Housing and home services	22	183	33	11
Transportation	5	71	5	7
Entertainment and recreation	4	65	22	4
Healthcare	4	29	5	2
Financial services	2	7	0	1
Education	1	11	1	1
Charity, personal contributions	2	9	0	4
Other/unknown goods and services	0	14	3	6

Numbers of Expenditure and Payment Categories, 2012

⁵² For more details, see the Appendix of <http://www.nber.org/papers/w17974.pdf>.

⁵³ For more details, see the 2015 CE Quarterly Interview CAPI Survey, <http://www.bls.gov/cex/capi/2015/cecapihome.htm>.

⁵⁴ For more details, see the 2013 CE Diary Survey Form, http://www.bls.gov/cex/csx801_2013.pdf.

⁵⁵ For more details, see Appendix Table A.1.

TABLE 4

Category	DCPC ⁵⁶	CE			FCS
		Total	Diary	Survey	
Total	11,226 [8861, 13592] ⁵⁷	6,400 (.57)	1,626 (.14)	4,774 (.43)	4,863 (.43)
Food, general merchandise, personal care supplies and services	3,039 [2781, 3296]	1,241 (.41)	1,024 (.34)	217 (.07)	1,080 (.36)
Housing and home services	3,038 [2592, 3484]	2,101 (.69)	136 (.04)	1,965 (.65)	2,267 (.75)
Transportation	1,574 [1051, 2097]	1,120 (.71)	140 (.09)	979 (.62)	755 (.48)
Entertainment and recreation	249 [188, 310]	318 (1.28)	94 (.38)	224 (.90)	174 (.70)
Healthcare	419 [185, 652]	442 (1.05)	212 (.51)	230 (.55)	242 (.58)
Financial services	1,119 [731, 1507]	696 (.62)	0 (.00)	696 (.62)	84 (.08)
Education	110 [60, 160]	150 (1.37)	6 (.06)	144 (1.31)	155 (1.41)
Charity, personal contributions	445 [346, 543]	238 (.53)	0 (.00)	238 (.53)	105 (.24)
Other/unknown goods and services	1,234 [927, 1542]	94 (.08)	13 (.01)	81 (.07)	0 (.00)

Aggregate Estimates of U.S. Consumer Expenditures, October 2012
(\$billions, annual rate)

⁵⁶ DCPC estimates are mapped to categories using the DCPC merchant codes. Food: M1–M3, M10–M14, M31. Housing: M18, M20–M28, M39. Transportation: M4–M9, M19. Entertainment: M15–M17, M33. Healthcare: M29, M31. Financial Services: M35, M38. Education: M30. Charity: M40, M42–M44. Other: M34, M36, M37, M41, none reported.

⁵⁷ NOTE: The brackets contain 95 percent confidence intervals, and the parentheses contain ratios of the CE and FCS estimates to the DCPC estimates.

TABLE 5

Category	CE Consumption ⁵⁸	PCE		DCPC
Total	6,337	11,051		11,226
(Percent PCE)	(.57)			(1.02)/[10205, 12247]
[95% confidence interval]				
Imputed rent	1,394 (1.10)	1,266		-
Mortgage payments, expenses for owned dwellings	-	-		1,211 (na)/[871, 1551]
Payments to other individuals, and non- classifiable items	-	-		1,286 (na)/[1018, 1553]
Goods and services furnished by non-profits	-	293		-
Adjusted total	4,943	9,492		8,729
	(.52)			(.92)/[7850, 9609]
<i>Mostly Non-comparable</i>	1,284 (.32)	4,006	4,399	2,715 (.62)/[2020, 3410]
<i>Mostly Comparable</i>	3,659 (.67)	5,486	5,093	6,014 (1.18)/[5556, 6473]
Food and food services	869 (.61)	1,433	1,433	1,742 (1.22)/[1604, 1880]
General merchandise, personal care supplies and services	445 (.42)	1,071	1,071	1,297 (1.21)/[1091, 1503]
Housing and home services	1,082 (.78)	1,382	1,382	1,827 (1.32)/[1551, 2103]
Transportation	796 (.88)	901	901	899 (1)/[738, 1061]
Entertainment, Recreation	163 (.53)	305	305	249 (.82)/[188, 310]
Pharmaceuticals	289 (.79)	365	Not comparable	
Other goods and services	14 (.50)	28	Not comparable	

