R: Innovating at the Bureau of Labor Statistics

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Division of Consumer Expenditure Surveys

Federal Committee on Statistical Methodology
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Overview

- **IPP**: Division of International Prices
- **PPI**: Division of Industrial Prices and Price Indexes
- **CE**: Division of Consumer Expenditure Survey
- **OCWC**: Office of Compensation and Working Conditions
- **OSMR**: Office of Survey Methods and Research

Overview

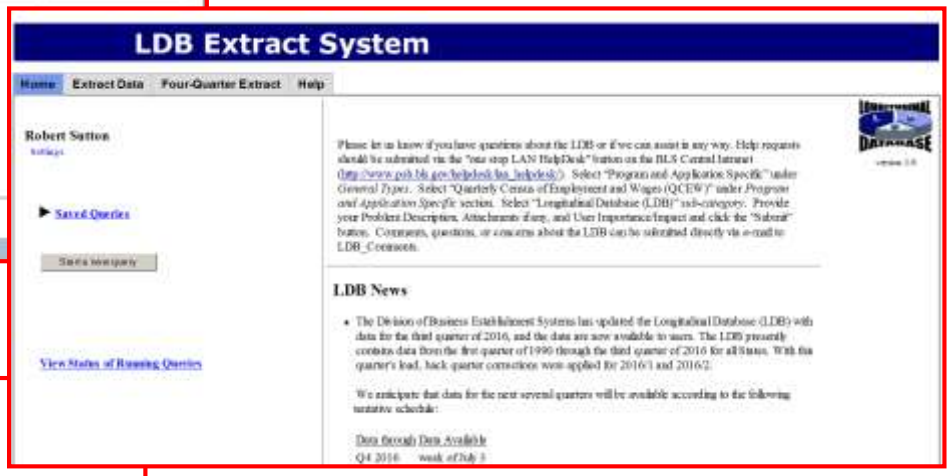
- Automation (IPP)
- Quality control (PPI)
- Real-time response rates (OCWC)
- Data visualization (CE)
- Other R Shiny applications
- R packages

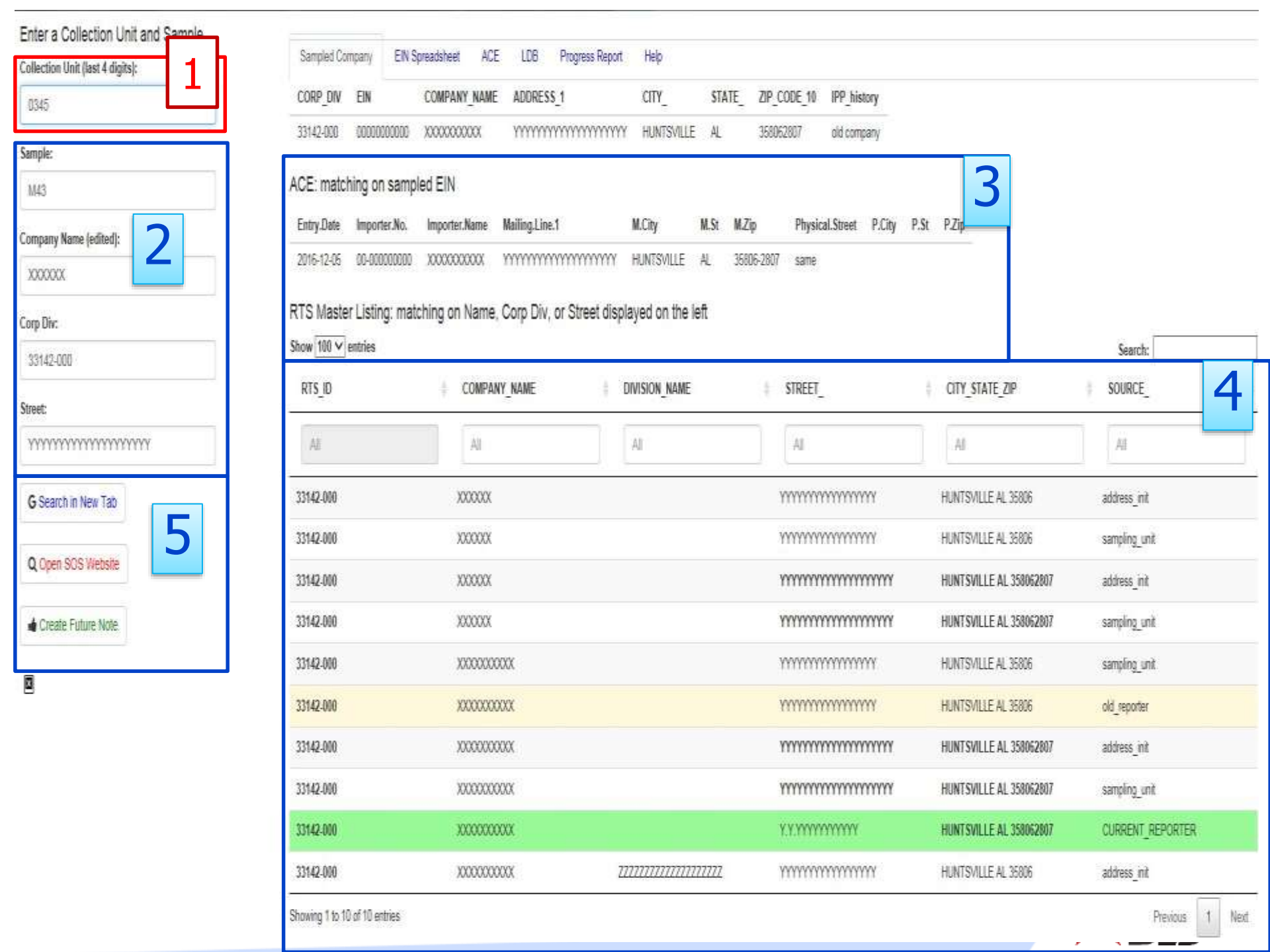
R Shiny Applications

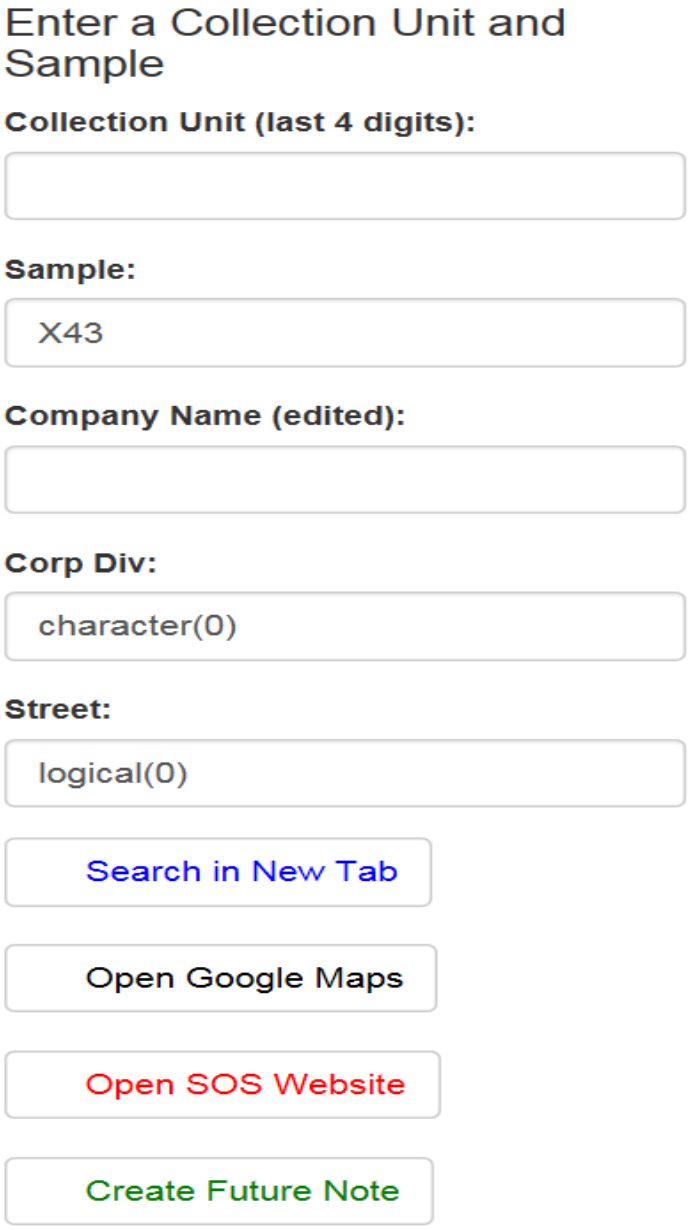
Sample Refinement Automation

- International Prices Program
  - Receive data from Census and Customs
  - Must verify Establishment ID Number (EIN), name, and address to provide to field economists
  - 1700 export collections units per sample
  - 2400 import collection units per sample
  - 6 IPP sample team members
  - 16 copies, 20 pastes, and 46 clicks per unit

