

WEB APPENDIX

CONSUMPTION INEQUALITY AND THE FREQUENCY OF PURCHASES

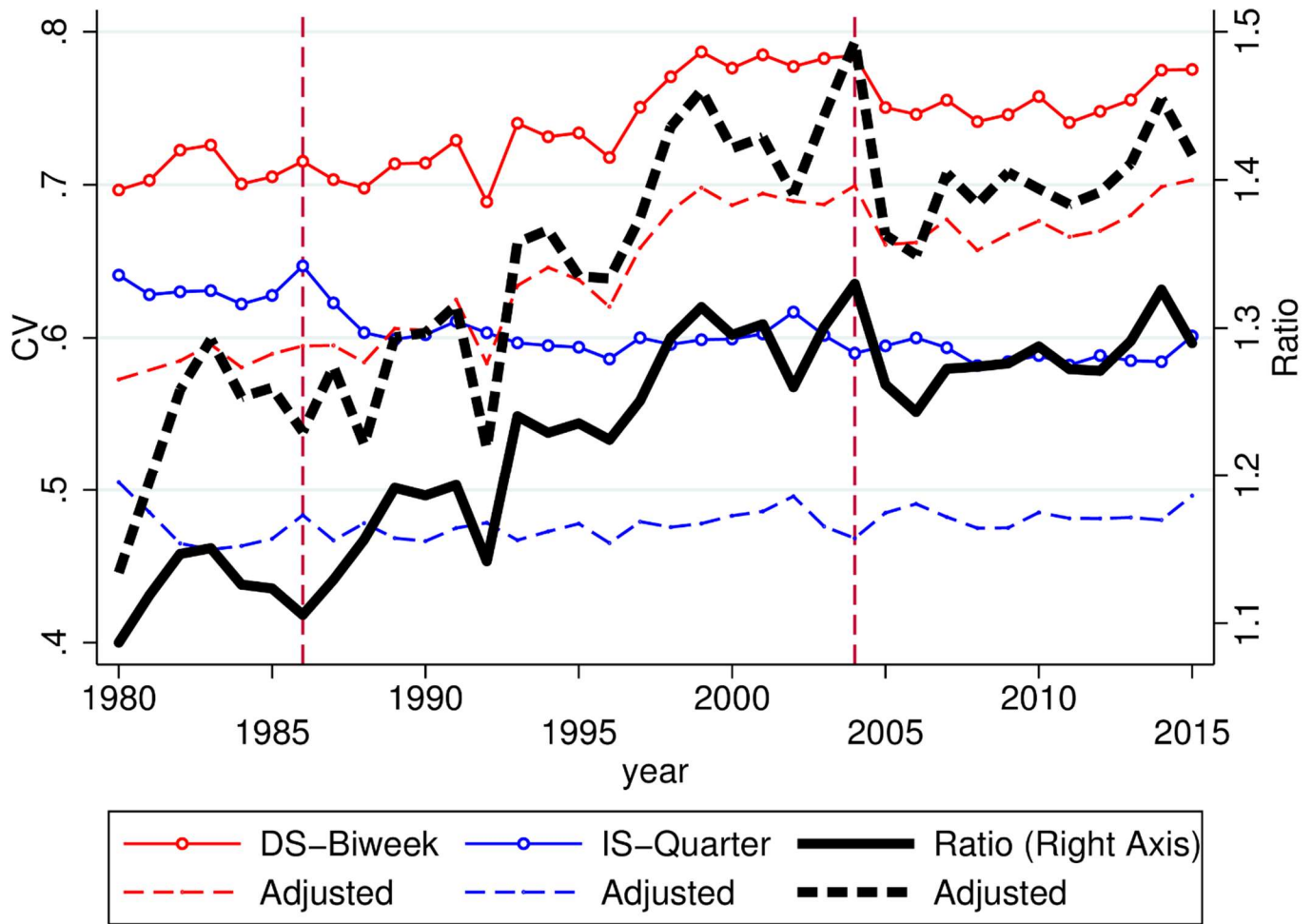
Olivier Coibion
UT Austin
and NBER

Yuriy Gorodnichenko
UC Berkeley
and NBER

Dmitri Koustas
University of Chicago

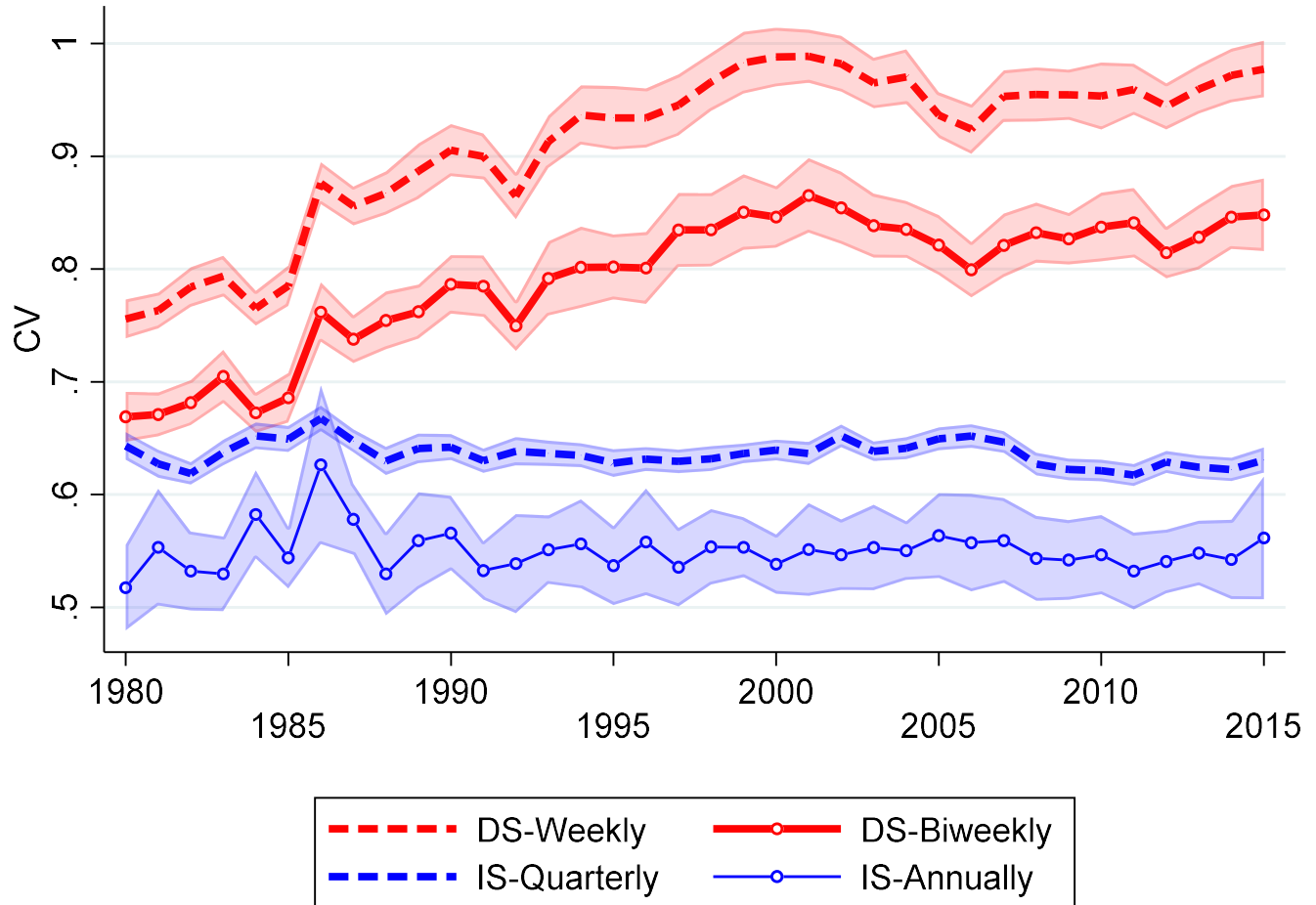
APPENDIX A. ADDITIONAL FIGURES AND TABLES

Appendix Figure A1. Expenditure inequality in the CEX for common set of products in the CEX and Nielsen data.



Notes: The figure plots the coefficient of variation (CV on left axis) of expenditures across households in the Diary survey (DS-biweekly) and Interview survey (IS-quarterly) over time. See section 1 for more details on the construction of these measures. The ratio of the two (DS/IS) is plotted using the bold black line and measured on the right axis. Solid lines are raw measures while dashed lines are residual measures, as described in section 1. Vertical dashed lines indicate breaks in how data are collected in the CEX. Unlike in Figure 1, the set of goods included are now restricted to be common to both the CEX surveys and the Nielsen data. The included categories are food-at-home, alcohol/tobacco, and small non-durables.

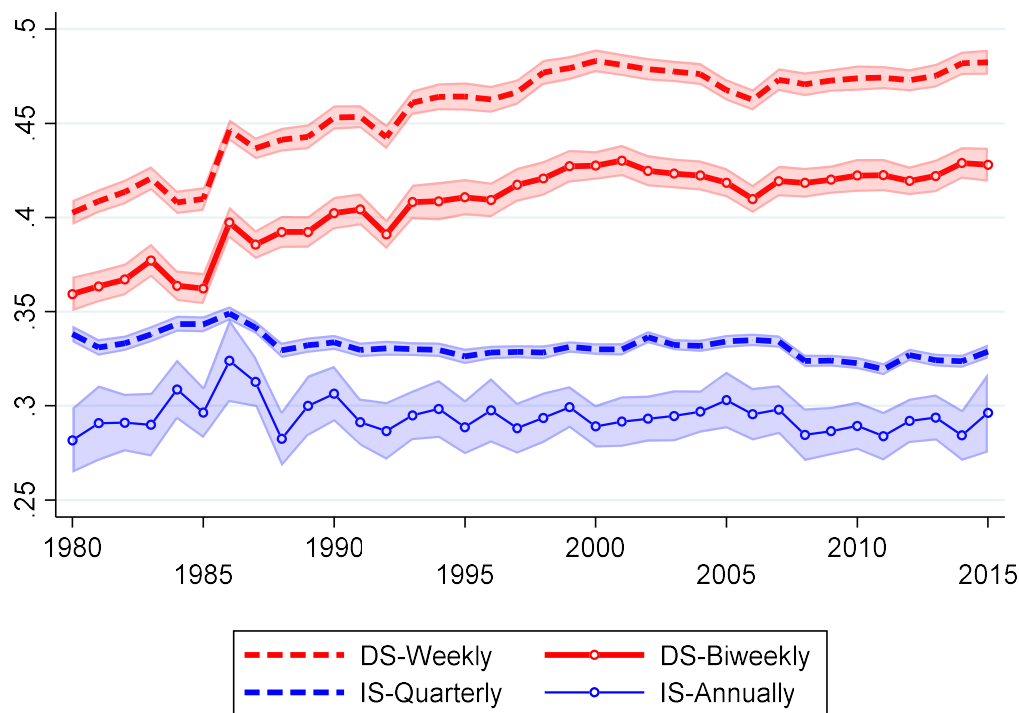
Appendix Figure A2. Expenditure inequality in the CEX by the frequency of time aggregation, coefficient of variation.



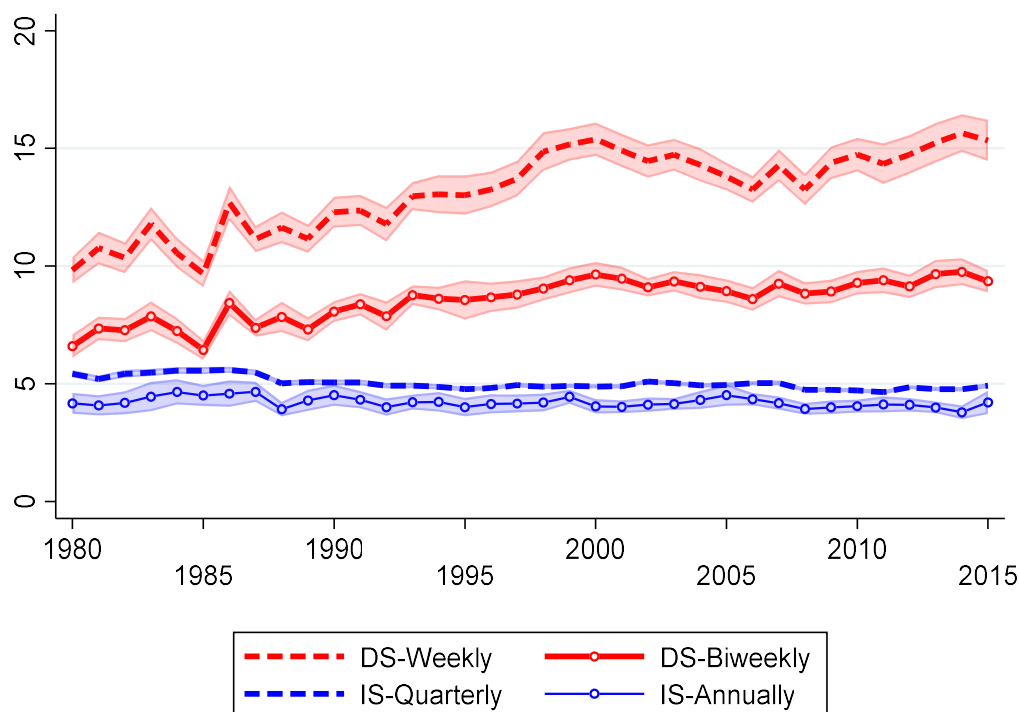
Notes: The figure plots the coefficient of variation (CV) of expenditures on nondurables and services across households in the Diary survey (DS-biweekly) and Interview survey (IS-quarterly and IS-annual) over time. See section 3.1 for more details on the construction of these measures. Shaded regions denote 95 percent bootstrapped confidence intervals.

Appendix Figure A3. Expenditure inequality in the CEX by the frequency of time aggregation