**Aggregate U.S. Estimates of Consumption, October 2012
(\$billions, annual rate)**

⁵⁸ A detailed account of the comparison between CE and PCE, as well as the raw numbers, can be found here: <https://www.bls.gov/cex/cecomparison.htm>

TABLE 6

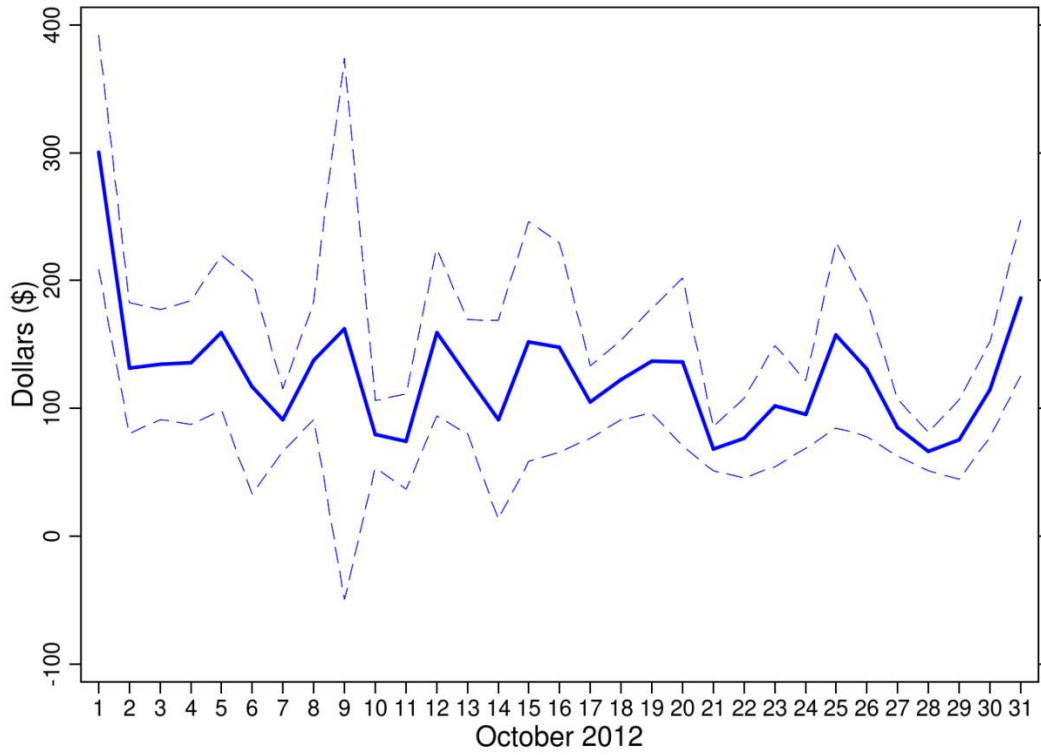
Source	\$ trillions
Disposable personal income (NIPA, 2012 Q4) ⁵⁹	12.4
Less: Supplements to wages and salaries	1.7
Less: Medicare and Medicaid	1.0
Plus: Sales Taxes	0.5
Adjusted disposable personal income (ADPI)	10.2
Consumer payments, October 2012 (annualized)	11.2
Less: Taxes/fees/other payments made to government	0.2
Less: Person-to-person payments	0.3
Adjusted consumer payments	10.7
Percentage of ADPI	(105%)

Note: numbers may not sum properly due to rounding.

Aggregate Estimates of Income and Consumer Payments, 2012

⁵⁹ Source: https://www.bea.gov/iTable/index_nipa.cfm (Personal Income and Outlays -> Personal Income and Its Disposition)

