

What is the Cost of a Human?

Augur Consulting

ICEAA Professional Development & Training Workshop 2023

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Introductions



Obai Kamara

- Sr. Technical Advisor
- BS Physics, MS Business Analytics



Stephen Koellner

- Technical Advisor
- BS Mathematics

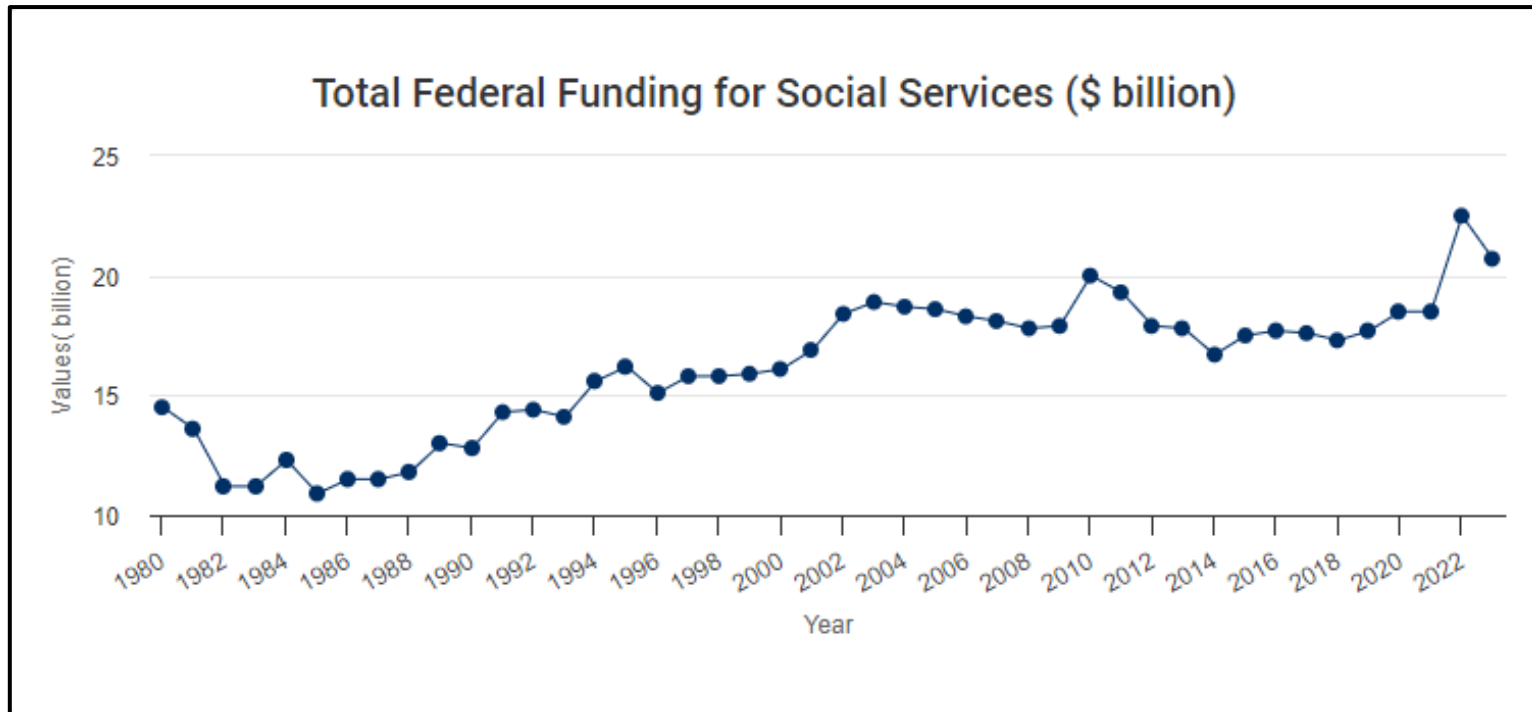


Nick Peeples

- Analyst
- BS Economics



Background – Funding Social Services



Source: <https://www.ibisworld.com/us/bed/federal-funding-for-social-services/4608/>

The U.S Government has funded social welfare for over 87 years. With the impact of COVID-19 causing distress amongst US citizens and federal budget allocations alike, better estimates are required to financially support the most vulnerable populations.