a. Gini coefficient



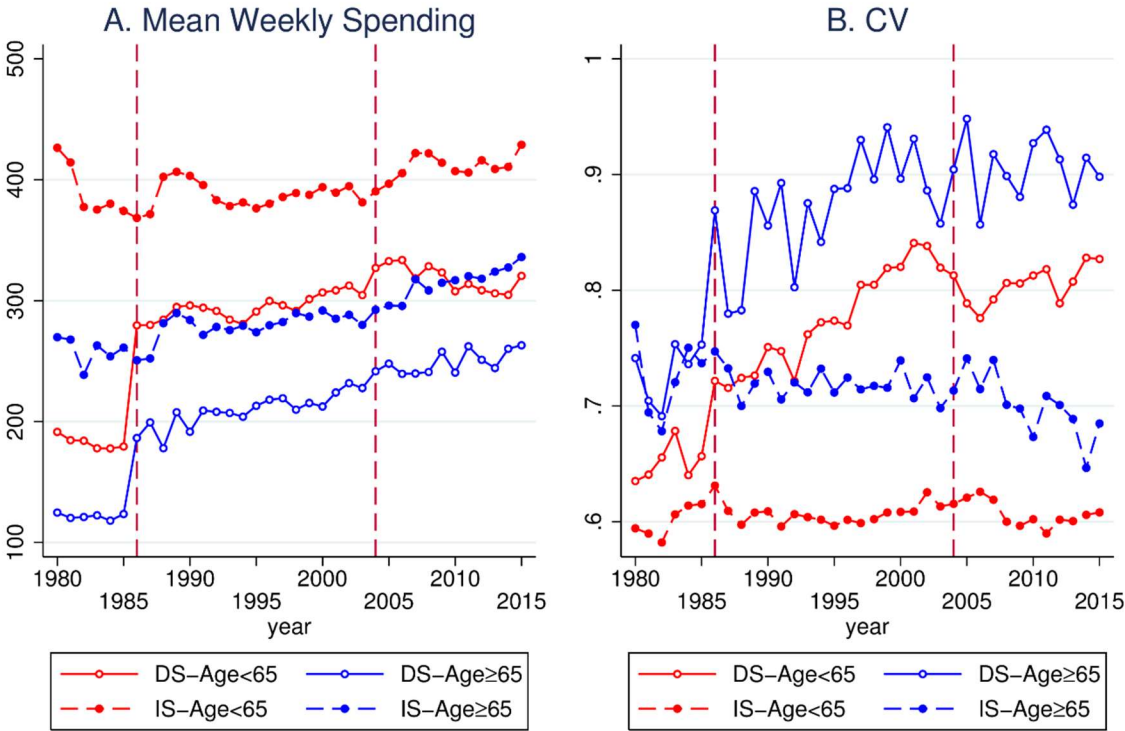
b. 90/10 Ratio



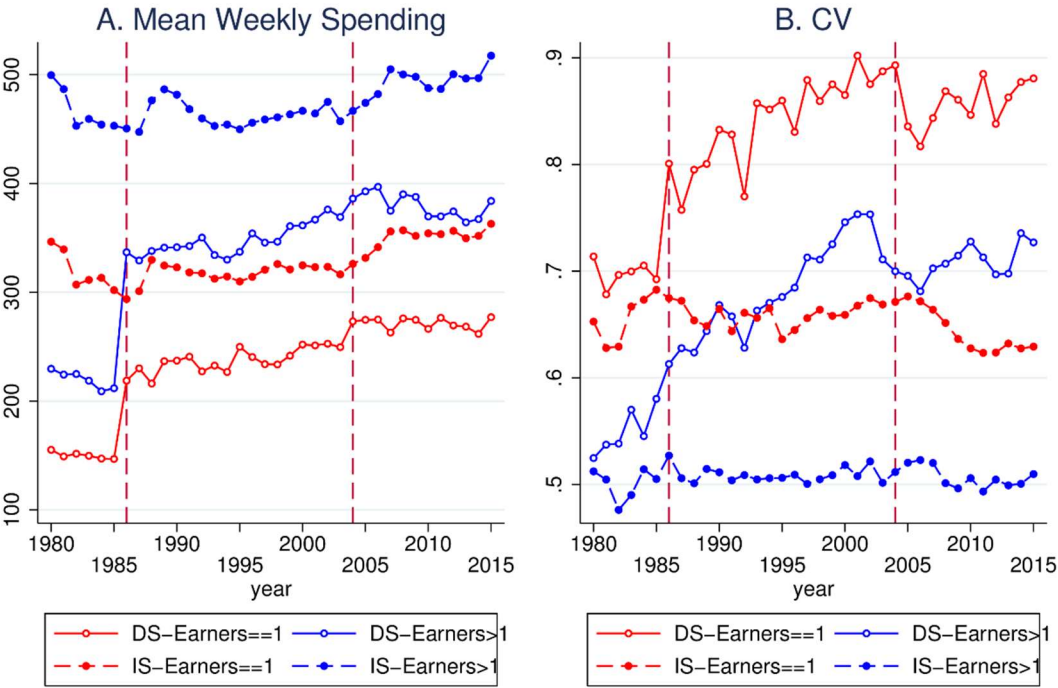
Notes: Panel A plots the Gini coefficient, and Panel B plots the ratio of the 90th percentile to 10th percentile, for expenditures on nondurables and services across households in the Diary survey (DS-weekly and DS-biweekly) and Interview survey (IS-quarterly and IS-annual) over time. See section 3.1 for more details on the construction of these measures.

Appendix Figure A4. Spending inequality by demographic characteristics, CEX.

By Age

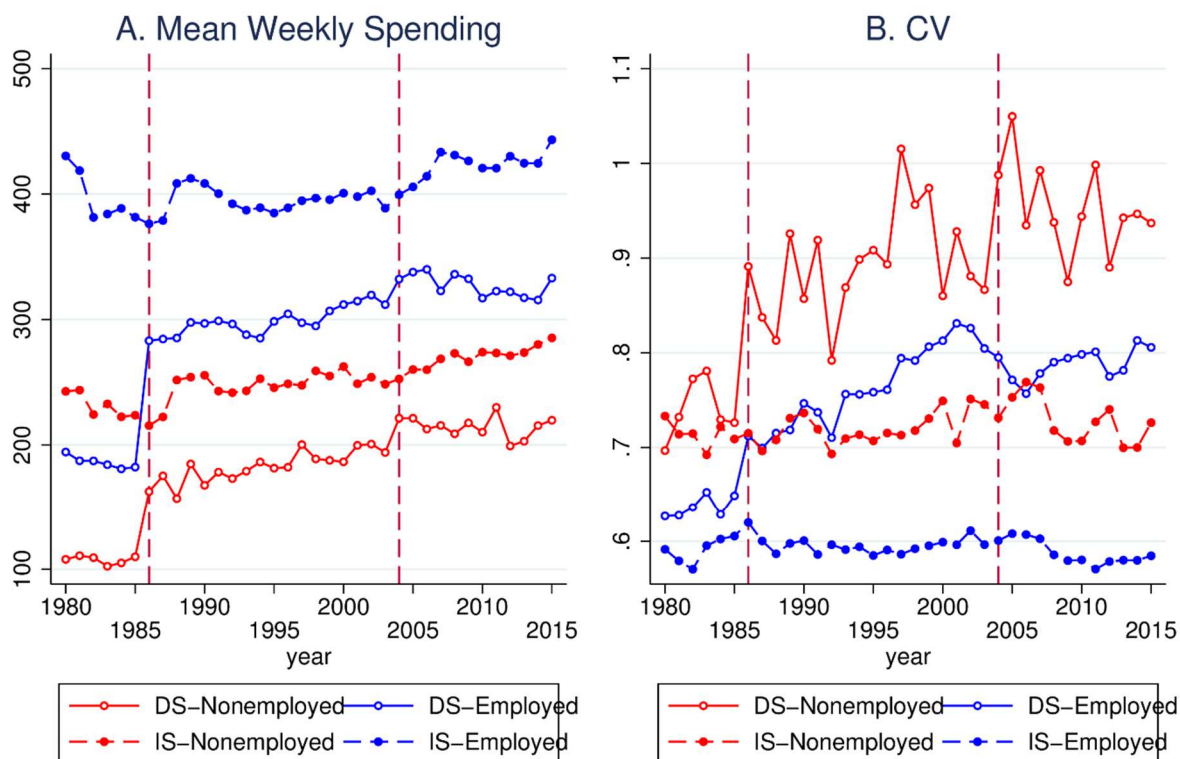


By Dual Earners

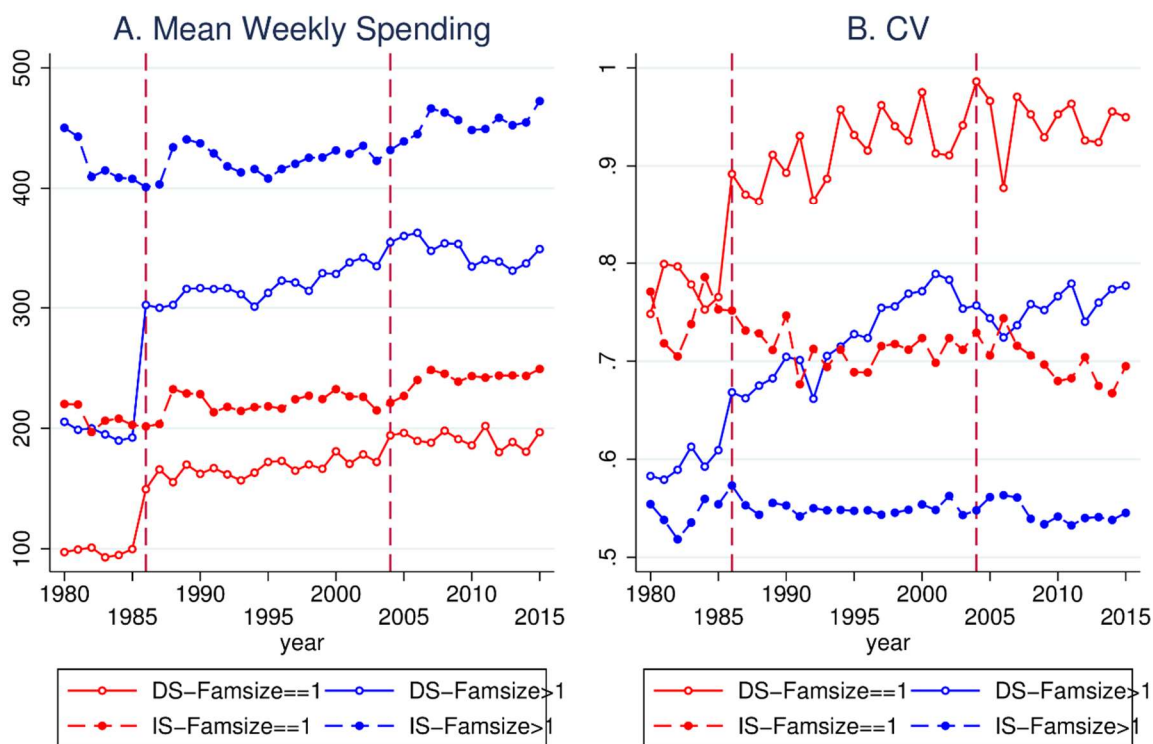


(continued on next page)

By Employment

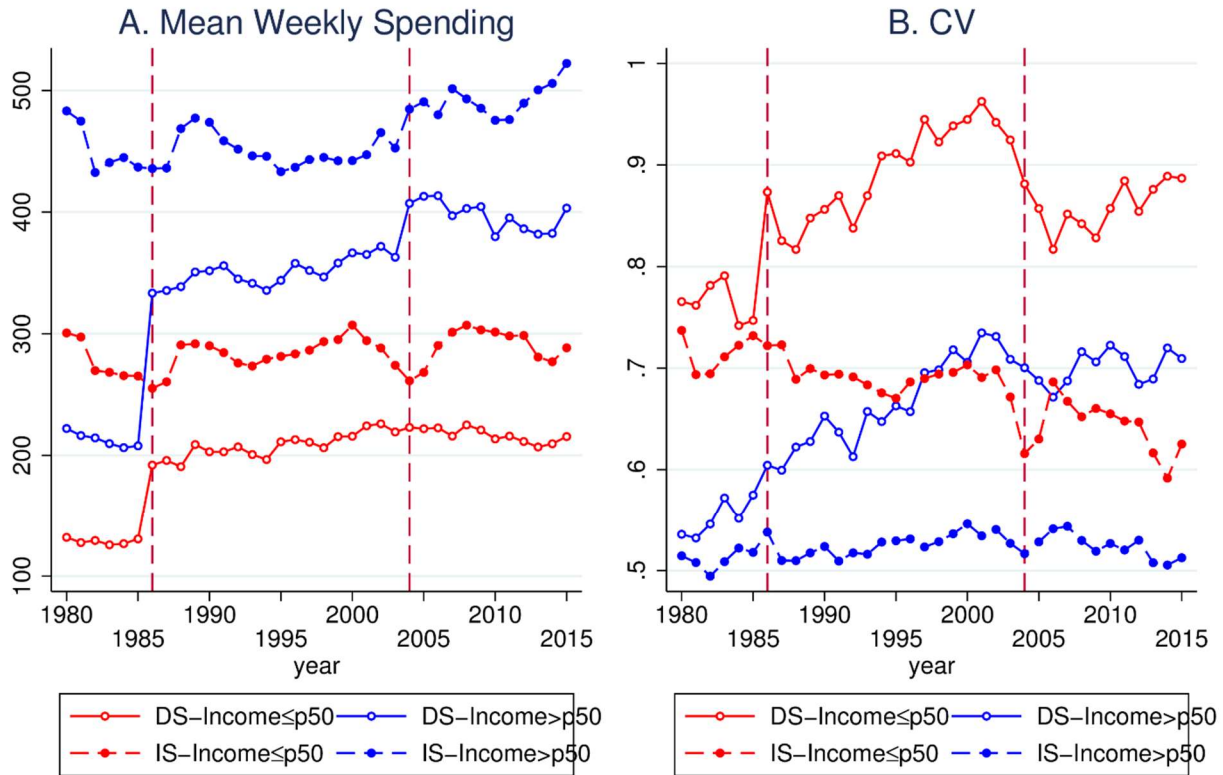


By Family Size

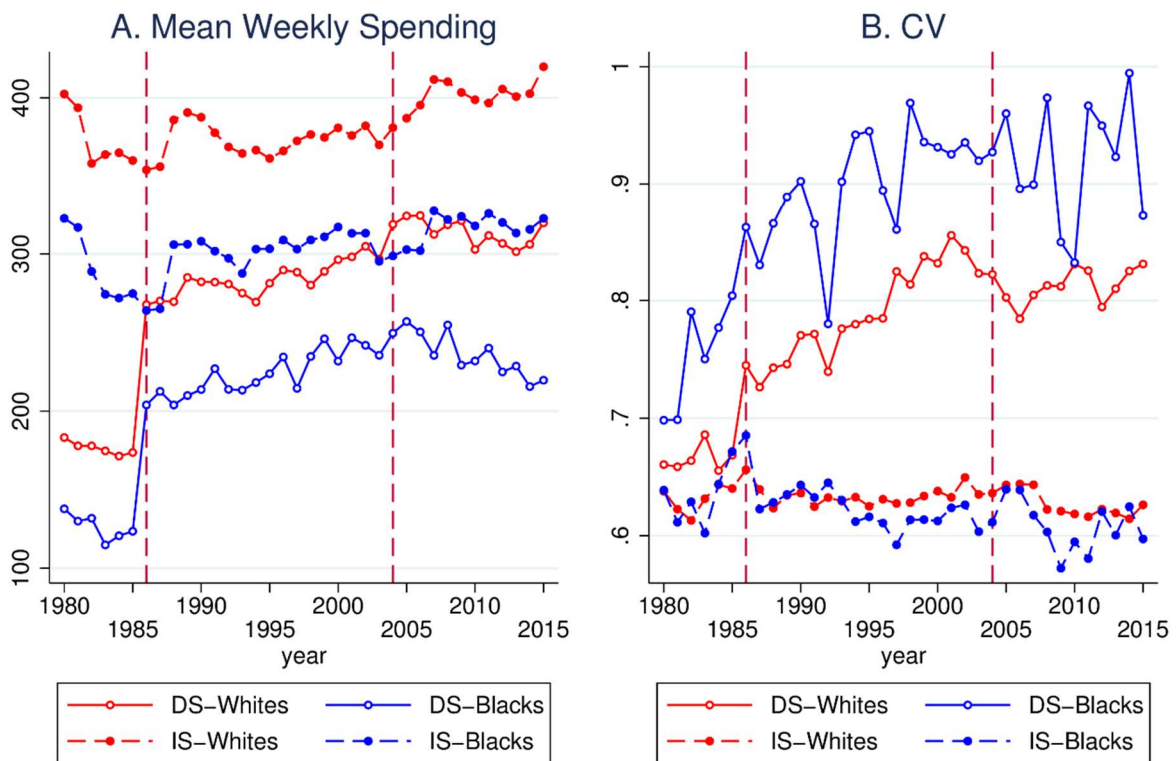


(continued on next page)

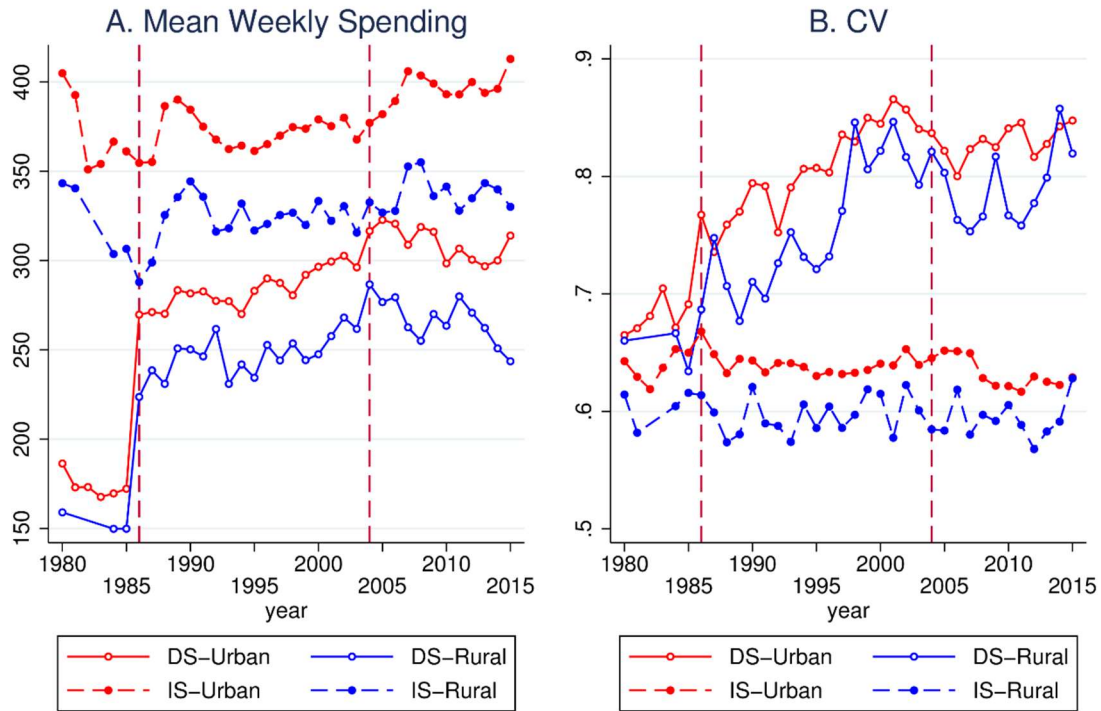
By Income



By Race



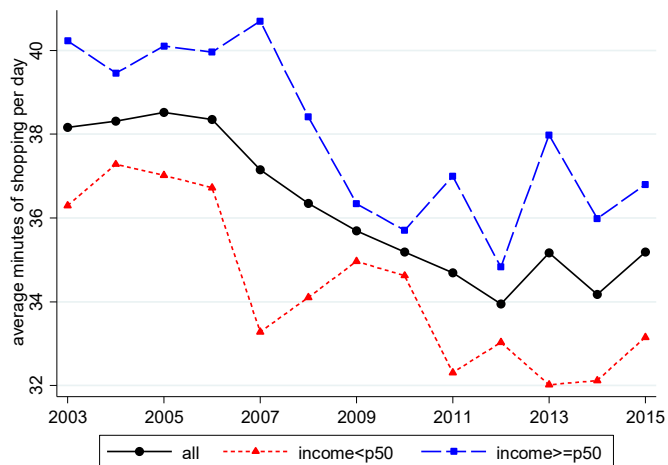
By Urban v. Rural



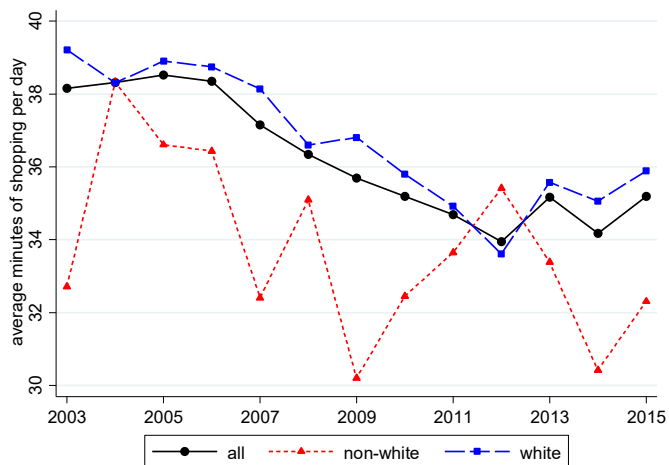
Notes: The figures report cross-sectional dispersion (coefficient of variation) for and mean of expenditures on nondurables and services spending by demographic characteristics of households in the Survey of Consumer Expenditures.