FIGURE 1

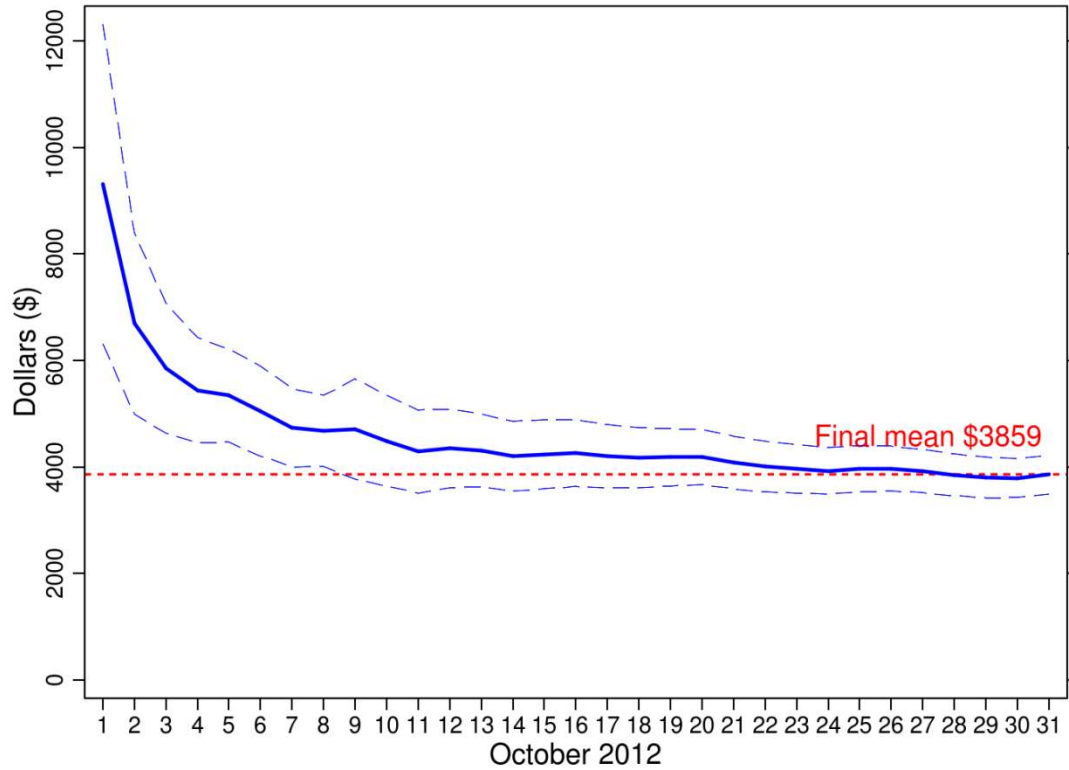


Daily Payments per U.S. Consumer, October 2012

Source: 2012 Diary of Consumer Payment Choice.

Note: Dashed lines indicate 95 percent confidence level.

FIGURE 2



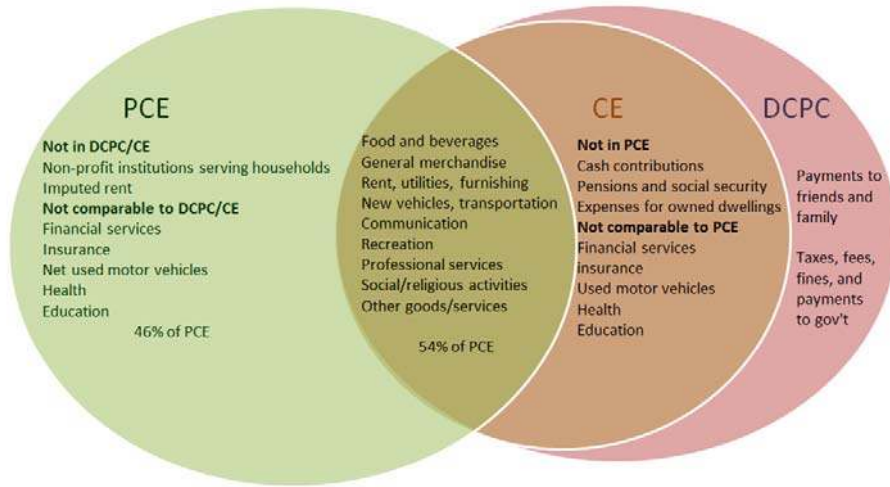
Daily Estimate of Monthly Payments per U.S. Consumer, October 2012⁶⁰

Source: 2012 Diary of Consumer Payment Choice.

Note: Dashed lines indicate 95 percent confidence level; dotted line indicates the final mean.