Data Sources




Enter a Collection Unit and Sample
Collection Unit (last 4 digits):
0345
1
Sample:
M43
Company Name (edited):
XXXXXX
2
Corp Div:
33142-000
Street:
YYYYYYYYYYYYYYYYYY
G Search in New Tab
Open SOS Website
Create Future Note
5
Sampled Company
EIN Spreadsheet
ACE
LDB
Progress Report
Help
CORP_DIV EIN COMPANY_NAME ADDRESS_1 CITY_ STATE_ ZIP_CODE_10 IPP_history
33142-000 0000000000 XXXXXXXXXX YYYYYYYYYYYYYYYYYY HUNTSVILLE AL 35806 2807 old company
ACE: matching on sampled EIN
3
Entry.Date Importer.No. Importer.Name Mailing.Line.1 M.City M.St M.Zip Physical.Street P.City P.St P.Zip
2016-12-06 00-00000000 XXXXXXXXXX YYYYYYYYYYYYYYYYYY HUNTSVILLE AL 35806-2807 same
RTS Master Listing: matching on Name, Corp Div, or Street displayed on the left
Show 100 entries
Search:
4
RTS_ID COMPANY_NAME DIVISION_NAME STREET_ CITY_STATE_ZIP SOURCE_
All All All All All All
33142-000 XXXXX YYYYYYYYYYYYYYY HUNTSVILLE AL 35806 address_init
33142-000 XXXXX YYYYYYYYYYYYYYY HUNTSVILLE AL 35806 sampling_unit
33142-000 XXXXX YYYYYYYYYYYYYYYYYY HUNTSVILLE AL 358062807 address_init
33142-000 XXXXX YYYYYYYYYYYYYYYYYY HUNTSVILLE AL 358062807 sampling_unit
33142-000 XXXXXXXXX YYYYYYYYYYYYYYY HUNTSVILLE AL 35806 sampling_unit
33142-000 XXXXXXXXX YYYYYYYYYYYYYYY HUNTSVILLE AL 35806 old_reporter
33142-000 XXXXXXXXX YYYYYYYYYYYYYYYYYY HUNTSVILLE AL 358062807 address_init
33142-000 XXXXXXXXX YYYYYYYYYYYYYYYYYY HUNTSVILLE AL 358062807 sampling_unit
33142-000 XXXXXXXXX Y.Y.YYYYYYYYYY HUNTSVILLE AL 358062807 CURRENT_REPORTER
33142-000 XXXXXXXXX ZZZZZZZZZZZZZZZZZZZZ YYYYYYYYYYYYYYY HUNTSVILLE AL 35806 address_init
Showing 1 to 10 of 10 entries
Previous 1 Next


Enter a Collection Unit and Sample
Collection Unit (last 4 digits):
Sample:
X43
Company Name (edited):
Corp Div:
character(0)
Street:
logical(0)
Search in New Tab
Open Google Maps
Open SOS Website
Create Future Note

Left Side

Right Side

Sampled Company | EIN Spreadsheet | ACE | LDB | Progress Report | Help

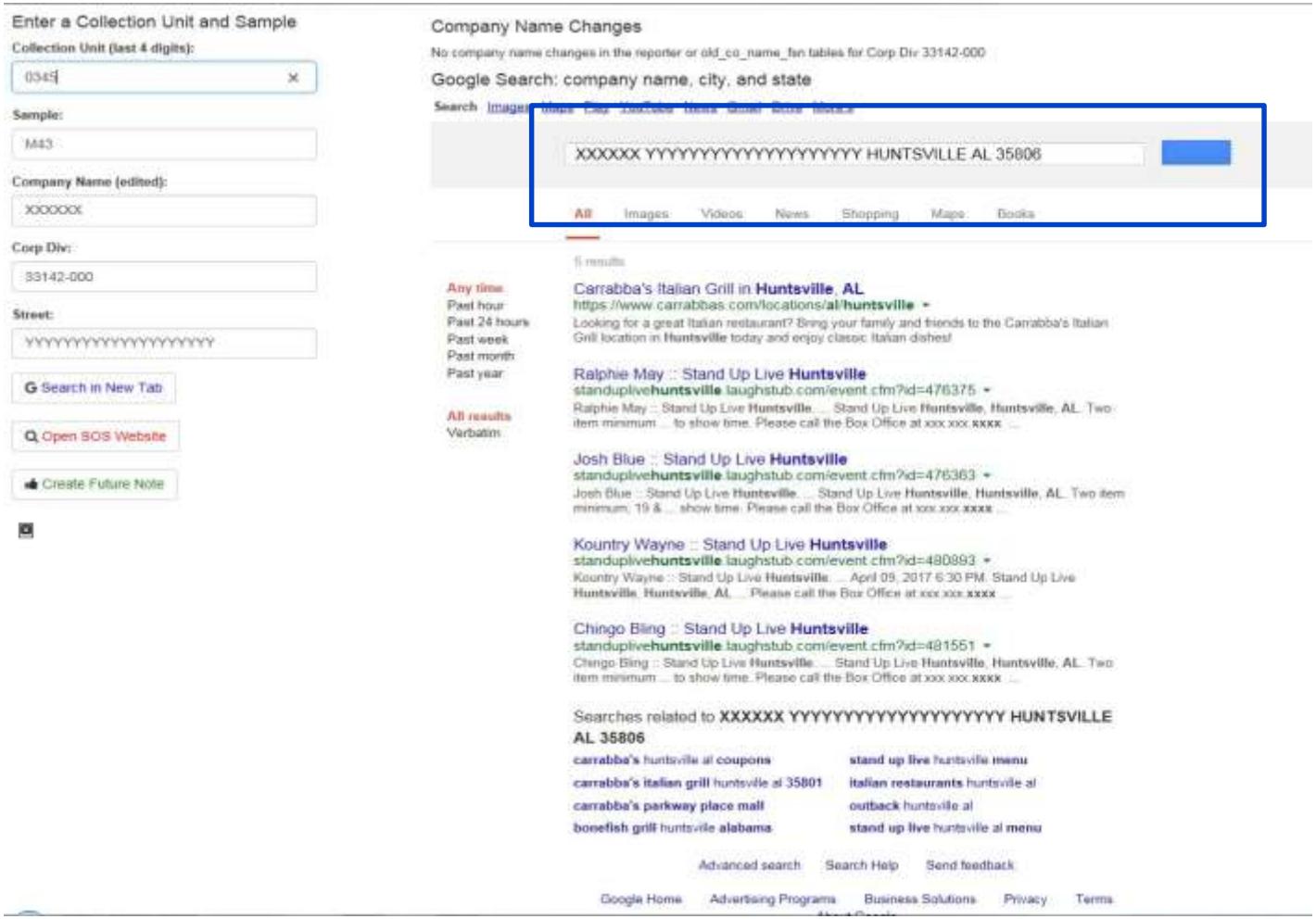
CORP_DIV	EIN	COMPANY_NAME	ADDRESS_1	CITY_	STATE_	ZIP_CODE_10	IPP_history