Appendix Figure A5. Shopping time by demographic groups, American Time Use Survey.

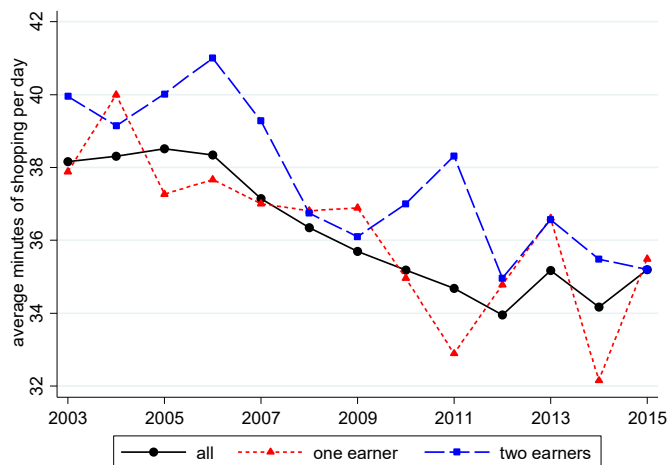
Panel A. By Family Income



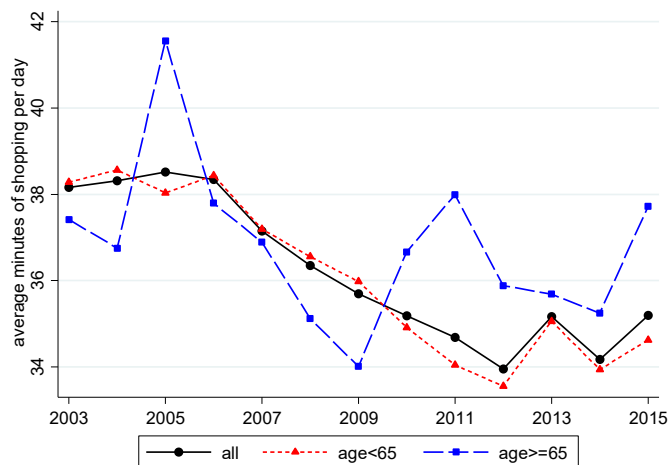
Panel B. By Race



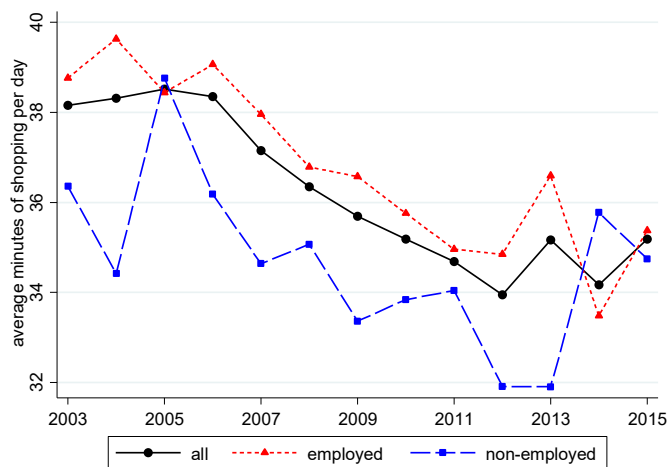
Panel C. By number of earners



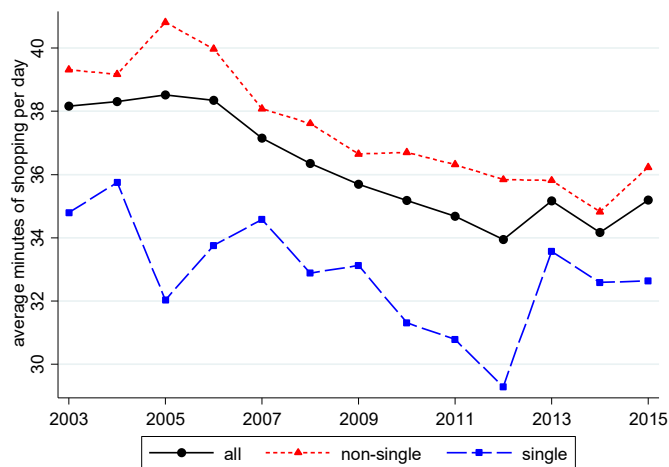
Panel D. By Age



Panel E. By Employment Status

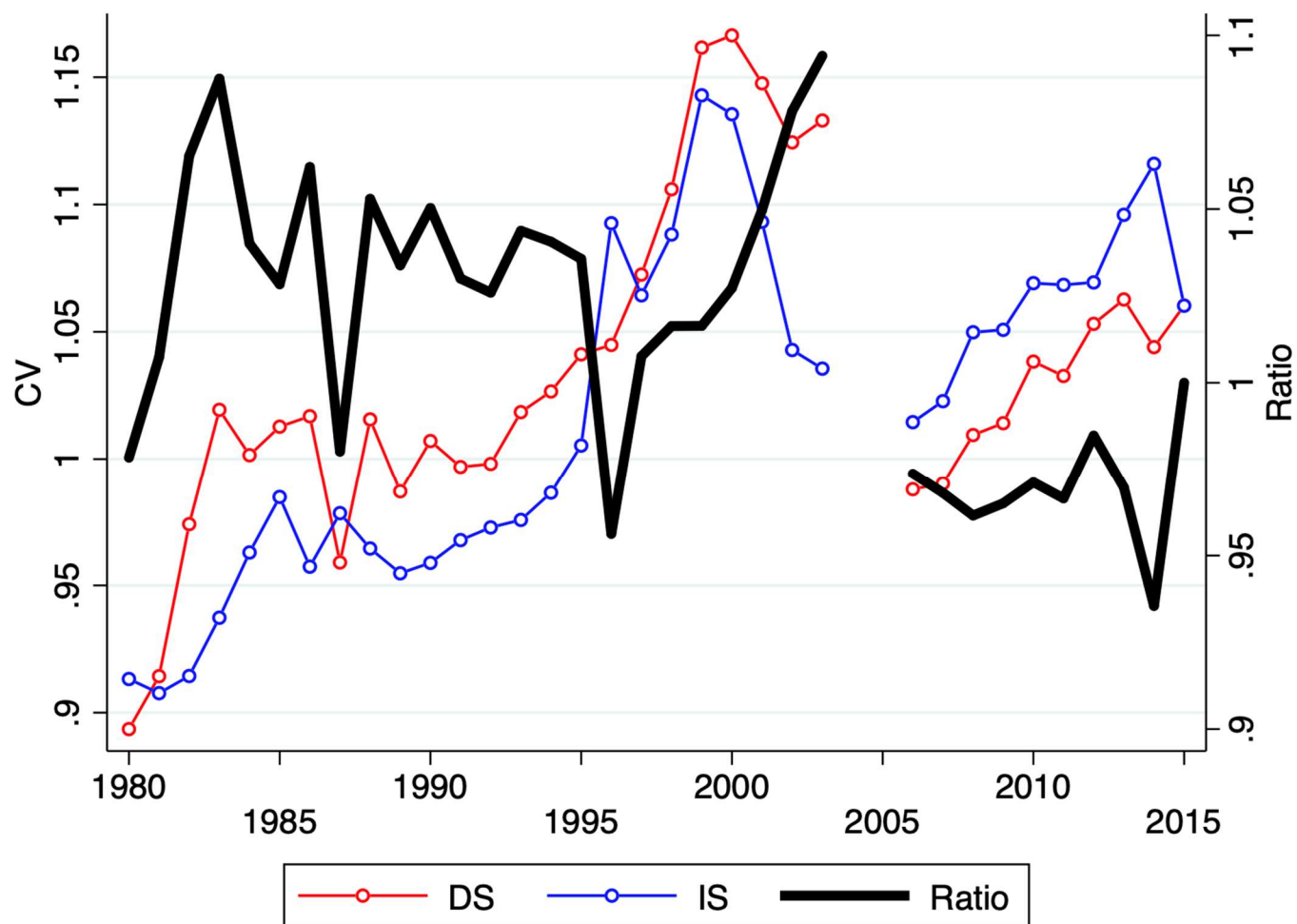


Panel F. By Household Size



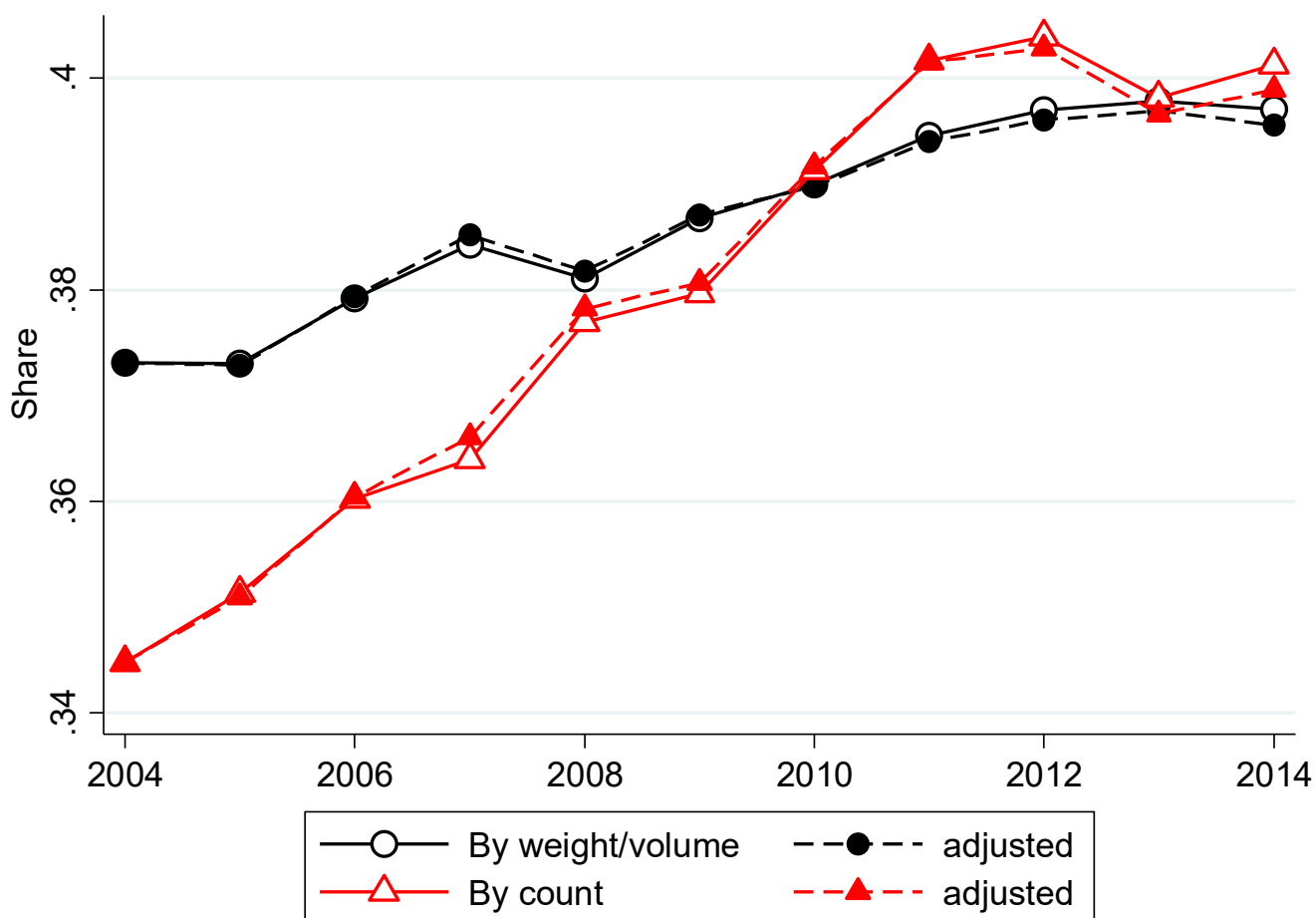
Notes: Each panel report total shopping time (includes travel and other purchase related activities).

Appendix Figure A6. Income inequality in the CEX by the frequency of time aggregation, coefficient of variation.



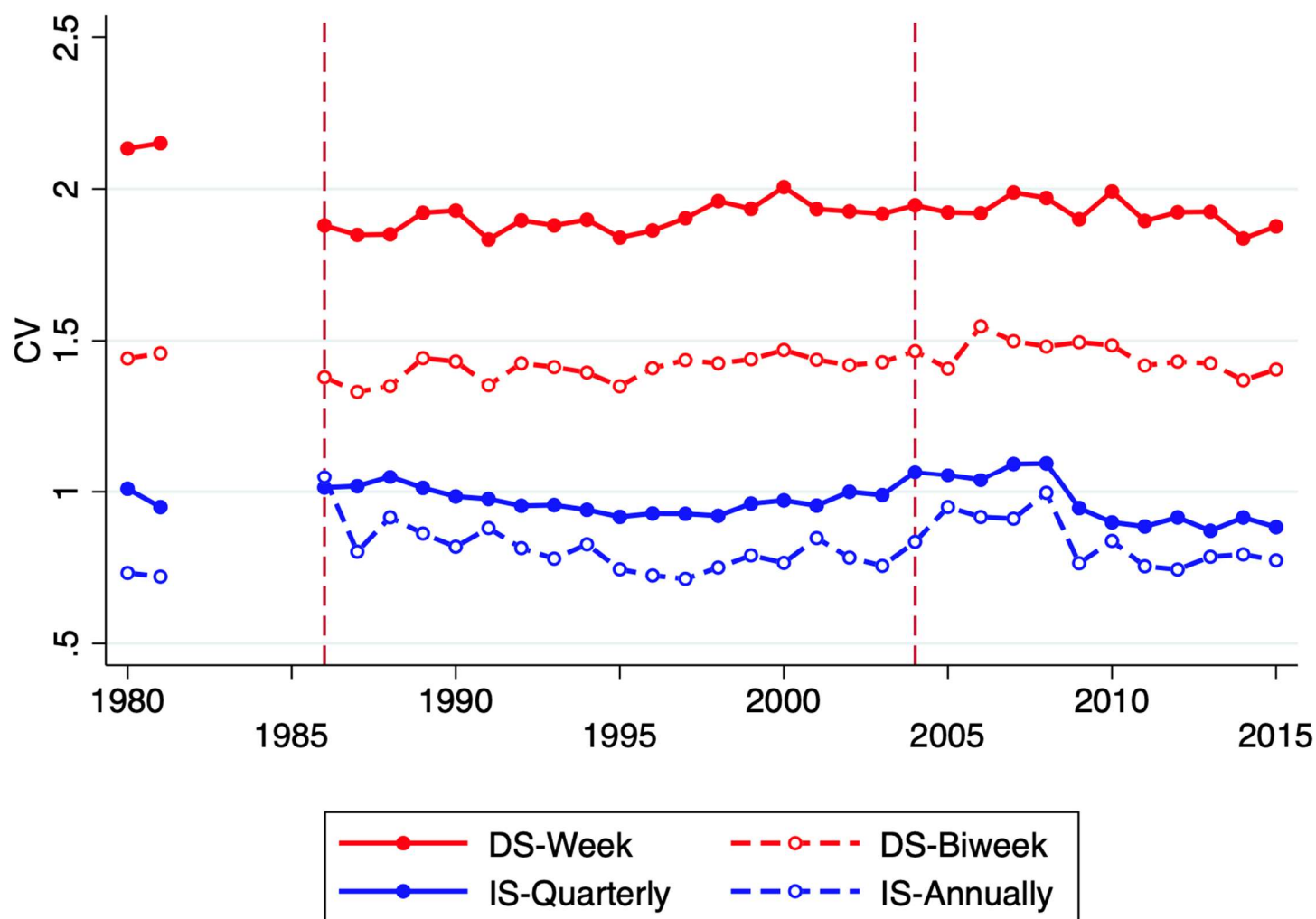
Notes: The figure plots the coefficient of variation (CV on left axis) of before-tax income across households in the Diary survey (DS-biweekly) and Interview survey (IS-quarterly) over time. See section 1 for more details on the construction of these measures. The ratio of the two (DS/IS) is plotted using the bold black line and measured on the right axis. In 2004-2005, only the imputation of before-tax income is available; we exclude these years for this reason.