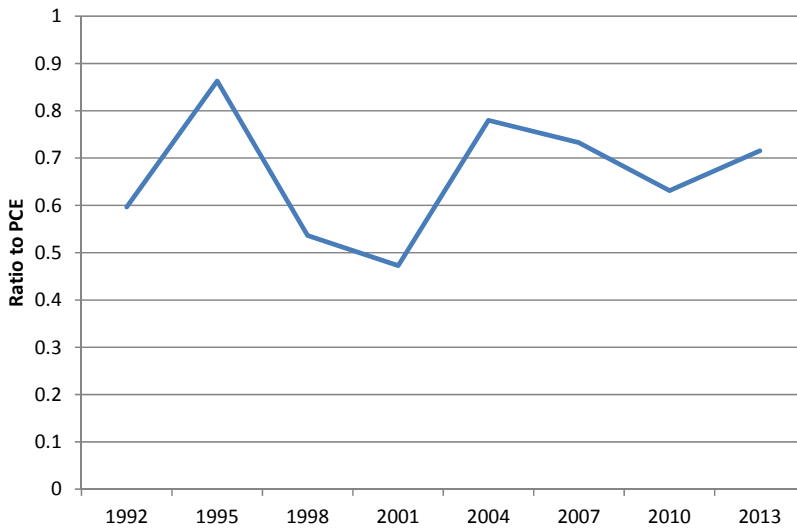
⁶⁰ The daily estimate of monthly payments equals the 31-day projection of average daily payments derived from the cumulative sum of payments since October 1, divided by the number of days (see formula in section 3.7). When calculating the standard errors for daily estimate of monthly payments, covariance across days becomes a factor. For the purposes of this figure, we assume that covariance across days only arises from the sample containing the same individuals for multiple days. Thus, if x_t is the average daily payments on date t , we assume that $Cov(x_t, x_k) = 0$ if $t - k > 2$, because an individual is only present in the sample for a maximum of three days. For $t - k \leq 2$, where covariance is not assumed to be zero, we use the sample covariance to calculate the standard errors.

FIGURE 3



Coverage of Expenditure Categories by U.S. Surveys

FIGURE 4



Aggregate Consumption Derived from the Survey of Consumer Finances, Relative to PCE

Source: Author's calculations.

Appendix Material

TABLE A.1

Merchant code	Merchant/expenditure description	NAICS code
M1	Fast food, food service, food trucks, snack bars	722
M2	Grocery, pharmacy, liquor stores, convenience stores (without gas stations)	44-45
M3	Restaurants, bars	722
M4	Auto maintenance and repair	811
M5	Auto rental and leasing	532
M6	Auto vehicle and parts dealers	441
M7	Gas stations	447
M8	Parking lots and garages	488
M9	Tolls	48-49
M10	Clothing and accessories stores	448
M11	Department and discount stores and websites, wholesale clubs and websites	44-45
M12	Online shopping (Amazon.com, etc.)	44-45
M13	Other stores (book, florist, hobby, music, office supply, pet, sporting goods)	44-45
M14	Vending machines	454
M15	Entertainment, recreation, arts, museums	71
M16	Hotels, motels, RV parks, camps	72
M17	Movie theaters	512
M18	Phone/Internet (wired/wireless/satellite), online and print news, online games	51
M19	Transportation (includes public transportation)	48-49
M20	Building contractors (electrical/plumbing/HVAC, tile, painting, etc.)	81
M21	Building services	561
M22	Electric, natural gas, water and sewage	22
M23	Furniture & home goods stores, appliance & electronics stores, hardware & garden stores	44-45
M24	Heating oil dealers, propane dealers	454
M25	Rent, real estate agents and brokers	53
M26	Mortgage	53
M27	Trash collection	562
M28	Child care, elder care, youth and family services, emergency and other relief services	62
M29	Doctors, dentists, other health professionals	62
M30	Education	61
M31	Hospitals, residential care	62
M32	Personal care, dry cleaning, pet grooming and sitting, photo processing, death care	81
M33	Veterinarians	81
M34	Employment services, travel agents, security services, office administrative services	561
M35	Financial services, insurance	52

M36	Legal, accounting, architectural, and other professional services	54
M37	Mail, delivery, storage	48-49
M38	Rental centers	532
M39	Repair/maintenance of electronics and personal and household goods	811
M40	Charitable, religious, professional, civic (not government) organizations	813
M41	Taxes, fees, fines and other payments to governments	-
M42	Friends and family	-
M43	People who provide goods and services	814
M44	Other people	-
M45	I don't know/missing	-