ACE: matching on sampled EIN

Entry.Date	Importer.No.	Importer.Name	Mailing.Line.1	M.City	M.St	M.Zip	Physical.Street	P.City	P.St	P.Zip

RTS Master Listing: matching on Name, Corp Div, or Street displayed on the left

Search Results



Export Addresses at a Glance

Enter a Collection Unit and Sample

Collection Unit (last 4 digits):

0345

Sample:

X42

Company Name (edited):

XXXXXXXXXXXXXXX

Corp Div:

67305-000

Street:

Sampled Company | EIN Spreadsheet | ACE | LDB | Progress Report | Help

EIN Spreadsheet: matching on sampled EIN

pct	export_id	eistrata	name	address	city	st	zip	eistrecs	addrecs	split	flag1	flag2	problem	Mike.s.Comment
33%	[redacted]							2398	800		1	1		
21%								2398	510					
11%								2398	260					
7%								2398	177					
5%								2398	127					
4%								2398	93					
3%								2398	82					

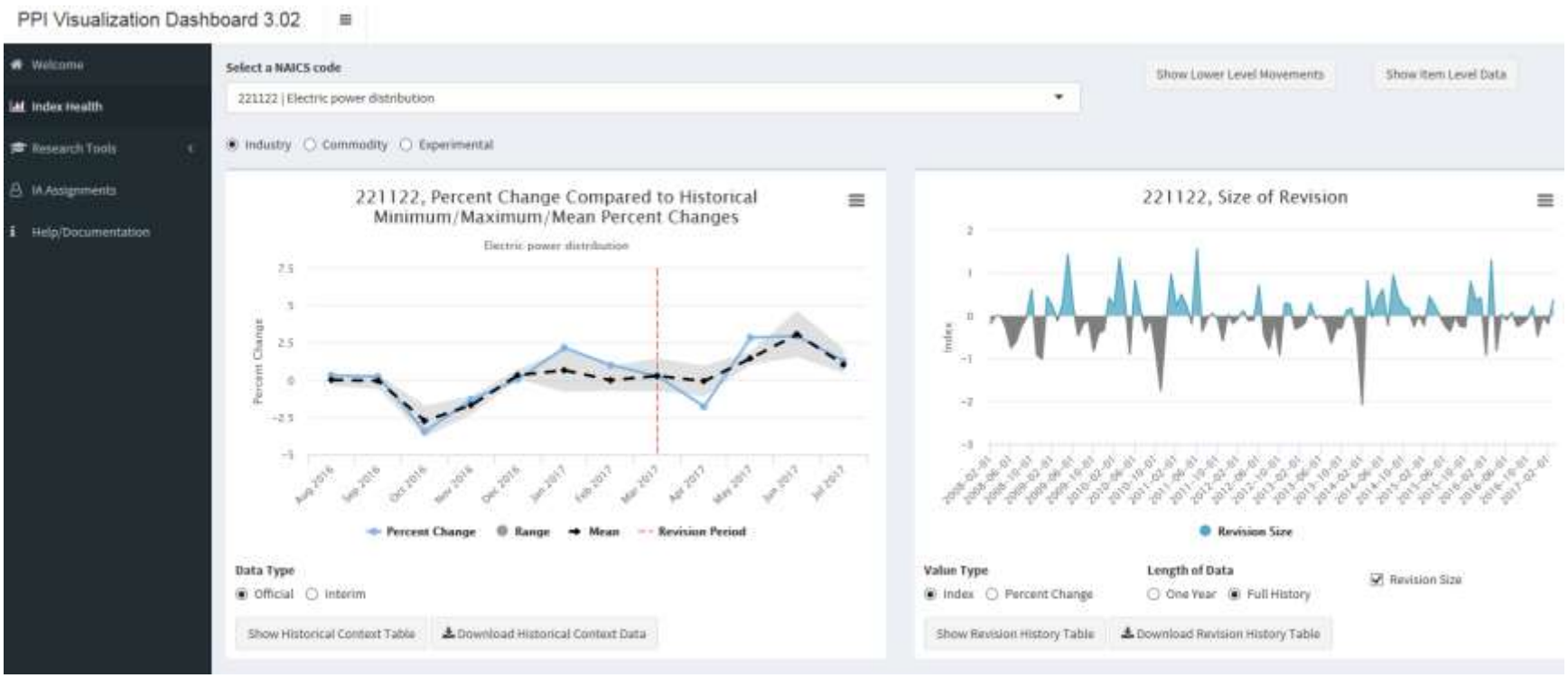
Benefits of Automation

- 80-100 hours per sample of time savings
  - Much less clicking
  - Better and more thorough sample review
  - More time to review more problematic collection units

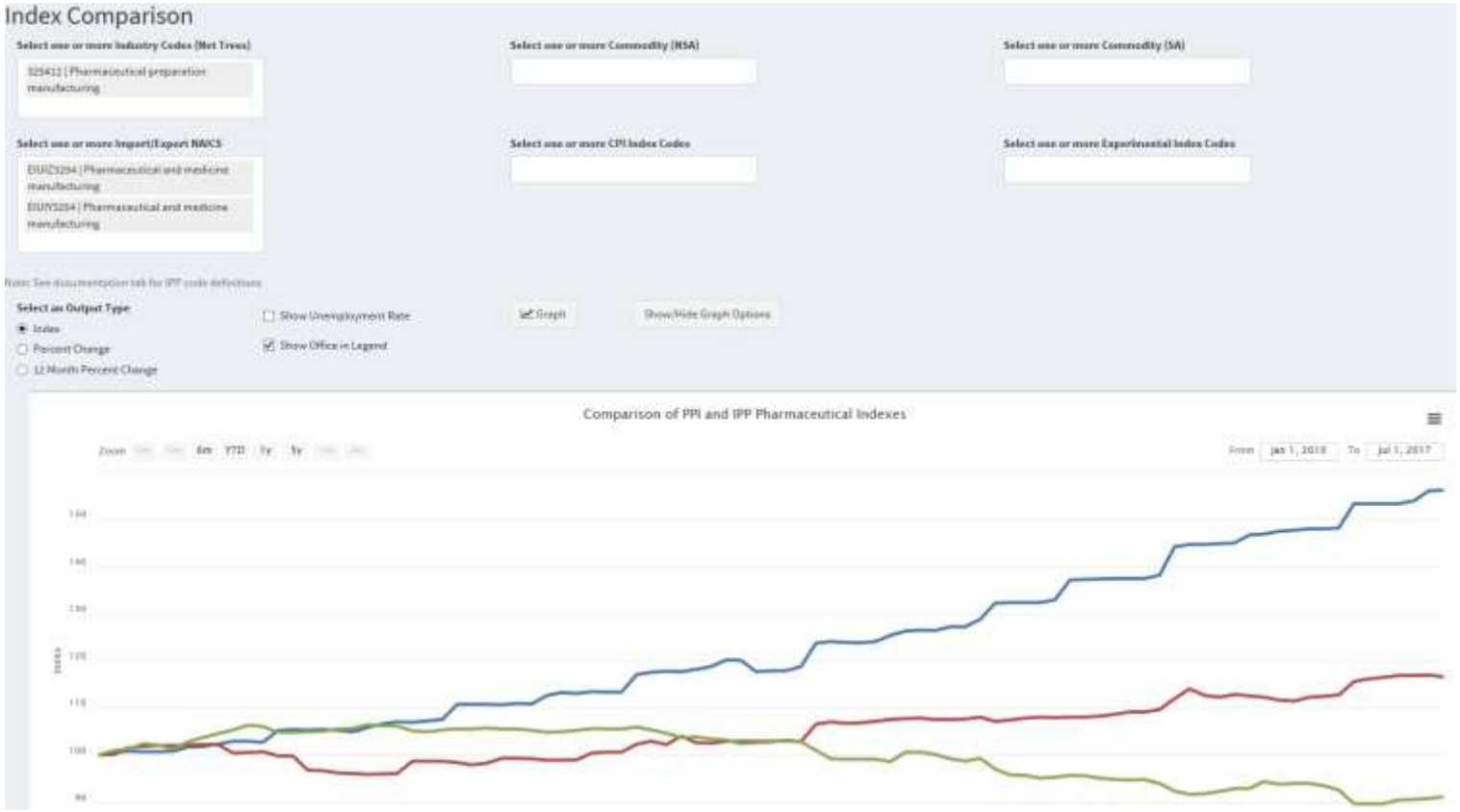
Sample Refinement Automation

- Ara Khatchadourian: khatchadourian.ara@bls.gov
- Rob Sutton: sutton.robert@bls.gov