Appendix Figure A7. Share of large-volume purchases
(Alternative definition using the 75th percentile of quantity purchased in 2004)



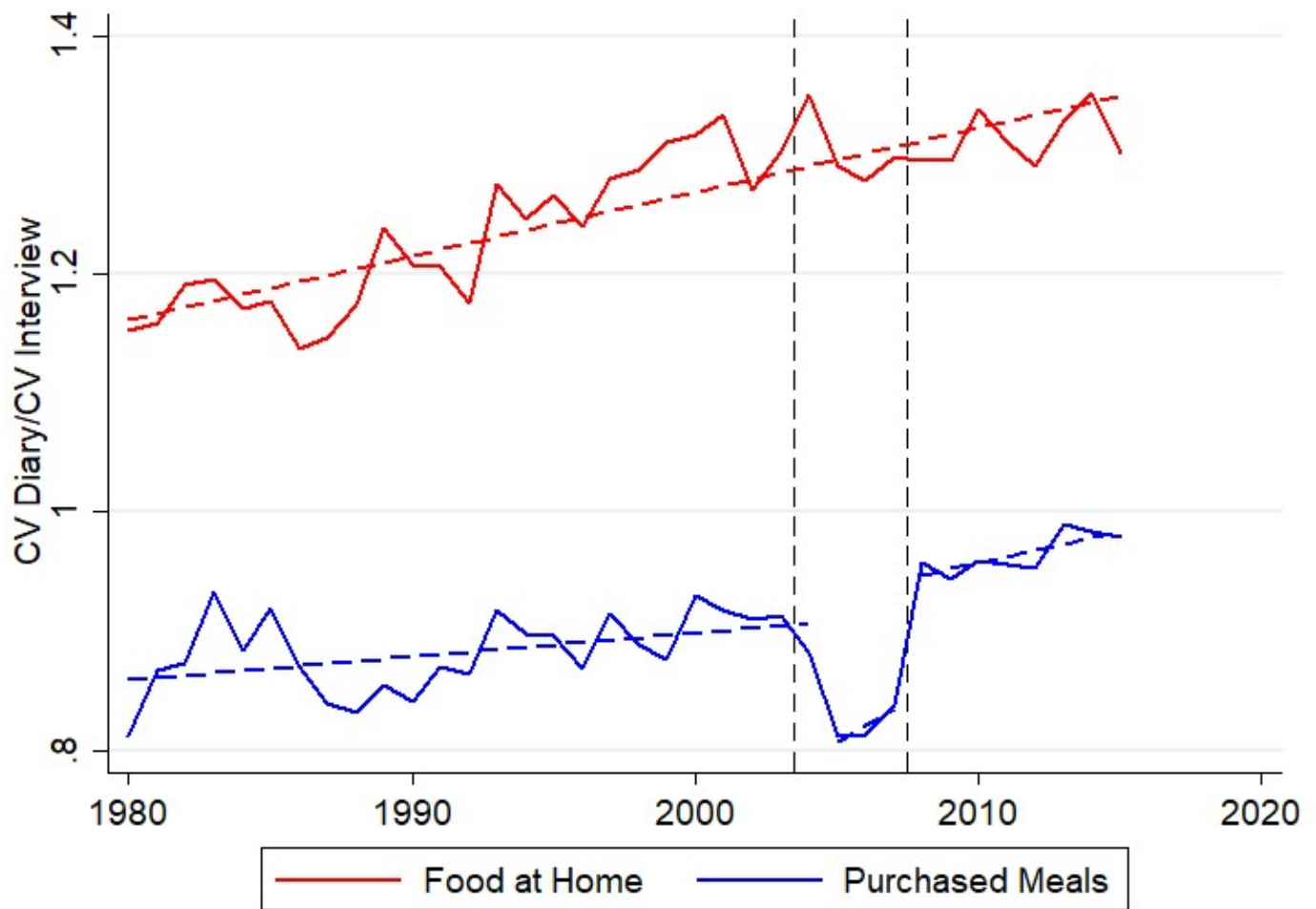
Notes: The figure shows the dynamics of the share of large-volume purchases in total purchases. Large-volume purchases are identified as purchases that exceed the 75th percentile of the distribution of the purchased weights or counts in 2004. Expenditure shares are used to weigh product modules. Sampling weights are used to aggregate across households. Solid lines with empty markers show the dynamics of the raw averages. Dashed lines with filled markers show the dynamics adjusted for changes in household characteristics (quadratic polynomial in the age of household head's age and a set of dummy variables for household size, employment status of household head and his/her spouse, number of children, and race). Approximately 55% of universal product codes (UPCs) are measured in ounces and 45% are measured in counts. See section 2 for details.

Appendix Figure A8. Expenditure inequality in the CEX for Services Excluding Purchased Meals.



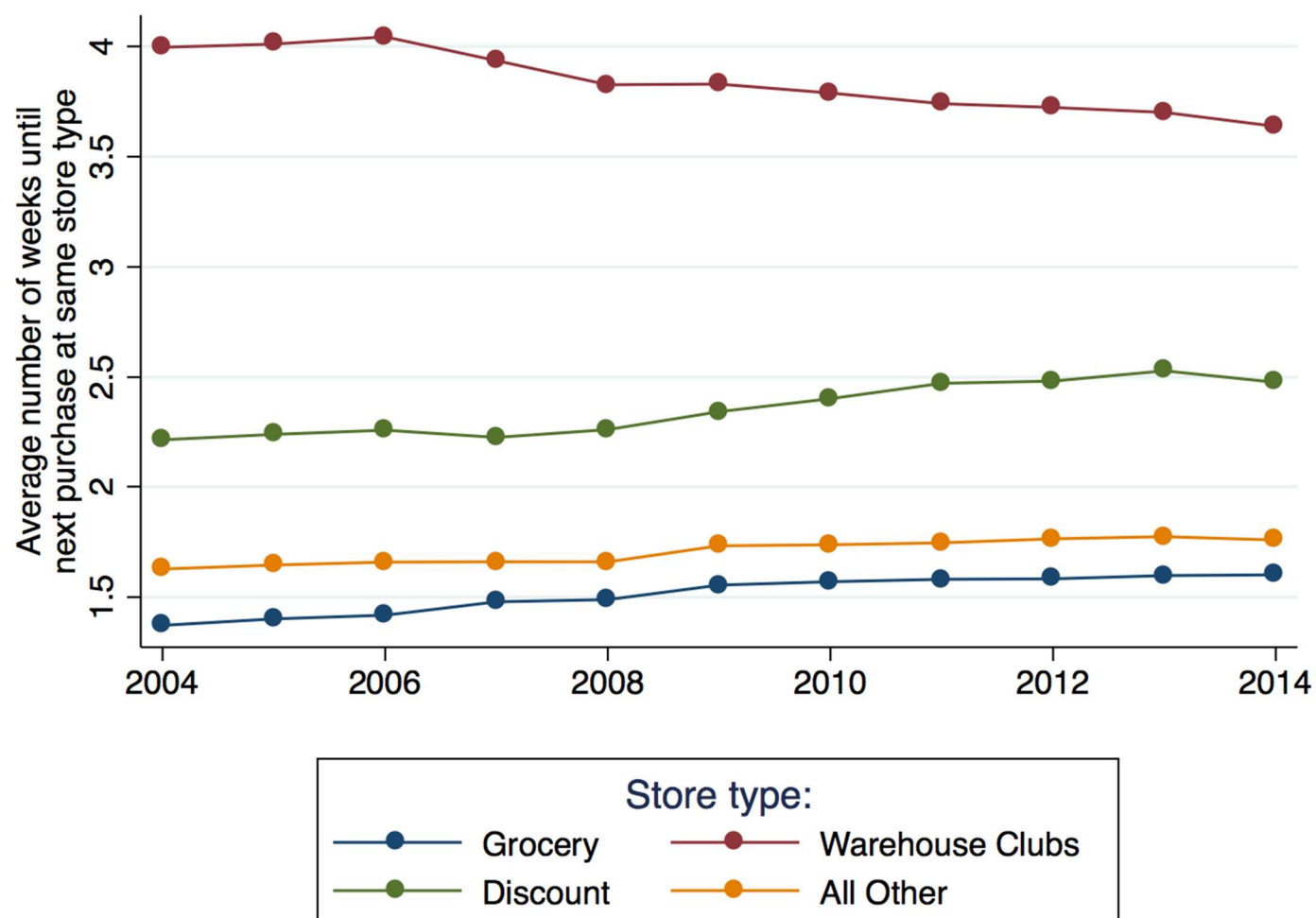
Notes: The figure plots the coefficient of variation (CV) of expenditures on services excluding purchased meals across households in the Diary survey (DS-weekly and DS-biweekly) and Interview survey (IS-quarterly and IS-annual) over time. Housing services were unavailable from 1982-1985; before 1986 there are few other services in the DS, so results should be interpreted with caution. See section 3.1 for more details on the construction of these measures.

Appendix Figure A9. Storability and differential trends in spending inequality measured at different frequencies.



Notes: the figure shows dynamics of the ratio of CV computed at the biweekly frequency (CV Diary) to CV computed at the annual frequency (CV Interview) for purchases of selected categories of goods. Vertical lines show breaks in the way data are collected in the Consumer Expenditure Survey (CEX). The first vertical line (year 2004) indicates when the U.S. Census Bureau introduced computers for CEX Diary collection. The second vertical line (year 2007) indicates when the survey question for purchased meals in the CEX Interview changed.

Appendix Figure A10. Shopping frequency by store type.



Notes: the figure shows the average number of weeks until the next trip to a store of the same type, e.g. grocery, warehouse club, discount or other, in the AC Nielsen data. Each line is estimated for a sample of households visiting that particular type of store in the indicated year. Time between shopping trips greater than 52 weeks (one year) are excluded (fewer than 0.5% of trips).

Appendix Table A1. Determinants of Club Store Usage

	Dep. var.:	
	Any Club Spending (Logit)	Club Share of Total Spending (OLS)
	(1)	(2)
Some High School	-0.0971 (1.152)	0.00238 (0.00590)
Graduated High School	0.0744 (1.149)	0.00473 (0.00347)
Some College	0.261 (1.149)	0.013 (0.00287)
Graduated College	0.347 (1.149)	0.0253 (0.00287)
Post College Grad	0.365 (1.149)	0.0326 (0.00307)
Education Unknown	0.295 (1.149)	0.0331 (0.00378)
Black	0.152 (0.0303)	0.00336 (0.00200)
Hispanic	-0.231 (0.0346)	-0.0177 (0.00305)
Middle Atlantic	-0.169 (0.0463)	-0.00216 (0.00335)
East North Central	-0.380 (0.0442)	-0.0184 (0.00312)
West North Central	-0.416 (0.0501)	-0.0163 (0.00336)
South Atlantic	-0.0345 (0.0443)	0.000166 (0.00320)
East South Central	-0.506 (0.0526)	-0.0246 (0.00332)
West South Central	-0.270 (0.0477)	-0.0101 (0.00340)
Mountain	0.425 (0.0537)	0.0480 (0.00443)

Pacific	0.803 (0.0481)	0.0820 (0.00402)
Head Age	-0.0150 (0.0753)	-0.00646 (0.00382)
Age ²	0.0000824 (0.00215)	0.000161 (0.000105)
Age ³	0.00000677 (0.0000262)	-0.00000136 (0.00000122)
Age ⁴	-6.76e-08 (0.000000115)	2.93e-09 (5.10e-09)
Household Size==2	0.381 (0.0268)	0.0175 (0.00179)
Household Size==3	0.421 (0.0339)	0.0232 (0.00243)
Household Size==4	0.528 (0.0410)	0.0262 (0.00314)
Household Size==6 or more	0.533 (0.0484)	0.0300 (0.00381)
1 Persons <18 years old	-0.0657 (0.0287)	-0.00564 (0.00205)
2 or more persons <18 years old	-0.0175 (0.0381)	0.00228 (0.00307)
1 Persons >=65 years old	0.0468 (0.0312)	0.000965 (0.00210)
2 or more Persons >=65 years old	0.267 (0.0460)	0.0102 (0.00332)
Head Employed	-0.0499 (0.0264)	-0.00355 (0.00194)
Female Head	0.123 (0.0292)	-0.00983 (0.00190)
Employed Spouse	0.174 (0.0219)	0.000279 (0.00183)
Household Income b/w \$5,000-\$7,999	-0.503 (0.0976)	-0.0206 (0.00451)

\$8,000-\$9,999	-0.241 (0.0989)	-0.0146 (0.00496)
\$10,000-\$11,999	-0.107 (0.0904)	-0.0123 (0.00479)
\$12,000-\$14,999	-0.0169 (0.0849)	-0.00971 (0.00470)
\$15,000-\$19,000	0.131 (0.0810)	-0.00487 (0.00461)
\$20,000-\$24,999	0.268 (0.0787)	-0.00238 (0.00455)
\$25,000-\$29,999	0.331 (0.0791)	0.00190 (0.00463)
\$30,000-\$34,999	0.511 (0.0786)	0.00917 (0.00460)
\$35,000-\$39,999	0.651 (0.0793)	0.0145 (0.00470)
\$40,000-\$44,999	0.714 (0.0793)	0.0207 (0.00476)
\$45,000-\$49,999	0.814 (0.0792)	0.0255 (0.00481)
\$50,000-\$59,999	0.870 (0.0778)	0.0291 (0.00466)
\$60,000-\$69,999	1.044 (0.0789)	0.0404 (0.00485)
\$70,000-\$99,000	1.222 (0.0775)	0.0547 (0.00475)
\$100,000+	1.426 (0.0794)	0.0758 (0.00501)
Year==2005	0.0296 (0.0192)	0.00277 (0.00106)
2006	-0.0487 (0.0225)	0.00193 (0.00131)
2007	-0.0495 (0.0214)	0.00228 (0.00128)
2008	-0.0920	0.00284

	(0.0228)	(0.00140)
2009	-0.0864 (0.0236)	0.00457 (0.00146)
2010	-0.0962 (0.0240)	0.00217 (0.00148)
2011	-0.0603 (0.0244)	0.00699 (0.00155)
2012	-0.0723 (0.0237)	0.00930 (0.00152)
2013	-0.0580 (0.0238)	0.0114 (0.00153)
2014	-0.0330 (0.0232)	0.0122 (0.00150)
Constant	-1.186 (1.497)	0.0949 (0.0504)
<i>N</i>	432,414	432,414

Notes: Column 1 reports the coefficients from a Logit regression of an indicator for any club store shopping on the observable demographics reported in the Table. Column 2 reports coefficients from an OLS regression of club share of Nielsen spending used in our estimation sample. Omitted categories include: Grade school, New England Census Region, Household Size=1, 0 Persons<=18, 0 Persons >=65, and Household Income under \$5,000.

Appendix Table A2. Lumpiness of purchases and shopping at club stores, ACNielsen Household Panel, fixed prices.