DCPC Merchant Categories

TABLE A.2

Expenditure Category	CE Categories	DCPC Merchant Codes
Food, general merchandise, personal care supplies and services	Food at home; Food away from home; Alcoholic beverages; Apparel and services; Personal care products and services; Reading; Tobacco Products	M1, M2, M3, M10, M11, M12, M13, M14, M32
Housing and home services	Shelter; Utilities, fuels, and public services; household operations; Housekeeping supplies; Household furnishings and equipment	M18, M20, M21, M22, M23, M24, M25, M26, M27, M28, M38, M39
Transportation	Vehicle purchases (net outlay); Gasoline and motor oil; Vehicle insurance; Vehicle rental, leases, licenses, and other charges; Air fare, taxis, bus fares; Miscellaneous transportation.	M4, M5, M6, M7, M8, M9, M19
Entertainment and recreation	Entertainment; Fees and admissions; Audio and visual equipment and services; Pets, toys, hobbies and playground equipment	M15, M16, M17, M33
Healthcare	Health insurance; Medical services; Drugs; Medical supplies	M29, M31
Financial services	Personal insurance and pensions	M35
Education	Tuition; Test prep; School books and supplies for all types of school	M30
Charity, personal contributions	Charity; Child support and alimony; Donations to charities, churches, educational institutions, and political organizations; Other gifts	M40, M42, M43, M44
Other/Unknown goods and services	Miscellaneous (includes legal fees, funeral expenses, bank service charges, etc.)	M34, M36, M37, M41, M43, M45, missing

Mapping between CE Expenditure Categories and DCPC Merchant Codes

TABLE A.3

Expenditure Category	PCE Categories	DCPC Merchant Codes
Payments to other individuals, and non-classifiable items	N/A	M41, M42, M44, M45, missing
Non-comparable categories	Financial services and insurance, motor vehicles, health, education, social services and religious activities	M5, M6, M29, M30, M31, M34, M36, M35, M37, M43
Food and food services	Food and beverages	M1, M2, M3
General merchandise, personal care supplies and services	General merchandise	M10, M11, M12, M13, M14, M32
Housing and home services	Rent, household appliances, televisions, audio equipment, personal computers and peripheral equipment, telephone and facsimile equipment, rent and utilities, communication, child care, household maintenance	M18, M22, M23, M24, M25, M27, M28, M38, M39
Transportation	Motor vehicles and parts, pleasure boats, other recreational vehicles, gasoline and other energy goods, other motor vehicle services	M4, M7, M8, M9, M19
Entertainment, Recreation	Pets and related products and services; film and photographic supplies; audio-video, photographic, and information processing equipment services; gambling	M15, M16, M17, M33
Pharmaceuticals	Pharmaceutical products	N/A
Other goods and services	Accounting and other business services	N/A

Mapping between PCE Expenditure Categories and DCPC Merchant Codes

EXHIBIT A.1

EXAMPLE				SUN	MON	TUE	WED	THU	FRI	SAT				
1. Food and Drinks Away from Home														
Examples: breakfast buffet, carry-out lunch, dinner & cocktails at restaurant, pizza delivery, Chinese takeout, child's school lunch, beer at happy hour, pretzels at ballgame, wine at tavern, croissant from café, ice cream from truck, wedding reception caterer, soda from vending machine, hot dog from convenience store, popcorn and soda at movies														
← Please unfold the LEFT FLAP to see Additional Examples														
Mark (X) one that best describes the type of meal	Description <i>(See examples above and on the flap)</i>				Mark (X) one that best describes where you made this purchase					Total Cost with tax & tip	If alcoholic beverages included, mark (X) all that apply			Enter the total cost of the alcohol
					Fast Food Take-out Delivery Concession	Full Service Places	Vending Machines or Mobile Vendors	Employer or School Cafeteria	Include tax & tip for part 1 only.		wine	beer	other	
1 X	2	3	4						X	2 79	1	2	3	
101				bagel, juice										
1	X	2	3	4						5 57	1	2	3	
102				pizza	X									
1	2	3	4			X	2	3	4	1 35	1	2	3	
103				coffee		X								
1	X	2	3	4					X	5 15	1	2	3	
104				sandwich, soda										
1	2	3	4							1 70	1	2	3	
105				chips				X						
1	X	2	3	4					X	45 00	1	2	3	
106				elem.school lunch - month										
1	2	3	4							65	1	2	3	
107				soda				X						
1	2	3	4				X			62 23	X			12 00
108				buffet			X							
1	2	3	4				X			15 00		X	X	15 00
109				drinks from cash bar										
1	2	3	4				X			350 00	X	X	X	95 00
110				caterer - Family Reunion										
111														
112														
113														
114														
115														