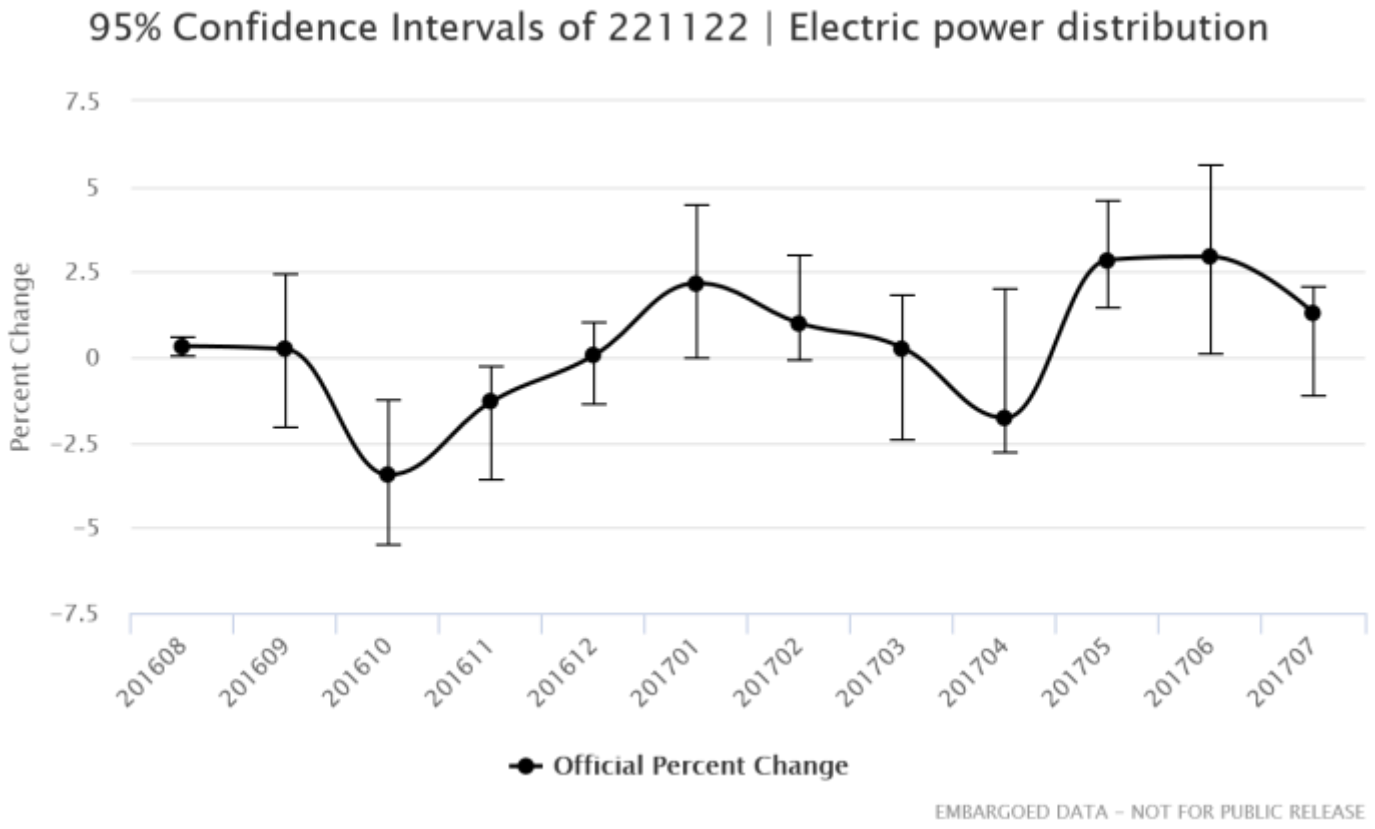
Industrial Prices Visualization Dashboard



Index Comparisons



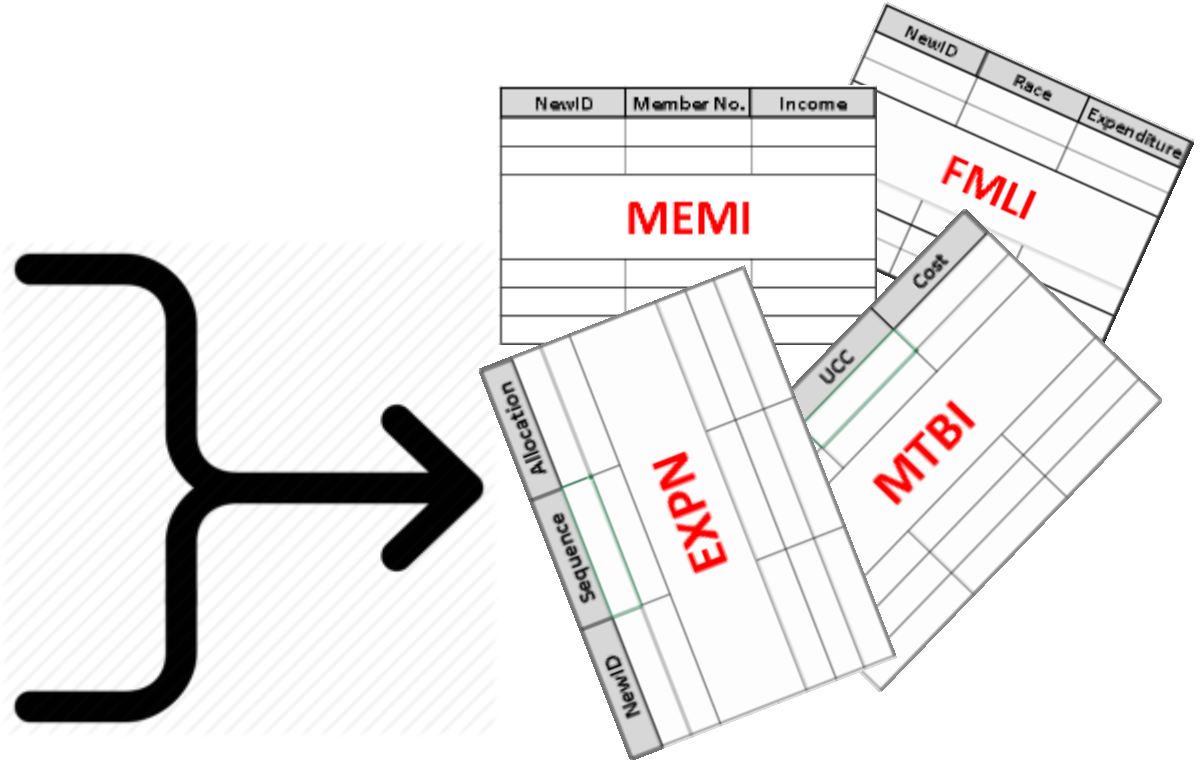
Index Review and Revision



Visualization Dashboard

- Neil Wagner: wagner.neil@bls.gov
- Steve York: york.stephen@bls.gov

Interactive CE Visualization Tool



CE Public-Use Microdata (PUMD)

- Public-Use Microdata
  - Family-level characteristics
  - Expenditures by Universal Classification Code (UCC)
  - Member-level characteristics
  - Expenditures and their characteristics by type of expenditure (EXPN… > 50 files each year!)
  - And more!