Panel A. Full Sample

Dep. var.: Coefficient of variation	Frequency of aggregation							
	Weekly		Biweekly		Monthly		Quarterly	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Club share	0.290 (0.011)	0.252 (0.196)	0.189 (0.009)	0.141 (0.141)	0.099 (0.006)	-0.057 (0.116)	0.0327 (0.006)	-0.054 (0.072)
N	384,320	384,320	384,320	384,320	384,320	384,320	384,320	384,320
R2	0.772	0.168	0.726	0.101	0.624	0.029	0.483	0.006
1 st stage <i>F</i> -stat		35.68		35.68		35.68		35.68

Panel B. Families

Dep. var.: Coefficient of variation	Frequency of aggregation							
	Weekly		Biweekly		Monthly		Quarterly	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Club share	0.269 (0.013)	0.414 (0.187)	0.175 (0.010)	0.242 (0.146)	0.087 (0.007)	-0.011 (0.130)	0.028 (0.006)	-0.031 (0.090)
N	283,740	283,740	283,740	283,740	283,740	283,740	283,740	283,740
R2	0.781	0.188	0.737	0.117	0.642	0.040	0.503	0.010
1 st stage <i>F</i> -stat		35.00		35.00		35.00		35.00

Notes: In this table we impute club-store prices to other stores. The dependent variable is the coefficient of variation (CV) calculated as follows. For each household, we calculate i) standard deviation of spending at a given frequency (weekly, biweekly, monthly, quarterly) for a given year and ii) average spending per period (total annual spending divided by the number of periods with shopping trips). The coefficient of variation (CV) is i) divided by ii) so that CV is time-series volatility of spending for a given household in a given year. *Club share* is the share of annual spending at club stores (Sam's Club, Costco, BJ's, etc.) in total annual spending at all stores. Spending includes only food, alcohol/tobacco, and small nondurables (paper towels, toothpaste, etc.). The sample of households includes only households with at least one shopping trip in each month of a given year. For each household, the instrumental variable is the distance to the closest club store (Sam's Club, Costco, BJ's). This distance is calculated between the centroid of the zip code where a given household lives and the centroid of the zip code where the nearest club store is located. Regressions include but do not report coefficients on the following controls: year and household fixed effects, age and age squared for the household head, a set of dummy variables for household income brackets, number of children, employment status, race, educational attainment, gender of household head. Standard errors are clustered at the zip-3 level (i.e., first three digits of zip code). Panel A is for all households, while Panel B restricts to households with a household size of at least two persons.

APPENDIX B. CONSTRUCTION OF THE CEX DIARY AND NIELSEN SAMPLES

A. CEX Data

CEX data is downloaded from the National Bureau of Economic Research (www.nber.org/ces), and, when unavailable on NBER, from ICPSR. If a household has no reported spending during the week, we see a diary with \$0 in spending. If a second week diary was not reported, we only use the first diary in our analysis of weekly spending and drop this household in our analysis of biweekly spending.

B. Nielsen data

Nielsen data are made available by the Kilts Center for Marketing at the University of Chicago Booth School of Business. The public release of Nielsen data contains households that have already been filtered by Nielsen for quality. According to the Nielsen codebook:

The household must transmit the minimum required spending dollars *per four-week period*, depending on the household size, to be considered eligible for the static. All of the households in the data meet Nielsen's 12-month static requirements for each corresponding calendar. [emphasis added]

We have noticed violations of this definition and have informed the Kilts Data Center. We impose our own filter that households must have positive spending in every month. We aggregate the Nielsen data to weekly frequency. We start numbering weeks with the first full week of the year. Because the Nielsen sample design has incomplete coverage of households in the last week of the year, we focus on the first 51 full weeks for weekly analysis, and the first 50 full weeks for biweekly analysis. We impute weeks with no reported spending as \$0 spending.

C. Inflation-adjustment

All spending is converted to 2010 dollars using the Personal Consumption Expenditures: Chain-Type Price Index (Fred series PCEPI).

D. Winsorization

For all our analysis, we winsorize positive spending (after aggregating to a specified frequency of aggregation) at the 1 percent level, for the right tail of the distribution only. This winsorization is done before calculating the standard deviation and means for an indicated year. When we report the average time-series CV, this is again winsorized at the 1% level (two-sided winsorization). In our main regressions on club share, we also winsorize the club share of spending and distance to club stores (right tail only).

E. Crosswalk between CEX and AC Nielsen

For the crosswalk between the CEX Interview Survey (IS) and CEX Diary Survey (DS), we begin with the crosswalk already developed in Bee et al. (2012)'s Appendix 1. We update it to include UCCs since 2010 and expand it to be comprehensive of all UCC codes referring to spending that ever appear in the Diary or Interview Survey. For a discussion about differences in time-varying spending coverage and quality across the two CEX surveys, see Bee et al. (2012, 2015).

Our main CEX analysis focuses on the UCCs for nondurable goods and services and excludes the "Durable Goods" as well as gasoline (due to its inconsistent coverage). We denote categories excluded from our analysis using the CEX with a "*" in the table below. UCCs with a "†" are UCCs that we add to the Bee et al. (2012) crosswalk.

Appendix Table B1: Crosswalk between CEX IS and CEX DS

Category	CEX IS UCC Code	CEX DS UCC Code
<i>Durable Goods*</i>		
New motor vehicles	1980: 450110 450116 450210 450216 †870101 870102 870301 450220 870302 870601 870602 870605 870608	1986: 450110 1986-2006: 450210
New vehicle accessories and parts	1980: 480110 480213 490501 2005-2010: 480212 870501 870502	1986: 480110 480212 480213 600903
†Used vehicles	460110 870201 870202 460901 460902	460903
Furniture and furnishings	1980: 290110 290120 290210 290310 290320 290410 290420 290440 320901 290430 340904 680320 320220 690242 690241 690243 320120 280210 1980-2006: 320210 320231 2007-2010: 320233 1980-1998: 220511 220614 230132 320110 320162 1999-2010: 220616 230133 320111 †320230	1986: 290110 290120 290210 290310 290320 290410 290420 290440 320901 290430 340904 320220 690242 690241 690243 230130 320110 320120 280210 1986-2006: 320210 320231 2007-2010: 320233
Household appliances	1980: 230117 230118 300111 300112 300211 300212 300221 300222 300311 300312 300321 300322 320150 300331 300332 300411 300412 320511 320512 320522 690245 690244 320521 †220612 220613 300216 300217 320221	1986: 230117 230118 300110 300210 300220 300310 300320 320150 300330 300410 320511 320512 300900 320522 320521 †320221 300218
Glassware, tableware, and household utensils	1980: 320310 320320 320330 320340 320350 320370 320360 †320345	1986: 320320 320340 320350 320370 320380 320310 320330 320360 † 320345
Outdoor equipment and supplies	1980: 320410	1986: 320410
†Hardware/ Tools	320420 320902	1980: 320430 320906 1986: 240120
Televisions	1980-2004: 310110 310120 310130 2005-2010: 310140	1986-2004: 310110 310120 310130 2005-2010: 310140
Audio/Video equipment	1980: 480214 310311 310313 310315 310320 490502 2005-2010: 310314 1980-1998: 310312 1996-2010: 310333 1980-1995: 310330 1980-1993: 480211 490500 †310210 310334 480215 310316	1986: 480214 310311 310312 310313 310315 310320 310331 310332 2005-2010: 310314 †310902 310903 310900 310334 310335 310316
†Computers and accessories	1982-: 690110 690230 690111 690112 2011: 310400 690119 690120	690119 690120
†Video games	1982-: 310230 310231 310232	310231 310232
Recording media	1980: 310220 1980-2004: 310341 310342 2005-2010: 310340	1986: 310340 310220
Photographic equipment	1980: 610230	1986: 610230 610903
Sporting equipment, supplies, guns, and ammunition	1980: 600142 600144 600210 600410 600420 600430 610120 1980-1993: 610900 1994-2010: 600901 600902 †600900	1986: 600130 600210 600410 600420 600430 600901 610120 610901
†Toys Games Hobbies	610110 610140	620913

Bicycles and accessories	1980: 600310	1986: 600310
Pleasure boats	1980: 600121 600132 600110 600138 600127 870401 870402 870701 870702	1986: 600120 600130 600110
Other recreational vehicles	1980: 600122 600128 1980-1993: 600131 600137 1994-2010: 600141 600143 †870801 870804	[none]
Recreational books	1980: 590220 590230 660310	1986: 590220 590230 660310
†Other books	660110 660210 660900 660901 660902 660410	
Musical instruments	1980: 610130	1986: 610130
Jewelry and watches	1980: 430110 430120	1986: 430110 430120
Telephone and facsimile equipment	1980: 320232 690210	1986: 320232 690210
†Medical Equipment	550330	550320 550330 550340
†Property	790710 790720 810101 810102 810201 810202	1986: 220400
†Capital improvement materials	220512 220513 240112 240113 240122 240123 240212 240213 240214 240220 240222 240223 240312 240313 240322 240323 320612 320613 990930 990940 990950 320625 320626	1986: 240110 240310 240320 240900 320620 320630 320627
†Other electronics	690220 520560 690115 690117 690118	690115 690117 690118
†Luggage	430130	
†Misc Durables	430130 320130 640420 320904	480211 480213
<u>Nondurable goods</u>		
Food purchased for off-premises consumption	1980-2006: 790220 790230 2007-2010: 790240 †790210	1980: 010110 010120 010210 010310 010320 020110 020210 020510 020610 020810 020310 020410 020620 020710 020820 030110 030210 030310 030410 030510 030610 030710 030810 040110 040210 040310 040510 040410 040610 050110 050210 050310 050410 050900 060110 060210 060310 070110 070230 070240 090110 090210 100210 100410 100510 160310 080110 160320 160211 160212 100110 160110 110110 110210 110310 110410 110510 120110 120210 120310 120410 130310 140110 140210 140220 140230 140320 140330 140340 140310 130320 150110 150211 150212 150310 180210 180220 180110 180310 180320 180410 180420 180510 180520 180620 180710 180611 180612 1994-2010: 070210 070220 130120 130210 160210 180610 †190904 180720 550410
Nonalcoholic beverages purchased for off-premises consumption	[none]	1980: 170520 170310 170410 130121 140410 140420 130122 130110 170110 170210 170510 170531 170532 130211 130212 2007-2010: 170533 2006-2010: 170530
Alcoholic beverages purchased for off-premises consumption	1980-2006: 790310 790320 2007-2010: 790330	1980: 200210 200410 200533 200310 200523 200111 200513 †200110
Women's and girls' clothing	1980: 380110 380210 380311 380312 380313 380320 380331 380332 380340 380410 380420 380430 380510 380901 380902	1986: 380110 380210 380311 380312 380313 380320 380331 380332 380340 380410 380420 380430 380510 380901 380902 390110 390120 390210

	380903 390110 390120 390210 390221 390222 390230 390310 390321 390322 390901 390902 <i>1980-2006:</i> 380331 380332 390221 390222 <i>2007-2010:</i> 380333 390223 †380315	390221 390222 390230 390310 390321 390322 390901 <i>1980-2006:</i> 380331 380332 390221 390222 <i>2007-2010:</i> 380333 390223 †380315
Men's and boys' clothing	<i>1980:</i> 360110 360120 360210 360311 360312 360320 360330 360340 360350 360410 360511 360512 360901 360902 370110 370120 370130 370211 370212 370213 370220 370311 370312 370313 370902 <i>1980-2006:</i> 360511 360512 370312 370313 <i>2007-2010:</i> 360513 370314 <i>1980-1994:</i> 370901 <i>1995-2010:</i> 370903 370904 †360420 370125	<i>1986:</i> 360110 360120 360210 360311 360312 360320 360330 360340 360350 360410 360511 360512 360901 370110 370120 370130 370211 370212 370213 370220 370311 370312 370313 370901 370904 <i>1986-2006:</i> 360511 360512 370312 370313 <i>2007-2010:</i> 360513 370314 †360420 370125
†Baby clothes	410111 410112 410121 410122 410131 410132 410141 410142 410901 410902 410903 410905 410904	<i>1986:</i> 410110 410120 410130 410140
Clothing materials	<i>1980:</i> 420110 420120	<i>1986:</i> 420110 420120
Shoes and other footwear	<i>1980:</i> 400110 400210 400310 400220	<i>1986:</i> 400110 400210 400310 400220
*Gasoline and other energy goods	<i>1980:</i> 470111 470112 470113 470211 470212 470220 250111 250112 250113 250114 250211 250212 250213 250214 250901 250902 250903 250904 250911 250912 250913 250914 250221 250222 250223 250224	<i>1980-1981, 1986:</i> 470111 470112 470114 470211 470220 250110 250210 250900 250220
Pets and related products	<i>1980:</i> 610320	<i>1986:</i> 610310 610320
Film and photographic supplies	<i>1980:</i> 610210	<i>1986:</i> 610210 610220
Household cleaning products	<i>1980:</i> 330511 <i>1980-1998:</i> 990910	<i>1980:</i> 320140 330110 330210 330610
Household paper products	[none]	<i>1980:</i> 330310
†Stationary/Gift Wrap, etc.		330410 660000
Household linens	<i>1980:</i> 280110 280120 280130 280220 280900 320904 †280140	<i>1986:</i> 280110 280120 280130 280220 280900 320904 †280140
Sewing items	<i>1980:</i> 280230 †420115	<i>1986:</i> 280230 †420115
Personal care products	<i>1980:</i> 640130 640420 †640430	<i>1985-2010:</i> 640110 640120 640130 640210 640220 640410 640310 640420 <i>1986:</i> 320130 †550210 550310 640430
Tobacco	<i>1980:</i> 630110 630210	<i>1980:</i> 630110 630210 630900 630220
Recreational Drugs		550900
Newspapers and periodicals	<i>1980:</i> 590310 590410 <i>1980-1993:</i> 590110 590210 <i>1994-2010:</i> 590111 590112 590211 590212	<i>1986:</i> 590110 590210 590900
†Eyeglasses	550110	550110
†Flowers/plants	320903	
†Prescription Drugs	540000	

Misc. nondurable goods not elsewhere classified		1986: 320610 610902 320905 330510
<u>Services</u>		
Rent and utilities	1980: 800710 210110 230121 230141 230150 240111 240121 240211 240221 240311 240321 320611 320621 270211 270212 270213 270214 270411 270412 270413 270414 260111 260112 260113 260114 260211 260212 260213 260214 1980-1998: 230131 1999-2010: 230134 320163 1980-1993: 230111 †210210 210310 210901 210902 230121 240111 320161 680905 320624 790690 990920 320631	1986: 800710 210110 270210 270410 260110 260210 270905
†Mortgage Payments	830101 830102 790910	9000
Imputed rental of owner-occupied nonfarm housing	1980: 910060 910070 1980-2006: 910100 2007-2010: 910101 910102 910103 1993-2010: 910050 †910080 910090 910104 910105 910106 910107	[none]
Other motor vehicle services	1980: 450312 450412 520511 520512 520521 520522 520902 520905 520904 620907 520541 520542 1980-1993: 620907 1994-2010: 620921 620922 1980-1990: 520530 620902 1991-2010: 520531 520532 620909 620919 450310 450313 450314 450410 450413 450414 †220900 220901 220902 520550 450116 450216 450226 450906 460116 460907 460908 460909 450352 450350 450351 450353 450354 520516 520517	1986: 450310 450410 520511 520521 520902 520904 520531 520541 †450350 530903 520516
†Other Transportation	530110 530210 530311 530312 530411 530412 530510 530901 530902	
Cable and satellite television and radio services	1980: 270310 270311	1986: 270310 270311
Photo processing	1980: 620330	1986: 620330
Photo studios	1999-2010: 620320	1980: 620320
Gambling	2001-2010: 620926	2001-2010: 620926 1984-2000: 620911 1980-1981: 620901
†Entertainment	620122 620211 620212 620221 620222 620310 620903 680310 620115 620213 620214	1996: 620510 620610 620115 620213 620214
†Medical Care Services	560110 560210 560310 560320 560330 560900 570110 570210 570220 570230 560400 570240 570111	1986: 570000
Veterinary and other services for pets	1980: 620410 620420	1986: 620410 620420
Purchased meals and beverages	1980: 190901 190902 190903 790410 790420 790430 200900	1998-2010: 190111 190211 190311 190321 190911 190921 190112 190212 190312 190322 190912 190922 190113 190213 190313 190323 190913 190923