Example of a Memory Aid Form in the CE Diary

EXHIBIT A.2

DAY 1 – DAILY PAYMENTS AND CASH ACTIVITY

- It's OK if you don't make any purchases today. Just tell us when you go online tonight. We're interested in all types of payment behavior, even 0 purchases.
- We will ask you about any bills and cash deposits online.
- Please write today's date in the space provided _____/_____/_____

Please circle the Payment Method codes to tell us what you carried out of the house today.	P1 P2 P3 P4/P5 P6 P9 P10	I did not leave the house today. <input type="checkbox"/>
--	---------------------------------	--

Time	Amount Spent	Payment Method	Location	Device	Merchant Type	Merchant Name
____ am ____ pm	\$ _____.	P	L	D	M	
____ am ____ pm	\$ _____.	P	L	D	M	
____ am ____ pm	\$ _____.	P	L	D	M	

<u>Payment Method Codes</u>	
P1: Cash	P7: Bank account number payment
P2: Check	P8: Online banking bill payment
P3: Credit card	P9: Money order
P4: Debit card (Used PIN)	P10: Traveler's check
P5: Debit card (Did not use PIN)	P11: Text message payment
P6: Prepaid/Gift/EBT card	P12: Other payment method

<u>Location Codes</u>	
L1: Payment in person	L2: Payment not in person

<u>Device Codes</u>	
D1: Computer (laptop or desktop)	D4: Landline phone
D2: Tablet (e.g., iPad, Kindle)	D5: Mail or delivery service
D3: Mobile phone	D6: None of the above

Main Page of the Long-Form Memory Aid in the 2012 DCPC

EXHIBIT A.3

Section 20, Part A asks for expenditure estimates for groceries, cigarettes, alcoholic beverages, and meals away from home.

IMPORTANT: The Census Bureau does not release to the Bureau of Labor Statistics any confidential information such as names and addresses. This information is only used during the course of the interview.

Now I am going to ask about expenses for food, beverages and other items you and/or your household have/has purchased since the first of the reference month.

What has been your or your household usual WEEKLY expense for grocery shopping?

* Include grocery home delivery service fees and drinking water delivery fees. [\[enter value\]](#) _____

About how much of this amount was for nonfood items, such as paper products, detergents, home cleaning supplies, pet foods, and alcoholic beverages? [\[enter value\]](#) _____

Other than your regular grocery shopping already reported, have you or any members of your household purchased any food or nonalcoholic beverages from places such as grocery stores, convenience stores, specialty stores, home delivery, or farmer's markets?

1. [Yes](#)
2. [No](#)

What was your usual WEEKLY expense at these places? [\[enter value\]](#) _____

What has been your or your household's usual WEEKLY expense for meals or snacks from restaurants, fast food places, cafeterias, carryouts or other such places?

(Do not include meals purchased at school.) [\[enter value\]](#) _____

Since the first of the reference month, have you or any members of your household purchased cigarettes?

1. [Yes](#)
2. [No](#)

What is the usual WEEKLY expense for cigarettes? [\[enter value\]](#) _____

Have you or any members of your household purchased other tobacco products such as cigars, pipe tobacco, or chewing tobacco?

1. [Yes](#)
2. [No](#)

What is the usual WEEKLY expense? [\[enter value\]](#) _____

What has been your or your household's usual MONTHLY expense for alcohol, including beer and wine to be served at home? [\[enter value\]](#) _____

What has been your or your household's usual MONTHLY expense for alcohol, including beer and wine at restaurants, bars and recreational events? [\[enter value\]](#) _____

Since the first of the reference month, not including the current month, have you or any members of your household

purchased any meals at school for preschool through high school age children?

1. [Yes](#)
2. [No](#)

What are the names of all household members who purchased meals at school?

* Enter line numbers for all that apply. [\[enter value\]](#) _____

Since the first of the reference month, not including the current month, what has been the usual expense for the meals for the household members who purchased at school? [\[enter value\]](#) _____

* Specify time period

1. [Day](#)
2. [Week](#)
3. [Two weeks](#)
4. [Month](#)
5. [Other, specify](#)

* Specify: [\[enter value\]](#) _____

How many WEEKS did the household member(s) purchase meals? [\[enter value\]](#) _____

End of Section 20A

Example of a Section in the CE Survey

EXHIBIT A.4

Food, beverages and gasoline

Please provide your best estimate of how much in total your household spent in the following categories. Please include spending by all members of your household, that is, by you and anyone living with you. Even if the amount your household spent last calendar month was unusual, please report that amount.