Files Required for Analysis

Family Characteristics File (34,177 Observations)

	newid	cutenure	fam_size	finlwt21	ref_race	region	fincbtxm	high_edu
1	02792005	Owner	1	16991.669	Black or African American	South	Second 20 Percent	High School Graduate
2	02792065	Renter	1	14256.350	White	West	Third 20 Percent	Some College or Assoc
3	02792075	Renter	3	16964.084	White	South	Second 20 Percent	Some College or Assoc
4	02792095	Owner	1	21831.304	White	South	Third 20 Percent	Less than High school
5	02792115	Renter	4	18482.601	Asian	Northeast	Third 20 Percent	Bachelor's Degree
6	02792125	Renter	3	14580.459	White	Northeast	Lowest 20 Percent	Some College or Assoc
7	02792155	Owner	1	6143.497	Asian	West	Fourth 20 Percent	Post-graduate Degree
8	02792225	Owner	1	13793.790	White	South	Lowest 20 Percent	Some College or Assoc
9	02792245	Renter	4	18926.631	White	West	Third 20 Percent	Some College or Assoc
10	02792265	Renter	2	15954.534	Asian	West	Second 20 Percent	High School Graduate
11	02792275	Owner	2	10781.501	Black or African American	South	Third 20 Percent	Bachelor's Degree
12	02792295	Renter	2	17750.726	Asian	South	Fourth 20 Percent	Bachelor's Degree
13	02792335	Owner	5 or More	18636.435	White	South	Second 20 Percent	Less than High school
14	02792385	Renter	1	17653.513	Black or African American	South	Fourth 20 Percent	Some College or Assoc
15	02792415	Owner	2	18687.147	White	Northeast	Third 20 Percent	Some College or Assoc
16	02792435	Owner	1	6171.729	Asian	West	Third 20 Percent	Bachelor's Degree
17	02792455	Renter	1	12064.521	White	Northeast	Lowest 20 Percent	High School Graduate
18	02792525	Owner	2	18976.791	Asian	West	Highest 20 Percent	Post-graduate Degree
19	02792585	Renter	5 or More	23060.929	Black or African American	Midwest	Third 20 Percent	Some College or Assoc
20	02792595	Owner	3	19092.108	Asian	West	Highest 20 Percent	Bachelor's Degree

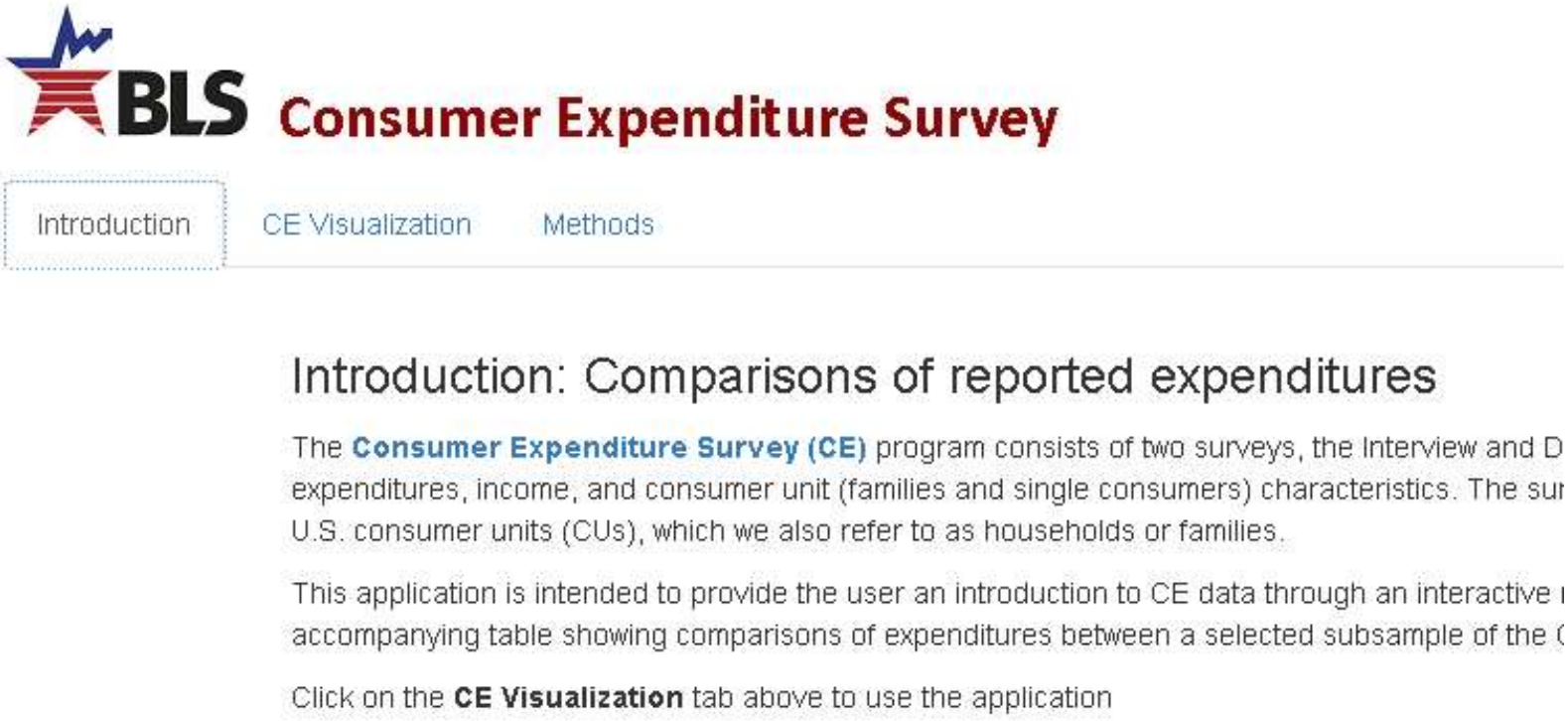
Expenditures File (1,720,755 Observations)

	newid	ref_mo	ucc	cost
1	02792065	01	210110	650.0000
2	02792075	01	210110	258.3333
3	02792115	01	210110	1370.0000
4	02792125	01	210110	426.0000
5	02792245	01	210110	3189.0000
6	02792265	01	210110	380.0000
7	02792295	01	210110	918.3333
8	02792385	01	210110	675.0000
9	02792455	01	210110	850.0000
10	02792585	01	210110	1500.0000
11	02792815	01	210110	880.0000
12	02793085	01	210110	1050.0000
13	02793345	01	210110	850.0000
14	02793355	01	210110	816.0000
15	02793455	01	210110	419.0000
16	02793525	01	210110	146.0000
17	02793645	01	210110	475.0000
18	02793775	01	210110	800.0000
19	02793805	01	210110	860.0000
20	02793815	01	210110	800.0000
21	02794175	01	210110	196.0000