		190114 190214 190314 190324 190914 190924 190115 190215 190315 190325 190915 190925 190116 190216 19031 190326 190916 190926 200511 200512 200516 200521 200522 200526 200531 200532 200536 1980-1997: 190110 190210 190310 190320 190901 190902 200510 200520 200530 †190316 200514 200524 200534
Food supplied to civilians	1980: 800700	1986: 800700
Communication	1980: 270104 620930 310350 690116 270105 690114 1980-2005: 270103 2005-2010: 310240F 1980-1997: 270510 270610 1980-1990: 270000 1991-2010: 270101 270102 †270106	1986: 270000 340110 340120 310241 310242 620930 310351 310352 690116 690114
Legal services	1980: 680110	1986: 680110
Accounting and other business services	1980: 680902 001400 680903	1986: 680902 680903
Funeral and burial services	1980: 680140 680901	1986: 680140 680901
Personal care services	1980: 440150 620115 1980-1998: 650110 650210 650900 2005-2010: 680904 1999-2010: 650310 †440130	1980: 650900 650110 650210 1986: 440150 2005-2010: 680904
Repair and hire of footwear	1980: 440110	1986: 440110
Child care	1980-1992: 340210 1993-2010: 340211 340212	1986: 340210
†Elder care	340906 340910	
Household maintenance	1980: 340310 340510 440900 340630 340620 230142 340901 340907 990900 270901 270902 270903 270904 340420 340903 340914 340911 340912 790640 340915 340410 790600 †220611 220615 230112 230113 230114 230115 230116 230119 230122 230123 320622 320623 320632 790610 790611 320633 230151 230152	1986: 340310 340510 440900 340630 340620 230140 340901 340907 340913 270900 340903 340410 †220000 230000 230120 230140 230900 270900 340913 230110 220610
†Auto repair	490110 490211 490212 490220 490231 490232 490311 490312 490313 490314 490315 490411 490412 490413 490900 490317 490318 490319 490221 490300	1986: 490000 490316 490300
†Rental and Other Repair Services	340610 340902 340905 340908 440140 520903 520906 520907 570901 620904 620905 620906 620908 680210 620912 690113 570903 620916 620917 620918	1986: 570902 620915 340909 620810
†Real Estate Services	1980: 230901 230902 790730 790830 790840 810301 810302 820301 820302 820401 790620 820402	1986: 9900 999000 (?)
†Education Services	670110 670210 670310 670901 670410 670903	670903
†Other Misc. Services	340520 340530 440120 440210 670902 690310 690320 690330 690340 690350 850216	
<i>*Non-Consumption</i>		

†Insurance	1980-: 220111 220112 220121 220122 350110 500110 580110 580210 580310 580901 580902 700110 580111 580112 580113 580114 580311 580312 580903 580904 580905 585906 580400 580907 580115 580116	1986: 2120 2100 220110 220120 580000
†Taxes	220210 220211 220212 950024	1986: 999900 950024
†Fees/Licenses	520110 520310 520410 520901 620110 620121 790630 840101 840102 450311 450411	1986: 520111 520112 620710
†Memberships/Clubs	620111 620112 620113 620114	620114
†Interest Payments/Finance Charges	220311 220312 510110 510901 510902 680220 710110 850300 220313 220314 880110 880210 880310	
†Penalties/Fines	220321 220322	620925
†Child Support/Alimony	800111 800121	5000
†Cash gifts / Contributions	800800 800803 810400 800804 800811 800821 800831 800841 800851 800861	4100 4190
Unidentifiable items		1986: 999935

F. Crosswalk between CEX and AC Nielsen

The crosswalk between the DS and AC Nielsen (Nielsen) was developed for this project, and, to the best of our understanding, has yet to be undertaken at our level of disaggregation. The smallest unit of aggregation for spending in the DS and IS is known as a Universal Classification Code (UCC). Approximately 600 UCC codes appear in the DS and IS survey across years, although some are overlapping. AC Nielsen (Nielsen) data contain over 2 million unique Universal Product Categories (UPC) codes. These codes correspond to the product's barcode, essentially representing a unique product identifier. UPCs are categorized into 1,075 product modules, 125 product groups in 10 departments. Our approach is to match the 125 Nielsen product groups to the DS UCC codes.

Our main analysis reported in the paper focuses on *non-durable* goods that have the potential to be sold in bulk. We exclude durables and clothes/soft goods, since these goods are not well represented or well-reported in Nielsen, and, while many of these goods can also be purchased at club stores, they are typically not sold or purchased in bulk. Another concern is that because these goods are relatively expensive, such purchases could inflate the club share of spending.

Note: Because Nielsen households scan the barcodes of purchases made in stores, non-barcoded items will not generally be recorded. This mainly affects fresh produce, which will be underreported in Nielsen.

The following Table provides a crosswalk between Diary UCC codes and Nielsen Product Groups used in Table 1. We indicate Nielsen Product Groups that are excluded from the Nielsen analysis with a “*.”

Appendix Table C1: Crosswalk between CEX DS and AC Nielsen

CEX DS UCC Code	AC Nielsen Product Group
20110 WHITE BREAD 20210 BREAD OTHER THAN WHITE 20310 FRESH BISCUITS, ROLLS, MUFFINS 20410 CAKES AND CUPCAKES 20710 DOUGHNUTS,SWEETROLLS,COFFEECAKE 20820 FRESH PIES, TARTS, TURNOVERS	1501 BREAD AND BAKED GOODS
30110 GROUND BEEF EXCLUDE CANNED 30210 CHUCK ROAST 30310 ROUND ROAST 30410 OTHER ROAST 30510 ROUND STEAK 30610 SIRLOIN STEAK 30710 OTHER STEAK 30810 OTHER BEEF (EXCLUDE CANNED) 40110 BACON 40210 PORK CHOPS 40310 HAM (EXCLUDE CANNED) 40410 OTHER PORK 40510 PORK SAUSAGE 50410 LAMB AND ORGAN MEATS 50900 MUTTON, GOAT, GAME 60110 FRESH & FROZEN WHOLE CHICKEN 60210 FRESH OR FROZEN CHICKEN PARTS 60310 OTHER POULTRY 70210 FRESH AND FROZEN SHELLFISH (1984-85) 70220 FRESH AND FROZEN FISH (1984-85) 70230 FRESH FISH & SHELLFISH	3501 FRESH MEAT
40610 CANNED HAM 50110 FRANKFURTERS 50210 BOLOGNA, LIVERWURST, SALAMI 50310 OTHER LUNCHMEAT	3002 PACKAGED MEATS-DELI
80110 EGGS	2505 EGGS
90110 FRESH MILK ALL TYPES 90210 CREAM	2506 MILK
100110 BUTTER 160110 MARGARINE	2501 BUTTER AND MARGARINE
100210 CHEESE	2502 CHEESE
100510 OTHER DAIRY PRODUCTS	2503 COT CHEESE, SOUR CREAM, TOPPINGS 2507 PUDDING, DESSERTS-DAIRY 2508 SNACKS, SPREADS, DIPS-DAIRY 2510 YOGURT
110110 APPLES 110210 BANANAS 110310 ORANGES 110410 OTHER FRESH FRUITS 110510 CITRUS FRUITS EXCL. ORANGES 120110 POTATOES 120210 LETTUCE 120310 TOMATOES 120410 OTHER FRESH VEGETABLES 140340 OTHER VEGETABLES MISC	4001 FRESH PRODUCE [Note: this is only packaged fresh produce, since it must have a barcode]
130110 FROZEN ORANGE JUICE 130122 FROZEN FRUIT JUICES	2006 JUICES, DRINKS-FROZEN
130121 FROZEN FRUITS 130120 FROZEN FRUIT, OTH. FRUIT JUICE (1984)	2003 DESSERTS/FRUITS/TOPPINGS-FROZEN
130211 FRESH FRUIT JUICE 130210 FRSH/CANNED/BOTTLED FRUT JUICE (1984) 130212 CANNED/BOTTLE FRUIT JUICE 140420 FRESH & CANNED VEGETABLE JUICES	507 JUICE, DRINKS - CANNED, BOTTLED

170510 NONCARB FRUT FLAV/LEMADE NONFROZ	
140320 OTHER PEAS 140330 OTHER BEANS	1021 VEGETABLES AND GRAINS - DRIED
180610 PREPARED SALADS/DESSERTS 180611 PREPARED SALADS	3001 DRESSINGS/SALADS/PREP FOODS-DELI
180710 MISC. PREPARED FOODS	510 PREPARED FOOD-READY-TO-SERVE
10110 FLOUR	1009 FLOUR
10120 PREPARED FLOUR MIXES	511 PREPARED FOOD-DRY MIXES 1001 BAKING MIXES 1002 BAKING SUPPLIES
10210 CEREAL	1005 CEREAL 1004 BREAKFAST FOOD
10310 RICE	1021 VEGETABLES AND GRAINS – DRIED
10320 PASTA CORNMEAL OTH CEREAL PRODS	1013 PASTA
20510 COOKIES	1505 COOKIES
20610 CRACKERS 20620 BREAD AND CRACKER PRODUCTS	1506 CRACKERS
20810 FROZEN & REFRIG. BAKERY PROD.	2001 BAKED GOODS-FROZEN 2504 DOUGH PRODUCTS
70110 CANNED FISH AND SEAFOOD	512 SEAFOOD – CANNED
70240 FROZEN FISH & SHELLFISH	2009 UNPREP MEAT/POULTRY/SEAFOOD-FRZN
100410 ICE CREAM AND RELATED PRODUCTS	2005 ICE CREAM, NOVELTIES
130310 CANNED FRUITS	504 FRUIT - CANNED
130320 DRIED FRUITS	1010 FRUIT - DRIED
140110 FROZEN VEGETABLES 140410 FROZEN VEGETABLE JUICES	2010 VEGETABLES-FROZEN
140210 CANNED BEANS 140220 CANNED CORN 140230 CANNED VEGETABLES MISC 140310 OTHER PROCESSED VEGETABLES	514 VEGETABLES - CANNED
150110 CANDY AND CHEWING GUM	503 CANDY 505 GUM
150211 SUGAR 150212 ARTIFICIAL SWEETENERS	1018 SUGAR, SWEETENERS
150310 OTHER SWEETS	1008 DESSERTS, GELATINS, SYRUP 1019 TABLE SYRUPS, MOLASSES
160210 OTH FATS/OILS/SALAD DRESSINGS 160211 FATS & OILS	1016 SHORTENING, OIL
160212 SALAD DRESSINGS	1015 SALAD DRESSINGS, MAYO, TOPPINGS
160310 NON-DIARY CREAM SUBSTITUTES	1012 PACKAGED MILK AND MODIFIERS
160320 PEANUT BUTTER	506 JAMS, JELLIES, SPREADS
170110 COLA DRINKS 170210 OTHER CARBONATED DRINKS	1503 CARBONATED BEVERAGES
170310 ROASTED COFFEE 170410 INSTANT/FREEZE DRIED COFFEE	1006 COFFEE
170520 TEA	1020 TEA
170530 OTHER NONCARB. BEVERAGES/ICE 170531 OTHER NONCARB. BEVERAGE/ICE 170532 BOTTLED WATER 170533 SPORTS DRINKS	1508 SOFT DRINKS-NON-CARBONATED 2004 ICE
180210 FROZEN MEALS 180220 FROZ/PREP. FOOD OTH THAN MEALS	2008 PREPARED FOODS-FROZEN 2002 BREAKFAST FOODS-FROZEN 2007 PIZZA/SNACKS/HORS D'OEUVRES-FRZN
180310 POTATO CHIPS AND OTHER SNACKS	1507 SNACKS
180320 NUTS	1011 NUTS
180410 SALT/OTHER SEASONINGS & SPICES	1017 SPICES, SEASONING, EXTRACTS
180420 OLIVES, PICKLES, RELISHES	1014 PICKLES, OLIVES, AND RELISH
180510 SAUCES AND GRAVIES 180520 OTHER CONDIMENTS	1007 CONDIMENTS, GRAVIES, AND SAUCES 2509 YEAST
180612 PREPARED DESSERTS	1501 BREAD AND BAKED GOODS

180620 BABY FOOD	501 BABY FOOD
180720 VITAMIN SUPPLEMENTS	6018 VITAMINS
550410 NONPRESCRIPTION VITAMINS	6005 DIET AIDS
200110 BEER AND ALE AT HOME	5001 BEER
200111 BEER AND ALE AT HOME	
200112 NON ALCOHOLIC BEER	
200210 WHISKEY AT HOME	5002 LIQUOR
200410 OTHER ALCOHOLIC BEV. AT HOME	
200310 WINE AT HOME	5003 WINE
630110 CIGARETTES	4510 TOBACCO & ACCESSORIES
630210 OTHER TOBACCO PRODUCTS	
630220 SMOKING ACCESSORIES	
330110 SOAPS AND DETERGENTS	4501 DETERGENTS
330210 OTHER LAUNDRY /CLEANING PRODS.	4506 LAUNDRY SUPPLIES
320140 LAUNDRY AND CLEANING EQUIP.	4504 HOUSEHOLD CLEANERS
	4503 FRESHENERS AND DEODORIZERS
330310 PAPER TOWELS/NAPKINS/TOILET TI	4507 PAPER PRODUCTS
330510 MISC HOUSEHOLD PRODUCTS	4505 HOUSEHOLD SUPPLIES
320610 MISC. SUPPLIES AND EQUIPMENT	5502 BATTERIES AND FLASHLIGHTS
320905 MISC. HOUSEHOLD EQUIP/PARTS	
550210 OVER-THE-COUNTER DRUGS	6012 MEDICATIONS/REMEDIES/HEALTH AIDS
640430 ADULT DIAPERS	6003 COUGH AND COLD REMEDIES
	6017 SKIN CARE PREPARATIONS
	6008 FIRST AID
610310 PET FOOD	508 PET FOOD
610320 PET-PURCHASE/SUPPLIES/MEDICINE	4509 PET CARE
640110 HAIR CARE PRODUCTS	6011 HAIR CARE
	6006 ETHNIC HABA
640210 ORAL HYGIENE PRODUCTS,ARTICLES	6014 ORAL HYGIENE
640220 SHAVING NEEDS	6016 SHAVING NEEDS
640310 COSMETICS, PERFUME, BATH PREP	6002 COSMETICS
	6009 FRAGRANCES – WOMEN
	4508 PERSONAL SOAP AND BATH ADDITIVES
640120 NON-ELEC ARTICLES FOR THE HAIR	6010 GROOMING AIDS
640410 DEOD,FEM HYG, MISC. PERS. CARE	6004 DEODORANT
	6007 FEMININE HYGIENE
	6013 MEN'S TOILETRIES
	6001 BABY NEEDS
	6015 SANITARY PROTECTION
	4502 DISPOSABLE DIAPERS
360311 MENS UNDERWEAR	*5521 SOFT GOODS
360312 MENS HOSIERY	*5512 HOSIERY/SOCKS
370211 BOYS UNDERWEAR	
370213 BOYS HOSIERY	
380420 WOMENS UNDERGARMENTS	
380430 WOMENS HOSIERY	
390321 GIRLS HOSIERY	
410110 INFANT COAT/JACKET/SNOWSUIT	
410120 INFANT DRESSES/OUTERWEAR	
410130 INFANT UNDERGARMENTS	
410140 INFANT NIGHTWEAR/LOUNGEWEAR	
410901 INFANTS ACCESSORIES	
280110 BATHROOM LINENS	
280120 BEDROOM LINENS	
280130 KITCHEN AND DINING ROOM *LINENS	
280210 CURTAINS AND DRAPES	
280220 SLIPCOVERS/DECORATIVE PILLOWS	
280900 OTHER LINENS	
280140 KITCHEN/DINING ROOM/OTHR LINENS	