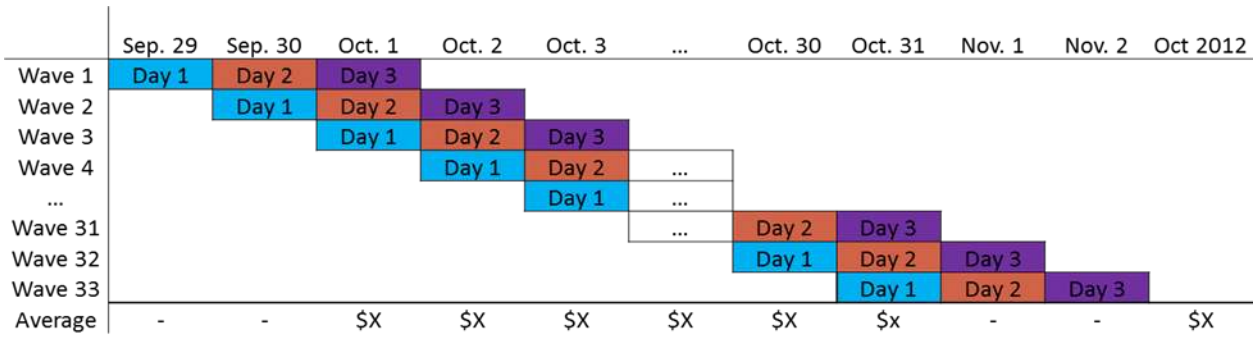
	Amount spent last month		No money spent on this last month
Food and beverages: <i>food and drinks, including alcoholic, that you buy in grocery or other stores</i>	\$ <input type="text"/> .00	OR	<input type="checkbox"/>
Dining and/or drinking out: <i>items in restaurants, cafes, bars and diners, including take-out food</i>	\$ <input type="text"/> .00	OR	<input type="checkbox"/>
Gasoline	\$ <input type="text"/> .00	OR	<input type="checkbox"/>
Other transportation expenses: <i>parking, tolls, public transport, taxi and similar (please exclude spending on trips and vacations)</i>	\$ <input type="text"/> .00	OR	<input type="checkbox"/>

<<Back Next>>



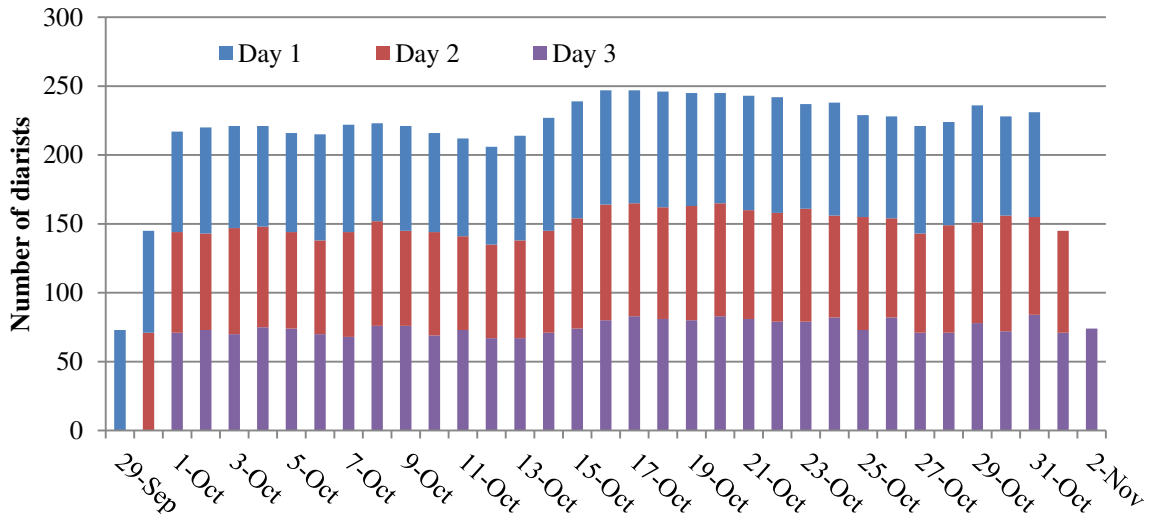
Example of a Screen in the Online Financial Crisis Survey

FIGURE A.1



Diary Waves and Implementation Design in the 2012 DCPC

FIGURE A.2



Daily Diary Participation by Wave in the 2012 DCPC