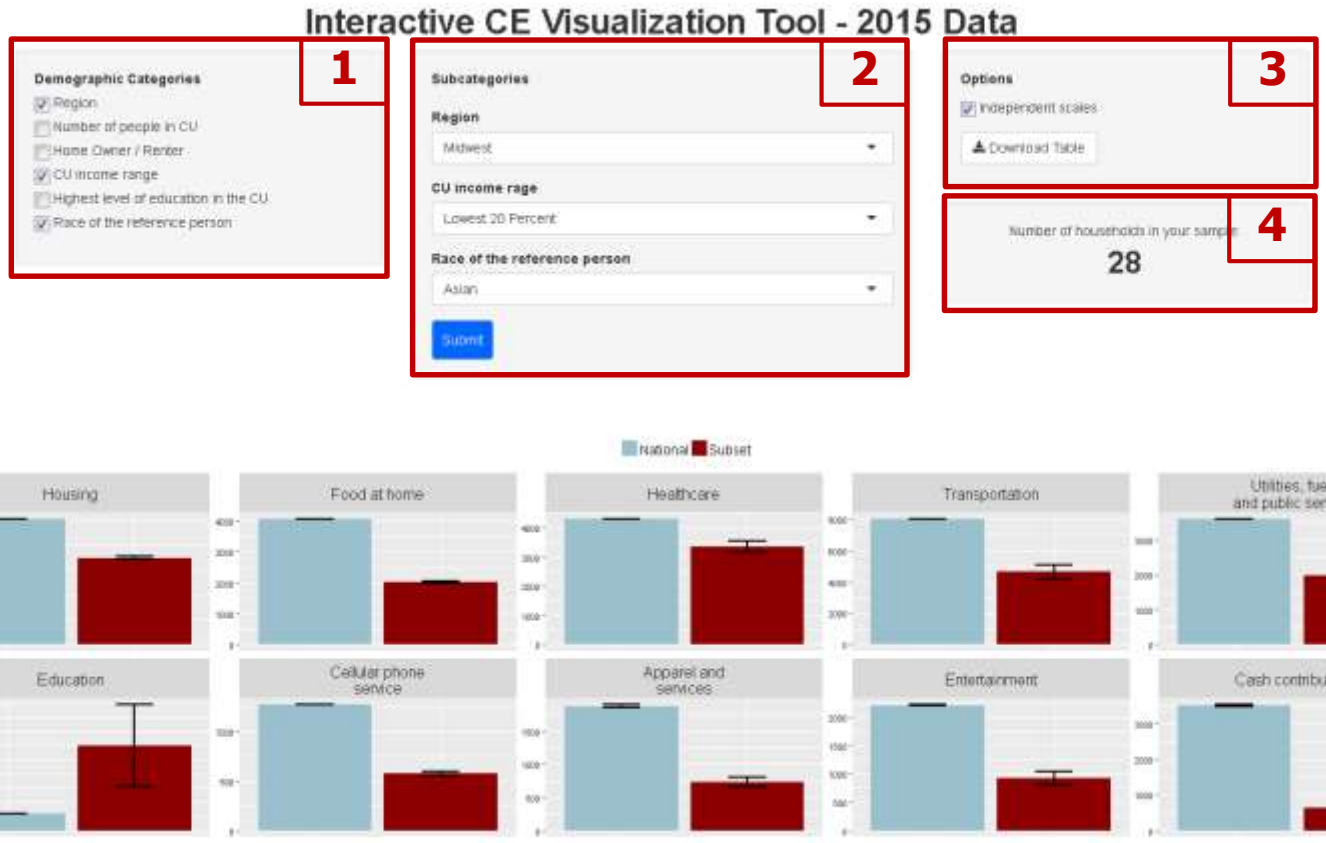
Required Resources / Skills

```
135 ##############################################################################
136 #                                                                            #
137 #                        Compute Annual Mean Estimates                       #
138 #                                                                            #
139 ##############################################################################
140
141 # Merge Interview CU weights and expenditures
142 int_df <- left_join(
143     fmli,
144     expend %>% filter(ucc %in% getUCCs(expenditure, stub)) %>%
145         group_by(newid) %>% summarise(cost = sum(cost)),
146     by = "newid"
147 ) %>%
148     mutate_each_(
149         funs(replace(., is.na(.), 0)),
150         vars = c("cost", paste0("wtrep", str_pad(1:44, 2, "left", 0)))
151     )
152
153 # Compute an Interview annual mean estimate
154 int_gm <- int_df %>%
155     mutate(wt_cost = cost * finlwt21) %>%
156     summarise(
157         grand_mean = sum(wt_cost, na.rm = TRUE) / sum(calwt)
158     ) %>% unlist() %>% unname()
159
160 # Merge Diary CU weights and expenditures
161 dia_df <- left_join(
162     fmld,
163     expend %>% filter(ucc %in% getUCCs(expenditure, stub)) %>%
164         group_by(newid) %>% summarise(cost = sum(cost)),
165     by = "newid"
166 ) %>%
167     mutate_each_(
168         funs(replace(., is.na(.), 0)),
169         vars = c("cost", paste0("wtrep", str_pad(1:44, 2, "left", 0)))
170     )
171
172 # Compute a Diary annual mean estimate
173 dia_gm <- dia_df %>%
174     mutate(wt_cost = cost * finlwt21) %>%
175     summarise(grand_mean = sum(wt_cost, na.rm = TRUE) / sum(popwt)) %>%
176     unlist() %>% unname()
```