280230 SEWING MATERIALS 420120 SEWING NOTIONS, PATTERNS	5519 SEWING NOTIONS
300110 REFRIGERATOR, HOME FREEZER 300210 WASHERS 300220 DRYERS 300310 STOVES, OVENS 300320 MICROWAVE OVENS 300330 PORTABLE DISHWASHERS 300410 WINDOW AIR CONDITIONERS 300900 MISC. HOUSEHOLD APPLIANCES 310110 BLACK AND WHITE TV 310120 COLOR TV - CONSOLE 310130 COLOR TV - PORTABLE/TABLE MOD 310140 TELEVISIONS 310210 VCRS/VIDEO DISC PLAYERS 310220 VIDEO CASSETTES/TAPES/DISCs 310230 VIDEO GAME HARDWARE/SOFTWARE 310230 VIDEO GAME CARTRIDGES, TV COMPUTER GAMES AND SOFTWARE, ATARI CARTRIDGES AND SUPPLIES, COMPUTER JOYSTICK, GAMES, AND GAME CARTRIDGES 310231 VIDEO GAME SOFTWARE 310232 VIDEO GAME HARDWARE AND ACCESSORIES 310311 RADIOS 310312 PHONOGRAPHS 310313 TAPE RECORDERS AND PLAYERS 310314 DIGITAL AUDIO PLAYERS 310320 COMPONENTS/COMPONENT SYSTEMS 310331 MISC SOUND EQUIPMENT 310332 SOUND EQUIP ACCESSORIES 310335 Miscellaneous video equipment 310340 RECORDS TAPES NEEDLES STYLI CLUBS 310900 ACCESS. FOR ELECTRONIC EQUIP. 320210 CLOCKS 320130 INFANTS EQUIPMENT 320232 TELEPHONES AND ACCESSORIES 320233 Clocks and other household decorative items 320511 ELECTRIC FLOOR CLEANING EQUIP 320512 SEWING MACHINES 320521 SMALL ELECTRIC KITCHEN APPLIANCES 320522 PORTABLE HEATING/COOLING EQUIP 640420 ELECTRIC PERSONAL CARE APPL. 690110 COMPUTER, COMP HRDWR NON *BUS USE 690110 Computers for non-business use, hardware and software excluding video games 690115 PERSONAL DIGITAL ASSISTANTS 690117 PORTABLE MEMORY 690118 Digital book readers 690119 Computer software 690120 Computer accessories 690210 TELEPHONE ANSWERING DEVICES 690220 CALCULATORS 690230 TYPWRITS/OTH OFF MACH NON-BUS USE 310316 RADIOS/SPEAKERS/SOUND COMP SYSTMS 320221 LAMPS/LIGHT FIXTURES/CEILING FANS 310315 Digital media players and recorders	*5507 ELECTRONICS/RECORDS/TAPES *5513 HOUSEWARES/APPLIANCES/ELECTRONICS *5516 LIGHT BULBS, ELECTRIC GOODS
320120 WINDOW COVERINGS 320231 OTH HOUSEHOLD DECORATIVE ITEMS 320231 Other household decorative items, including fireplace equipment and accessories 320420 POWER TOOLS 320430 OTHER HARDWARE 320902 HAND TOOLS	*5511 HARDWARE, TOOLS [Household accessories are included here too]

320904 CLOSET AND STORAGE ITEMS	
320220 TABLEWARE/NON-ELEC. KITWARE 320380 TABLEWARE/NON-ELEC. KITWARE 320310 PLASTIC DINNERWARE 320320 CHINA AND OTHER DINNERWARE 320330 FLATWARE 320340 GLASSWARE 320350 SILVER SERVING PIECES 320360 OTHER SERVING PIECES 320345 DISHES/CUPS/GLASSES/SERVING PIECS	*5509 GLASSWARE, TABLEWARE *5515 KITCHEN GADGETS *5504 CANNING, FREEZING SUPPLIES
320370 NONELECTRIC COOKWARE	*5506 COOKWARE
330610 LAWN AND GARDEN SUPPLIES	5508 FLORAL, GARDENING 5514 INSECTICIDS/PESTICIDS/RODENTICIDS
330410 STATIONERY, GIFTWRAP, ETC. 660000 SCHOOL SUPPL., ETC. - UNSPEC. 660110 SCHOOL BK/SUPL/EQUIP FOR COLLEGE 660210 SCHOOL BK/SUPL/EQUIP FOR ELEM/HS	4511 WRAPPING MATERIALS AND BAGS 5522 STATIONERY, SCHOOL SUPPLIES 5510 GRT CARDS/PARTY NEEDS/NOVELTIES
430110 WATCHES	*9599 UNGROUPED ITEMS
480211 PARTS/EQUIP/ACCESSORIES 480212 VEHICLE PRODUCTS 480213 PARTS/EQUIP/ACCESSORIES	*5501 AUTOMOTIVE
590110 NEWSPAPERS 590210 MAGAZINES 590220 BOOKS THRU BOOK CLUBS 590230 BOOKS NOT THRU BOOK CLUBS	*5503 BOOKS AND MAGAZINES
600210 GENERAL SPORT/EXERCISE EQUIP 600310 BICYCLES 600410 CAMPING EQUIPMENT 600420 HUNTING, FISHING EQUIPMENT 600430 WINTER SPORT EQUIPMENT 600900 WATER SPORT EQUIPMENT 610110 TOYS GAMES HOBBIES TRICYCLES 610130 MUSIC INSTRUMENTS/ACCESSORIES	*5524 TOYS & SPORTING GOODS
610210 FILM 610220 OTHER PHOTOGRAPHIC SUPPLIES	5517 PHOTOGRAPHIC SUPPLIES
No comparable diary category	*5518 SEASONAL
No comparable diary category	*5523 SUNGLASSES
250900 MISC. FUELS	*5505 CHARCOAL, LOGS, ACCESSORIES
440110 SHOE REPAIR, OTH SHOE SERVICE	*5520 SHOE CARE
1000 STOCKS, BONDS, MUTUAL FUNDS 1100 PRECIOUS METALS 1200 MISCELLANEOUS INVESTMENTS 1400 EMPLOY. COUNSELING & FEES 2100 INSUR. OTH THAN HEALTH/VEHICLE 2200 RETIREMENT PLANS 4000 CONTRIBUTIONS 4100 CASH GIFTS 4190 GIFTS NOT SPECIFIED 5000 ALIMONY AND CHILD SUPPORT 9000 MORTGAGE PAYMENT 9900 PROPERTY ASSESSMENT 190110 LUNCH 190110 Lunch at restaurants, cafes, etc... 190111 Lunch at Fast Food 190112 Lunch at Full Service 190113 Lunch at Vending Machine 190114 Lunch at Employer 190115 Lunch at Board 190116 Lunch at Catered Affairs 190210 DINNER 190210 Dinner at restaurants, cafes, etc...	*No comparable Nielsen category

190211	Dinner at Fast Food
190212	Dinner at Full Service
190213	Dinner at Vending Machine
190214	Dinner at Employer
190215	Dinner at Board
190216	Dinner at Catered Affairs
190310	Snacks and non alcoholic beverages, including tip
190311	Snacks at Fast Food
190312	Snacks at Full Service
190313	Snacks at Vend Machine
190314	Snacks at Employer
190315	Snacks at Board
190316	Snacks at Catered Affairs
190320	BREAKFAST AND BRUNCH
190320	Breakfast and brunch at restaurants, cafes, etc...
190321	Breakfast at Fast Food
190322	Breakfast at Full Service
190323	Breakfast at Vending Machine
190324	Breakfast at Employer
190325	Breakfast at Board
190326	Breakfast at Catered Affairs
190901	BOARD (INCLUD AT SCHOOL)
190901	Food or board, at school and rooming/boarding houses
190902	CATERED AFFAIRS
190911	Board at Fast Food
190912	Board at Full Service
190913	Board at Vending Machine
190914	Board at Employer
190915	Board at Board
190916	Board at Catered Affairs
190921	Catered Affairs at Fast Food
190922	Catered Affairs at Full Service
190923	Catered Affairs at Vending Machine
190924	Catered Affairs at Employer
190925	Catered Affairs at Board
190926	Catered Affairs at Catered Affairs
200510	BEER AND ALE AWAY FROM HOME
200511	Beer at Fast Food
200512	Beer at Full Service
200513	Beer at Vending Machine
200514	Beer at Employer
200515	Beer at Board
200516	Beer at Catered Affairs
200520	Wine away from home
200520	WINE AWAY FROM HOME
200521	Wine at Fast Food
200522	Wine at Full Service
200523	Wine at Vending Machine
200524	Wine at Employer
200525	Wine at Board
200526	Wine at Catered Affairs
200530	Other alcoholic beverages away from home
200531	Alcoholic Beverage Excluding Beer/Wine Fast Food
200532	Alcoholic Beverage Excluding Beer/Wine Full Service
200533	Alcoholic Beverage Excluding Beer/Wine Vending Machine
200534	Alchoic Beverage Excluding Beer/Wine at Employer
200535	Alchoic Beverage Excluding Beer/Wine at Board
200536	Alcoholic Beverage Excluding Beer/Wine Catered Affairs
210110	RENT OF DWELLING
210210	LODGING AWAY FROM HOME
210310	HOUSING FOR SOMEONE AT SCHOOL

210900	GROUND OR LAND RENT
220000	CAPITAL IMPROVEMENTS - N/SPEC.
220110	FIRE/EXTENDED COVERAGE INSUR
220120	HOMEOWNERS INSURANCE
220210	PROPERTY TAXES
220310	CONTRACTED MORTGAGE INTEREST
220400	PURCHASE OF PROPERTY
220410	HOME PURCHASE
220510	CAPITAL IMPROVEMENTS - COMMOD
220610	CAPITAL IMPROVEMENTS - SERVICE
220900	PARKING-OWNED DWELLING
230000	REPAIR/MAINT/IMPROV. N/SPEC.
230110	MAINTENANCE OF PROPERTY
230120	INSTALLED HARD SURFACE FLOORIN
230130	INSTALLED WALL-TO-WALL CARPET
230140	REPAIR-DISPL/DISHR/RANG HD
230900	MAINTENANCE FEES
240110	PAINT, WALLPAPER AND SUPPLIES
240120	TOOLS/EQUIP. FOR PAINTG,PAPERG
240210	LUBER,PANLING,TILE,AWNING,GLAS
240220	BLACKTOP AND MASONRY MATERIALS
240310	PLUMBING SUPPLIES AND EQUIP.
240320	ELEC HEATG/A.C. SUPP. EQUIP
240900	SOFT SURFACE FLOOR COVERING
250110	FUEL OIL
250210	BOTTLED OR TANK GAS
250220	COAL
260110	ELECTRICITY
260210	UTILITY - NATURAL GAS
270000	TELEPHONE SERVICE NOT SPEC.
270210	WATER AND SEWERAGE MAINTENANCE
270310	COMMUNITY ANTENNA OR CABLE TV
270311	Cable/Satellite/Com Antenna Serv
270410	GARBAGE/TRASH COLLECTION
270510	TELEPHONE INTERSTATE CALLS
270510	Telephone interstate calls
270610	TELEPHONE INTRASTATE CALLS
270610	Telephone intrastate calls
270900	SEPTIC TANK CLEANING
270905	STEAM HEAT
290110	MATTRESS AND SPRINGS
290120	OTHER BEDROOM FURNITURE
290210	SOFAS
290310	LIVING ROOM CHAIRS
290320	LIVING ROOM TABLES
290410	KITCHEN/DINING ROOM FURNITURE
290420	INFANTS FURNITURE
290430	OUTDOOR FURNITURE
290440	WALL UNITS, CABINETS, OCCAS FURN
300218	WASHERS AND DRYERS
310241	STREAMING VIDEO FILES
310242	DOWNLOADING VIDEO FILES
310334	Satellite dishes
310351	STREAMING AUDIO FILES
310352	DOWNLOADING AUDIO FILES
320110	FLOOR COVERINGS (NON-PERM.)
320150	OUTDOOR EQUIPMENT
320410	LAWN AND GARDEN EQUIPMENT
320620	PERM HARD SURFACE FLR COVERING
320627	FLOORING INSTALL/REPAIR/REPLACE
320630	LANDSCAPING ITEMS
320901	OFFICE FURNITURE HOME USE

320903 INDOOR PLANTS, FRESH FLOWERS	
340110 POSTAGE	
340120 DELIVERY SERVICES	
340210 BABYSITTING	
340310 DOMESTIC SERVICE	
340410 GARDENING/LAWN CARE SERVICE	
340510 MOVING, STORAGE,FREIGHT EXPRES	
340520 HSHLD LNDRY,DRYCLN NOT COIN-OP	
340530 COIN-OP HSHLD LNDRY, DRY CLN	
340610 REPAIR OF TV/RADIO/SOUND EQUIP	
340620 REPAIR OF HOUSEHOLD APPLIANCES	
340630 REUPHOLSTERY OF FURNITURE	
340901 RENTAL/REPAIR-TOOLS,LAWN/GARDEN	
340903 MISC. HOME SERVICES	
340904 RENTAL OF FURNITURE	
340906 CARE OF INVALIDS, ELDERLY, ETC	
340907 RENTAL OF HOUSEHOLD EQUIPMENT	
340908 RNTL OFF EQUIP NON-BUS USE	
340909 RENTAL OF TV/RADIO SOUND EQUIP	
340913 REPAIR OF MISC HSHLD EQ/FSHGS	
350110 TENANTS INSURANCE	
360110 MENS SUITS	
360120 MENS SPORTCOATS/TAILORED JACKETS	
360210 MENS COATS AND JACKETS	
360320 MENS NIGHTWEAR/LOUNGEWEAR	
360330 MENS ACCESSORIES	
360340 MENS SWEATERS AND VESTS	
360350 MENS ACTIVE SPORTSWEAR	
360410 MENS SHIRTS	
360420 MENS SWEATERS/SHIRTS/VESTS	
360511 MENS PANTS	
360511 Men's pants	
360512 MENS SHORTS/SHORTS SETS	
360512 Men's shorts and shorts sets, excluding athletic	
360513 Men's pants and shorts	
360901 MENS UNIFORMS	
370110 BOYS COATS AND JACKETS	
370120 BOYS SWEATERS	
370125 BOYS SWEATERS/SHIRTS/VESTS	
370130 BOYS SHIRTS	
370212 BOYS NIGHTWEAR	
370220 BOYS ACCESSORIES	
370311 BOYS SUITS, SPORTCOATS,VESTS	
370312 BOYS PANTS	
370312 Boys' pants	
370313 BOYS SHORTS, SHORTS SETS	
370313 Boys' shorts and shorts sets, excluding athletic	
370314 Boys' pants and shorts	
370901 BOYS UNIFORMS/ACTIVE SPORTSWE	
380110 WOMENS COATS AND JACKETS	
380210 WOMENS DRESSES	
380311 WOMENS SPORTCOATS, TAIL. JKTS	
380312 WOMENS VESTS AND SWEATERS	
380313 WOMENS SHIRTS, TOPS,BLOUSES	
380315 WOMENSSWEATERS/SHIRTS/TOPS	
380320 WOMENS SKIRTS	
380331 WOMENS PANTS	
380331 Women's pants	
380332 WOMENS SHORTS,SHORTS SETS	
380332 Women's shorts and shorts sets, excluding athletic	
380333 Women's pants and shorts	
380340 WOMENS ACTIVE SPORTSWEAR	

380410	WOMENS SLEEPWEAR
380510	WOMENS SUITS
380901	WOMENS ACCESSORIES
380902	WOMENS UNIFORMS
390110	GIRLS COATS AND JACKETS
390120	GIRLS DRESSES, SUITS
390210	GIRLS SHIRTS/BLOUSES/SWEATERS
390221	GIRLS SKIRTS AND PANTS
390221	Girls' skirts, culottes, and pants
390222	GIRLS SHORTS, SHORTS SETS
390222	Girls' shorts and shorts sets, excluding athletic
390223	Girls' pants and shorts
390230	GIRLS ACTIVE SPORTSWEAR
390310	GIRLS UNDERWEAR AND SLEEPWEAR
390322	GIRLS ACCESSORIES
390901	GIRLS UNIFORMS
400110	MENS FOOTWEAR
400210	BOYS FOOTWEAR
400220	GIRLS FOOTWEAR
400310	WOMENS FOOTWEAR
420110	MATERIAL FOR MAKING CLOTHES
420115	SEWING/NDLWRK/QUILT MATRLS/ITEMS
430120	JEWELRY
430130	LUGGAGE
440120	COIN-OP APPAREL LDRY/DRY CLNG
440130	ALTER/REPAIR OF APPAREL, ACCESS
440140	CLOTHING RENTAL
440150	WATCH AND JEWELRY REPAIR
440210	APPAREL LNDRY/DRY CLNG N/COIN-OP
440900	CLOTHING STORAGE
450110	NEW CARS
450210	NEW TRUCKS
450220	NEW MOTORCYCLES
450310	CAR LEASE PAYMENTS
450350	CAR/TRUCK LEASE PAYMENTS
450410	TRUCK LEASE PAYMENTS
450900	AIRCRAFT
460110	USED CARS
460901	USED TRUCKS
460902	USED MOTORCYCLES
460903	USED AIRCRAFT
470111	GASOLINE
470112	DIESEL FUEL
470114	GASAHOL
470211	MOTOROIL
470220	COOLANT/ADDITIVES/BRK/TRNS FLD
480110	TIRES PURCHASED/REPLACED/INSTALL
480214	VEHICLE AUDIO EQ. EXCL. LABOR
490000	MISC. AUTO REPAIR/SERVICING
490110	BODY WORK AND PAINTING
490211	CLUTCH, TRANSMISSION REPAIR
490212	DRIVE SHAFT AND REAR-END REPAIR
490220	BRAKE WORK
490231	REPAIR TO STEERING OR FRONT END
490232	REPAIR TO ENGINE COOLING SYSTEM
490300	VEHICLE OR ENGINE REPAIRS
490311	MOTOR TUNE-UP
490312	LUBE, OIL CHANGE AND OIL FILTERS
490313	FRNT END ALIGN, WHEEL BAL/ROTAT
490314	SHOCK ABSORBER REPLACEMENT
490315	BRAKE ADJUSTMENT
490316	GAS TANK REPAIR,REPLACEMENT