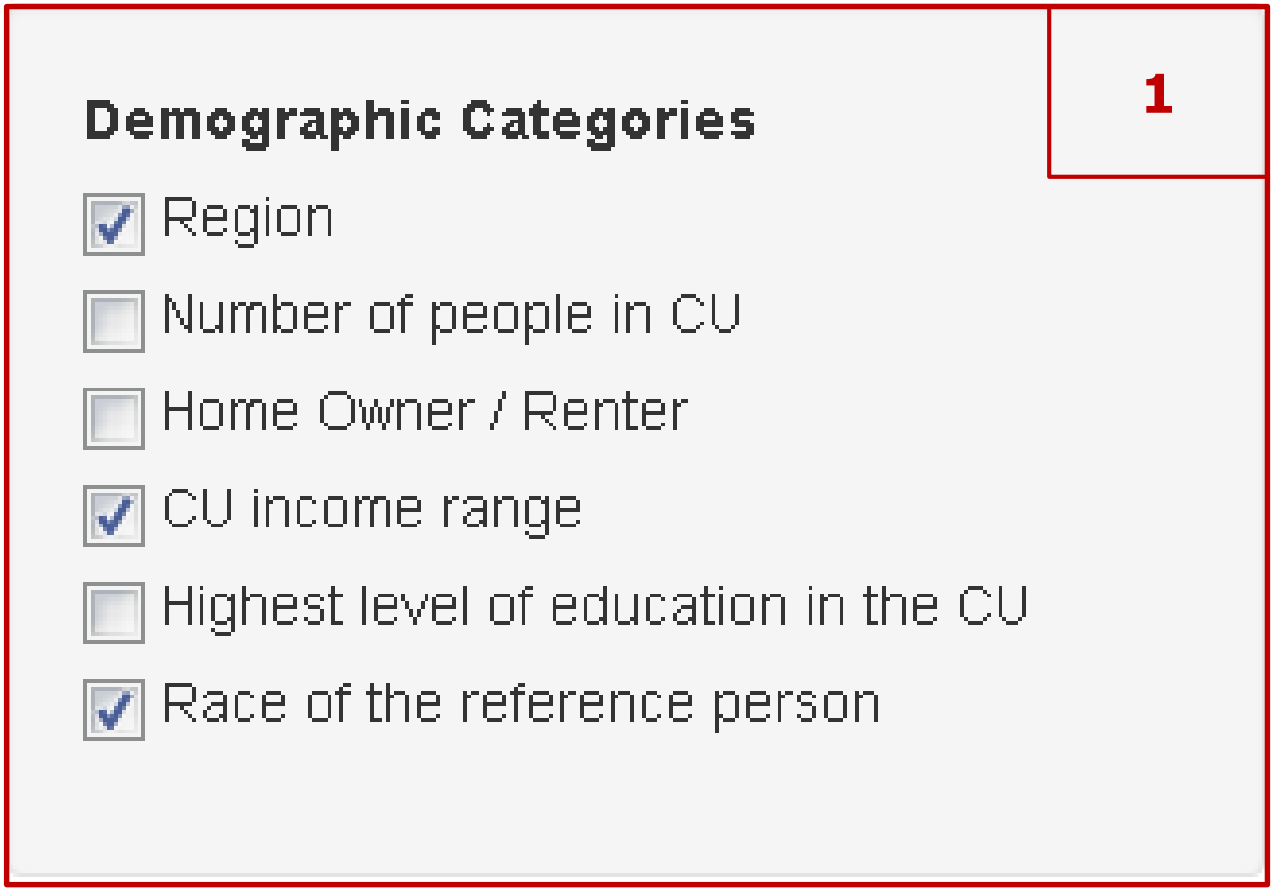
Interactive CE Visualization Tool



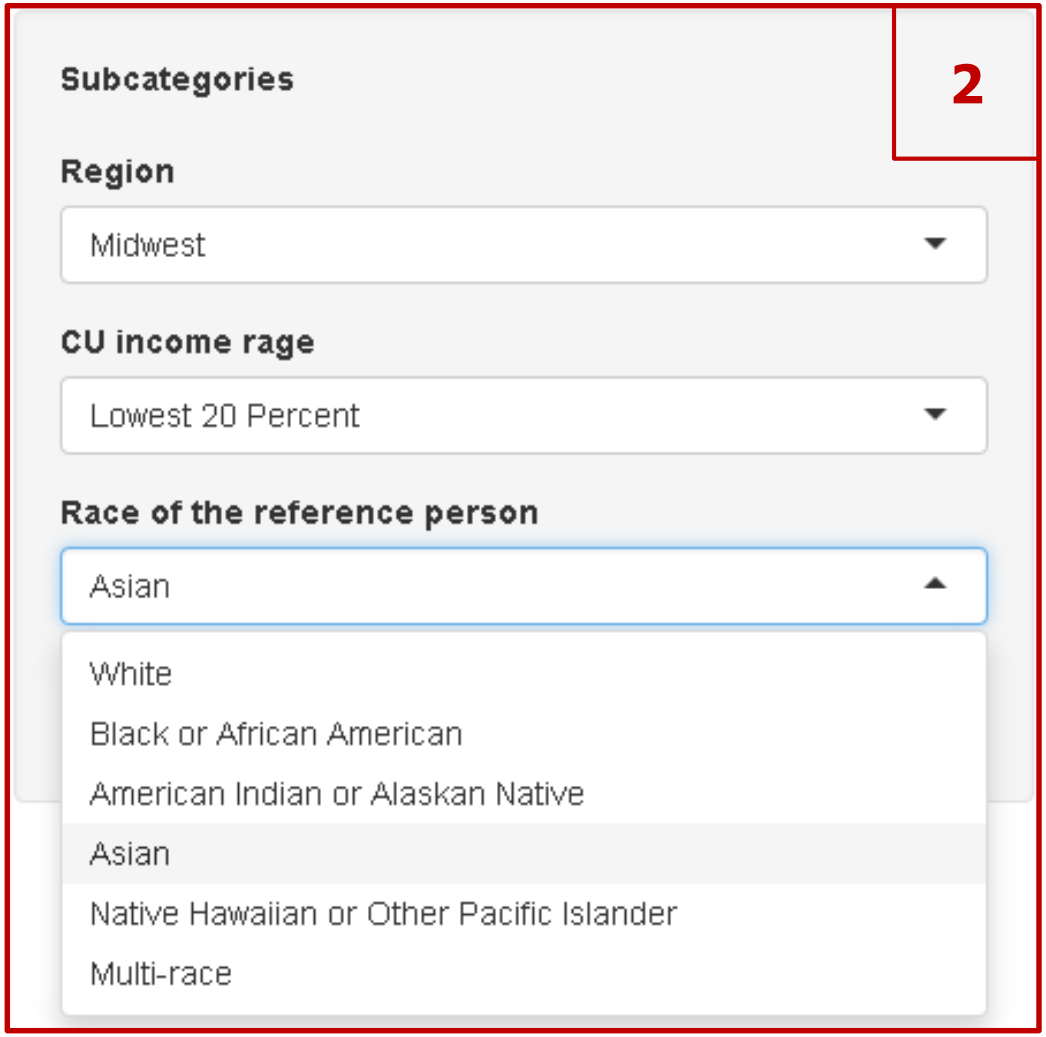
Interactive CE Visualization Tool



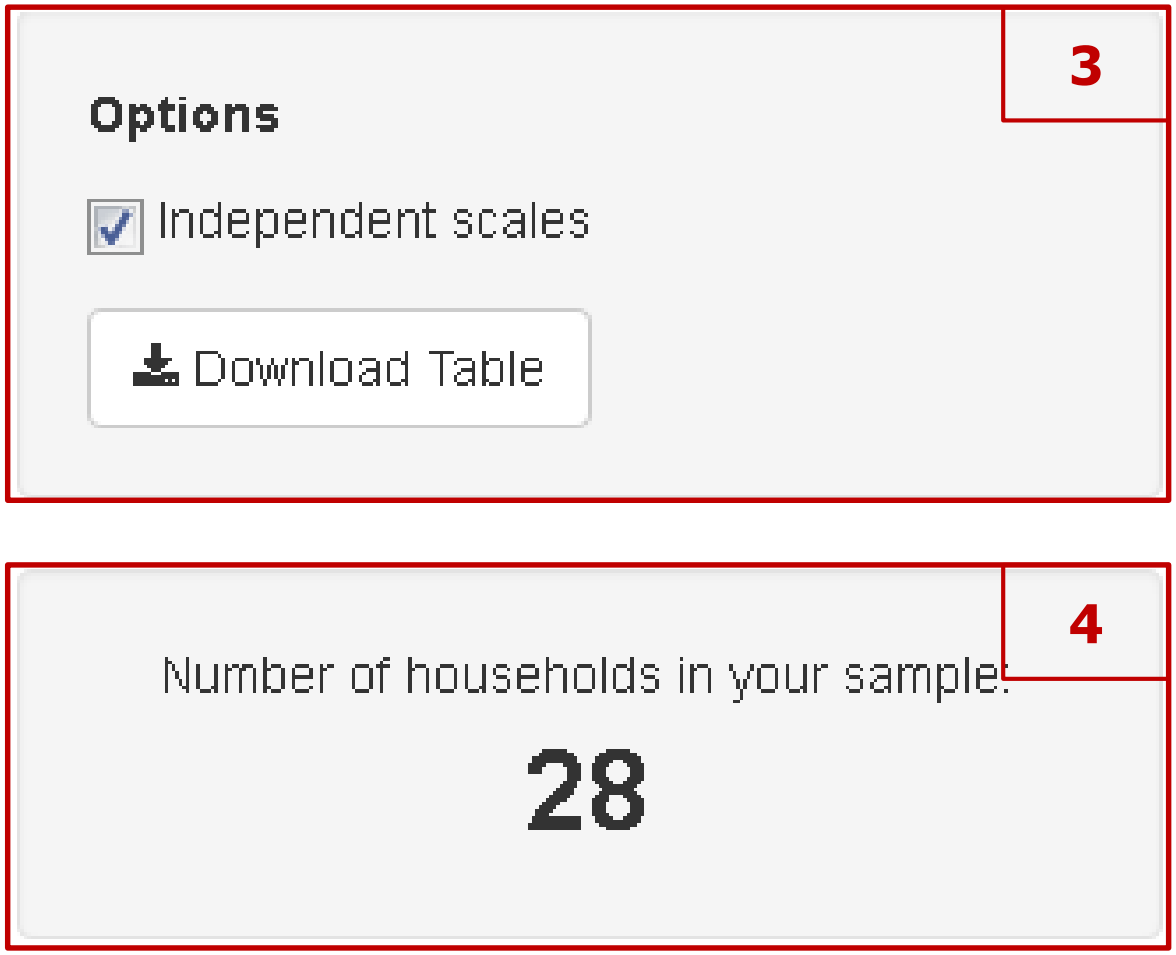
Interactive CE Visualization Tool



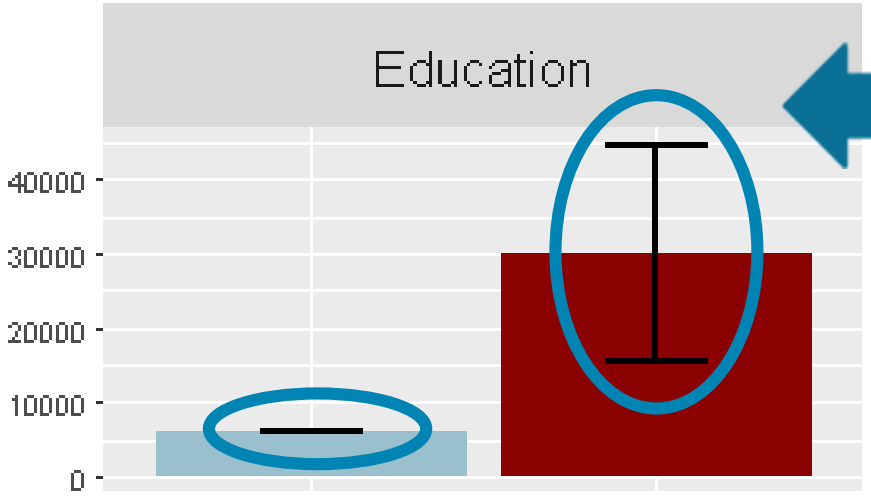
Interactive CE Visualization Tool



Interactive CE Visualization Tool



Interactive CE Visualization Tool



Error Bars

Mean = **$30,040.00**

CV = **24.12%**

Sample Size = **3**

Lower Bound = **$15,548.70**

Upper Bound = **$44,531.30**

Sample	Expenditure	Cost	CV (%)	Lower Bound	Upper Bound	Sample Size
Subset	Education	30040.00	24.12	15548.70	44531.30	3
National	Education	5946.81	0.64	5870.69	6022.93	4024

Benefits to the user

- Accessibility: The user can access the app for **free** as long as they have internet access on a device with a web browser
- Usability: The user operates only the clean, user-friendly UI to get data, results, and visualizations

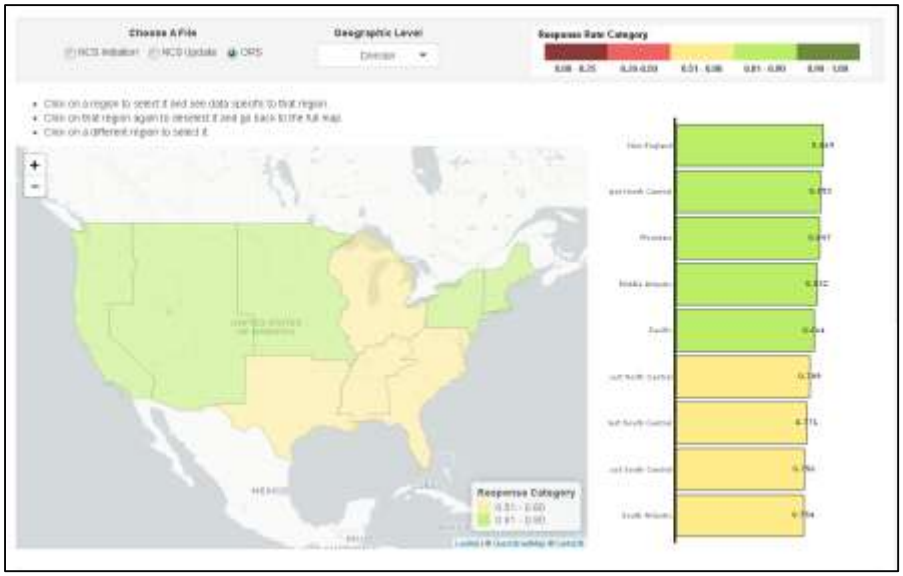
Interactive CE Visualization Tool

- Arcenis Rojas: rojas.arcenis@bls.gov

Real-time Response Rate Tool

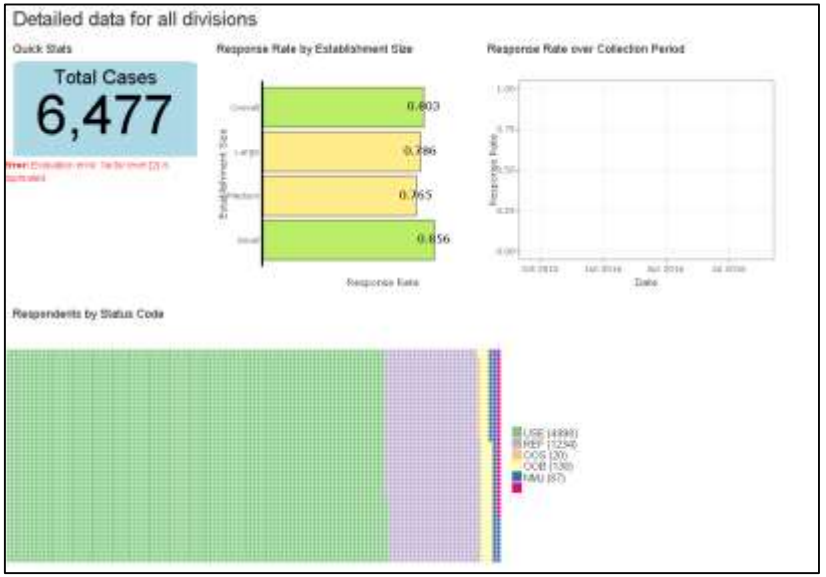
- Office of Compensation and Working Conditions
- Provide real-time response rates to field offices
  - Focus on problem collection areas
  - Improved sample representativity

Real-time Response Rate Tool



Response rates by region and/or establishment size

Detailed summaries for each region



Real-time Response Rate Tool

- Brandon Kopp (OSMR): kopp.brandon@bls.gov
- Randall Powers (OSMR): powers.randall@bls.gov
- Arcenis Rojas (CE): rojas.arcenis@bls.gov

Other Shiny Applications

- Choropleth maps of unemployment data (OSMR)
- Energy Information Administration analyzer (PPI)
- Text analysis Shiny App (Survey Methods)

R Packages

R Packages

- rpms: Recursive Partitioning for Modeling Survey Data package (Survey Methods)
- growfunctions: Bayesian Non-Parametric Dependent Models for Time-Indexed Functional Data package (Survey Methods)

rpms

- Fits a linear model to survey data in each node obtained by recursively partitioning the data.
- Adjusts for complex sample design features used to obtain the data.
- Produces design-consistent coefficients to the least squares linear model between the dependent and independent variables.

rpms

- The main function returns the resulting binary tree with the linear model fit at every end-node.
- Daniell Toth (OSMR): toth.daniell@bls.gov

growfunctions

- Bayesian Non-Parametric Dependent Models for Time-Indexed Functional Data package (Survey Methods)
- Estimates a collection of time-indexed functions under either of Gaussian process (GP) or intrinsic Gaussian Markov random field (iGMRF) prior formulations

growfunctions

- Dirichlet process mixture allows sub-groupings of the functions to share the same covariance or precision parameters
- The GP and iGMRF formulations both support any number of additive covariance or precision terms, respectively, expressing either or both of multiple trend and seasonality.

growfunctions

- Terrance Savitsky (OSMR): savitsky.terrance@bls.gov

Challenges

Challenges

- Data confidentiality
- Need for an R server to make apps/programs public
- Can only put Shiny apps on a webpage via iFrames or setting up an account on a cloud server (i.e., Digital Ocean, R Studio)

Contact Information

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