490411	EXHAUST SYSTEM REPAIR
490412	ELECTRICAL SYSTEM REPAIR
490413	MOTOR REPAIR/REPLACEMENT
490900	AUTO REPAIR SERVICE POLICY
500110	VEHICLE INSURANCE
520110	STATE OR LOCAL VEHICLE REGISTRATION
520111	VEHICLE REGISTRATION STATE
520112	VEHICLE REGISTRATION LOCAL
520310	DRIVERS LICENSE
520410	VEHICLE INSPECTION
520511	AUTO RENTAL
520516	AUTO/TRUCK RENTAL
520521	TRUCK RENTAL
520530	PARKING FEES
520531	PRKNG FEE IN HME CITY EXCL RSDNC
520541	TOLLS
520550	TOWING CHARGES
520560	GLOBAL POSITIONING SERVICES
520901	DOCKING/LANDING FEES
520902	MOTORCYCLE RENTAL
520903	AIRCRAFT RENTAL
520904	RENTAL NON-CAMPER TRAILER
530110	AIRLINE FARES
530210	INTERCITY BUS FARES
530311	INTRACITY MASS TRANSIT FARES
530412	TAXI FARES
530510	INTERCITY TRAIN FARES
530901	SHIP FARES
530902	SCHOOL BUS
530903	CAR/VAN POOL & NON-MOTOR TRANS
540000	PRESCRIPTION DRUGS
550110	EYEGASSES AND CONTACT LENSES
550310	TOPICALS AND DRESSINGS
550320	MEDICAL EQUIP. FOR GENERAL USE
550330	SUPPORTIVE/CONVAL MED. EQUIP.
550340	HEARING AIDS
560110	PHYSICIANS SERVICES
560210	DENTAL SERVICES
560310	EYECARE SERVICES
560320	SERVICE BY OTH THAN PHYSICIANS
560330	LAB TESTS, X-RAYS
560400	SERV BY PROS OTH THAN PHYSICIANS
560900	NURSE/THERAPY/MISC. MEDIC SERV
570000	HOSPITAL CARE NOT SPECIFIED
570220	CARE IN CONVL OR NURSING HOME
570230	OTHER MEDICAL CARE SERVICE
570901	RENTAL OF MEDICAL/SURGICAL EQUIP
570902	REPAIR OF MEDICAL EQUIPMENT
570903	RENTAL OF SUPORTIVE/CONVAL EQUIP
580000	HEALTH INSURANCE NOT SPEC.
580110	COMMERCIAL HEALTH INSURANCE
580210	BLUECROSS/BLUE SHIELD
580310	HEALTH MAINTENANCE PLANS
580901	MEDICARE PAYMENTS
590900	NEWSLETTERS
600110	OUTBOARD MOTOR
600120	UNPOWERED BOATS, TRAILERS
600130	POWERED SPORTS VEHICLES
600903	GLOBAL POSITIONING SYSTEM DEVICES
610120	PLAYGROUND EQUIPMENT
610140	STAMP AND COIN COLLECTING
610230	PHOTOGRAPHIC EQUIPMENT

610901 FIREWORKS	
610902 SOUVENIRS	
610903 VISUAL GOODS	
620110 CLUB MEMBERSHIP DUES AND FEES	
620111 SOCIAL/RECRE/CIVIC CLUB MEMBRSHIP	
620112 CREDIT CARD MEMBERSHIPS	
620113 AUTOMOBILE SERVICE CLUBS	
620114 AUTO SERVICE CLUBS/GPS SERVICES	
620121 FEES FOR PARTICIPANT SPORTS	
620211 MOVIE, THEATER, OPERA, BALLET	
620213 TKTS TO PLAY/THEATR/OPERA/CONCERT	
620214 TKTS TO MOVIE, PARK, MUSEUMS	
620221 ADMISSION TO SPORTING EVENTS	
620310 FEES FOR RECREATIONAL LESSONS	
620320 PHOTOGRAPHER FEES	
620330 FILM PROCESSING	
620410 PET SERVICES	
620420 VET SERVICES	
620510 ADMISSIONS MISC	
620610 MISC. ENTERTAINMENT SERVICES	
620710 CAMP FEES	
620810 REN/REP SPT/PHOT/MUSIC EQUIP	
620911 MISC FEES,PARIMUTUEL LOSSES	
620911 Miscellaneous fees, pari-mutuel losses, and taxidermist fees	
620912 RNTL VIDEO CASS/TAPES/DISCS/FILMS	
620913 PINBALL/ELECTRONIC VIDEO GAMES	
620915 PASSPORT FEES	
620925 Lotteries and Parimutuel Losses	
620926 Miscellaneous Fees	
620930 ONLINE ENTERTAINMENT SERVICES	
640130 WIGS AND HAIRPIECES	
650110 PERS. CARE SERV FOR FEMALES	
650210 PERS. CARE SERV FOR MALES	
650900 REPAIR OF PERS. CARE APP.	
660310 ENCYL. OTH SETS OF REFRNCE BKS	
660900 SCH BK/SUP/EQ-DAY CARE,NURS,OTH	
670110 COLLEGE TUITION	
670210 ELEM./H.S. TUITION	
670310 DAY CARE/NURS/PRSCH EXP INCL TUIT	
670410 VOC/TECH SCHOOL TUITION	
670901 OTHER SCHOOL TUITION	
670902 OTH SCH EXPENSES INCLUD RENTALS	
670903 UNDOCUMENTED?	
680110 LEGAL FEES	
680140 FUNERAL EXPENSE	
680210 SAFE DEPOSIT BOX RENTAL	
680220 CHECK ACCTS / OTH BANK SERV CHGS	
680901 CEMETERY LOTS,VAULTS,MAINT FEES	
680902 ACCOUNTING FEES	
680903 MISC. PERS. SERVICES	
680904 DATING SERVICES	
690114 COMPUTER INFORMATION SERVICES	
690116 INTERNET SERVICES AWAY FROM HOME	
950024 VEHICLE PERSONAL PROPERTY TAXES	

References

- Bee, Adam, Bruce D. Meyer and James X. Sullivan. 2012. "The Validity of Consumption Data: Are the Consumer Expenditure Interview and Diary Surveys Informative?" NBER Working Paper No. 18308.
- Bee, Adam, Bruce D. Meyer and James X. Sullivan. 2015. "The Validity of Consumption Data: Are the Consumer Expenditure Interview and Diary Surveys Informative?" in *Improving the Measurement of Consumer Expenditures* (2015), Christopher D. Carroll, Thomas F. Crossley, and John Sabelhaus, editors (p. 204 - 240).

APPENDIX C. A MODEL OF CONSUMER EXPENDITURES

Suppose consumers have a “target” level of consumption C_i (in dollars) per T units of time (e.g., T is the number of weeks in a year) for household i . The task of consumers is to minimize the cost of this consumption bundle.

$$\text{cost} = \frac{\delta_i d_i^\beta C_i}{2N} + F_i N C_i^\alpha + d_i C_i$$

where F_i is the fixed cost of a trip to a store (this cost depends on parameter α : with $\alpha = 1$ this is an iceberg cost, with $\alpha = 0$ this is a fixed cost), N is the number of shopping trips, d_i is the price discount (the baseline model reported in the paper imposes $d_i = 1$), δ_i is the storage cost of the average inventory (the average inventory is $p_i^\beta \bar{C}_i / 2N$). We can use different values of β to obtain different interpretations of the storage cost. With $\beta = 0$, storage cost is measured in physical units but δ can be interpreted as a price. With $\beta = 1$, we have storage cost is measured in dollars with δ being a “depreciation” rate (rather than price). While assumptions about storage costs, discounts, etc. may be important for specific applications, we will show below that for our analysis we do not need to take a stand on exact functional forms, particular interpretations, or certain parameter values. For example, whether δ captures storage costs or depreciation is not material for us. As a result, we can consider a general form for the cost function.

The optimality condition implies that

$$N_i^* = \sqrt{\frac{\delta_i d_i^\beta C_i^{1-\alpha}}{2F_i}}.$$

The size of the purchase is $X_i = d_i C_i / N_i^*$ (if there is a purchase; this happens N_i^* / T fraction of times) or 0 (no purchase; this happens $1 - N_i^* / T$ fraction of time). Note that for this household the time-series mean is

$$E_t(X_{it}) = \frac{d_i C_i}{N_i^*} * \frac{N_i^*}{T} + 0 * \left(1 - \frac{N_i^*}{T}\right) = \frac{d_i C_i}{T} \equiv \bar{X}_i$$

The time-series variance of purchases for household i is

$$\text{var}_i(X_{it}) = \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \frac{d_i C_i}{T} \right)^2 + \left(1 - \frac{N_i^*}{T} \right) \left(-\frac{d_i C_i}{T} \right)^2 = \left(\frac{d_i C_i}{T} \right)^2 \left(\frac{T}{N_i^*} - 1 \right) = (\bar{X}_i)^2 \left(\frac{T}{N_i^*} - 1 \right)$$

Hence the time-series coefficient of variation is given by

$$CV_T(X_{it}) = \frac{\sqrt{\text{var}_i(X_{it})}}{\bar{X}_i} = \sqrt{\frac{T}{N_i^*} - 1}$$

Using the delta method, we can find that the average (across households) time-series coefficient of variation is

$$\overline{CV_T} = E_i[CV_T(X_{it})] = E \left[\sqrt{\frac{T}{N_i^*} - 1} \right] \approx$$

Define the cross-sectional average of the desired per-week consumption as

$$\bar{X} = E(X_{it}) = E(E(X_{it}|i)) = E_i \left(\frac{d_i C_i}{T} \right) = E_i \bar{X}_i.$$

Now consider the cross-sectional variance

$$\text{var}(X_{it}) = E \left[(X_{it} - \bar{X})^2 \right] = E_i \left[E \left\{ (X_{it} - \bar{X})^2 | i \right\} \right].$$

For household i , we have

$$\begin{aligned}
E(X_{it} - \bar{X})^2 &= \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \bar{X} \right)^2 + \left(1 - \frac{N_i^*}{T} \right) (-\bar{X})^2 = \\
&= \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \frac{d_i C_i}{T} + \frac{d_i C_i}{T} - \bar{X} \right)^2 + \left(1 - \frac{N_i^*}{T} \right) \left(\frac{d_i C_i}{T} - \bar{X} - \frac{d_i C_i}{T} \right)^2 \\
&= \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \frac{d_i C_i}{T} \right)^2 + \frac{N_i^*}{T} \left(\frac{d_i C_i}{T} - \bar{X} \right)^2 + 2 \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \frac{d_i C_i}{T} \right) \left(\frac{d_i C_i}{T} - \bar{X} \right) \\
&\quad + \left(1 - \frac{N_i^*}{T} \right) \left(\frac{d_i C_i}{T} - \bar{X} \right)^2 + \left(1 - \frac{N_i^*}{T} \right) \left(\frac{d_i C_i}{T} \right)^2 - 2 \left(1 - \frac{N_i^*}{T} \right) \left(\frac{d_i C_i}{T} - \bar{X} \right) \left(\frac{d_i C_i}{T} \right) \\
&= \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \bar{X}_i \right)^2 + \left(1 - \frac{N_i^*}{T} \right) (\bar{X}_i)^2 + \frac{N_i^*}{T} (\bar{X}_i - \bar{X})^2 + \left(1 - \frac{N_i^*}{T} \right) (\bar{X}_i - \bar{X})^2 \\
&\quad + 2 \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \frac{p_i C_i}{T} \right) \left(\frac{d_i C_i}{T} - \bar{X} \right) - 2 \left(1 - \frac{N_i^*}{T} \right) \left(\frac{d_i C_i}{T} - \bar{X} \right) \left(\frac{d_i C_i}{T} \right) \\
&= \text{var}_i(X_{it}) + (\bar{X}_i - \bar{X})^2 + 2 \left(\frac{d_i C_i}{T} - \bar{X} \right) \left\{ \frac{N_i^*}{T} \left(\frac{d_i C_i}{N_i^*} - \frac{p_i C_i}{T} \right) - \left(1 - \frac{N_i^*}{T} \right) \left(\frac{d_i C_i}{T} \right) \right\} \\
&= \text{var}_i(X_{it}) + (\bar{X}_i - \bar{X})^2 + 2 \left(\frac{d_i C_i}{T} - \bar{X} \right) \left\{ \frac{d_i C_i}{T} - \frac{N_i^*}{T} \frac{d_i C_i}{T} - \frac{d_i C_i}{T} + \frac{N_i^*}{T} \frac{d_i C_i}{T} \right\} \\
&= \text{var}_i(X_{it}) + (\bar{X}_i - \bar{X})^2
\end{aligned}$$

If we take an average across households in this group, we have

$$\begin{aligned}
E_i \left[E \left\{ (X_{it} - \bar{X})^2 | i \right\} \right] &= E_i \left\{ \left(\frac{d_i C_i}{T} \right)^2 \left(\frac{T}{N_i^*} - 1 \right) + \left(\frac{d_i C_i}{T} - \bar{X} \right)^2 \right\} \\
&= E_i \left\{ \left(\frac{d_i C_i}{T} \right)^2 \left(\frac{T}{N_i^*} - 1 \right) \right\} + E_i \left\{ \left(\frac{d_i C_i}{T} - \bar{X} \right)^2 \right\} = E_i \left\{ \left(\frac{d_i C_i}{T} \right)^2 \left(\frac{T}{N_i^*} - 1 \right) \right\} + \text{var} \left(\frac{d_i C_i}{T} \right) \\
&= \overline{\text{var}_T(X_{it})} + \text{var} \left(\frac{d_i C_i}{T} \right) \approx E \left\{ \left(\frac{d_i C_i}{T} \right)^2 \right\} E \left\{ \left(\frac{T}{N_i^*} - 1 \right) \right\} + \text{var} \left(\frac{d_i C_i}{T} \right).
\end{aligned}$$

The coefficient of variance for the cross-section is then

$$\begin{aligned}
CV(X_{it}) &= \frac{\sqrt{E(X_{it} - \bar{X})^2}}{\bar{X}} = \frac{\sqrt{\text{var} \left(\frac{d_i C_i}{T} \right) + \overline{\text{var}_T(X_{it})}}}{E \left(\frac{d_i C_i}{T} \right)} \\
&= \frac{\sqrt{\text{var} \left(\frac{d_i C_i}{T} \right) + \overline{\text{var}_T(X_{it})}}}{\left[E \left(\frac{d_i C_i}{T} \right) \right]^2} = \sqrt{CV(\bar{X}_i)^2 + \frac{\overline{\text{var}_T(X_{it})}}{\left[E \left(\frac{d_i C_i}{T} \right) \right]^2}} \\
&\approx \sqrt{CV(\bar{X}_i)^2 + \frac{E \left\{ \left(\frac{d_i C_i}{T} \right)^2 \right\} E \left\{ \left(\frac{T}{N_i^*} - 1 \right) \right\}}{\left[E \left(\frac{d_i C_i}{T} \right) \right]^2}} = \sqrt{CV(\bar{X}_i)^2 + \frac{E \left\{ \left(\frac{d_i C_i}{T} \right)^2 \right\}}{\left[E \left(\frac{d_i C_i}{T} \right) \right]^2} * \overline{CV_T}^2}
\end{aligned}$$

$$\begin{aligned}
&= \sqrt{CV(\bar{X}_i)^2 + \frac{E\left\{\left(\frac{d_i C_i}{T}\right)^2\right\} - \left[E\left(\frac{d_i C_i}{T}\right)\right]^2 + \left[E\left(\frac{d_i C_i}{T}\right)\right]^2}{\left[E\left(\frac{d_i C_i}{T}\right)\right]^2} \overline{CV_T}^2} \\
&= \sqrt{CV(\bar{X}_i)^2 + \frac{var\left(\frac{d_i C_i}{T}\right) + \left[E\left(\frac{d_i C_i}{T}\right)\right]^2}{\left[E\left(\frac{d_i C_i}{T}\right)\right]^2} \overline{CV_T}^2} \\
&= \sqrt{CV(\bar{X}_i)^2 + (CV(\bar{X}_i)^2 + 1)\overline{CV_T}^2} = CV(\bar{X}_i) \sqrt{1 + \left(\frac{1}{CV(\bar{X}_i)^2} + 1\right) \overline{CV_T}^2}
\end{aligned}$$

where $CV(\bar{X}_i)$ is the cross-sectional CV if there is not shopping heterogeneity (i.e. households spend the same amount every week). Note that while deriving this formula, we used only N_i^* without specifying what parameter (e.g., δ , d , F , β) determines it. Thus, our formula holds under general conditions that allow a variety of functional forms and parameter values.