Estimate Purpose & Scope

Purpose

- Forecast social services cost per person in the U.S.
- Identify aspects of U.S. life that drive social services costs
 - Advise federal agencies on future risks that inform budgets
 - Mitigate future spending risks via proactive measures

Scope

- Federal spending on social services starting FY2024 to FY2060
- Only elements of budget classified as social services included

Ground Rules & Assumptions

Ground Rules

- Social services: public services intended to provide support for the disadvantaged
 - Transportation, education, & small businesses excluded from estimate
- Estimate captures forecasted federal costs from FY2024 – FY2060
- Only current US federal agencies/departments accounted for
- Selected agencies are representative of required social services
- Unprecedented events (apocalyptic meteor, World War III, etc.) excluded from projection
 - Cyclical economic downturns, natural disasters, & peacetime included in estimate

Assumptions

- Social services dependent on needs of U.S. population
- Needs of US population determined by the following:
 - Demographics, economic conditions, natural disasters, & other regularly documented metrics
- Historical federal expenditures (2000-2022) sufficient for projecting expenditures
- Historical events (2000-2022) sufficient for projecting future events (and frequency)

Work Breakdown Structure

- Defined social services based on scope of federal agencies
 - 52 total departments → 7 identified as social services (Table 2.1.A)
 - Organized agencies within work breakdown structure by human needs


Table 2.1.A List of Social Services and other Federal Departments/Organizations

Federal Department/Organization	Social Service (Y = Yes, N = No)
Department of Agriculture	Y
Department of Health and Human Services	Y
Department of Housing and Urban Development	Y
Department of Labor	Y
Department of Veterans Affairs	Y
Federal Emergency Management Agency	Y
Social Security Administration	Y

Table 3.A WLC Work Breakdown Structure

WBS #	WBS Element Name	WBS Element Description
1.0	Total Whole Life Cost	<i>Per person federal cost for social services</i>
1.1	Shelter	<i>Per person federal cost for social services pertaining to shelter</i>
1.1.1	Department of Housing and Urban Development	<i>Per person federal cost for Housing and Urban Development</i>
1.1.2	Federal Emergency Management Agency	<i>Per person federal cost for disaster relief and emergency management</i>
1.2	Health and Wellness	<i>Per person federal cost for social services pertaining to health and wellness</i>
1.2.1	Department of Health and Human Services	<i>Per person federal cost for Health and Human Services</i>
1.2.2	Department of Agriculture	<i>Per person federal cost for Department of Agriculture</i>
1.3	Income & Retirement	<i>Per person federal cost for Income Assistance and Retirement</i>
1.3.1	Department of Labor	<i>Per person federal cost for the Department of Labor</i>
1.3.2	Department of Veterans Affairs	<i>Per person federal cost of Veterans Affairs</i>
1.3.3	Social Security Administration	<i>Per person federal cost for Social Security Benefits</i>

Data Gathering Overview



1) Gathered historical
spending data by
year/agency

List of Control Variables

Control Variables	
Variable	Measured Proxy
Age	Age Groups as % of Total Pop.
Natural Disasters	Damages as result of Natural Disasters (\$B)
Number of Veterans	Veteran % of Total Pop.
Unemployment	% of Pop. receiving Unemployment Benefits
Disability	% of Pop. receiving Disability Benefits
Private Insurance	% of Pop. using Private Insurance
Public Insurance	% of Pop. using Public Insurance
Uninsured	% of Pop. Uninsured
GDP	Real GDP per capita
Number of Retired Persons	Number of Retired Persons
Food Assistance	% of Pop. receiving SNAP Benefits
Homeless Population	% of Pop. Homeless
Life Expectancy	Life Expectancy
Inflation	CPI
Fertility	Fertility Rate
Crime	Crime Rate
Poverty	% of Pop. under Poverty Line
Urban/Rural Residential Makeup	% of Pop. living in Urban area

Data Summary: Descriptive Statistics

FY00-FY22 Federal Spending

<i>Total Federal Spending (\$B)</i>	
Mean	7,614.4
Standard Error	610.3
Median	7,321.6
Standard Deviation	2,927.0
Sample Variance	8,567,561.2
Kurtosis	1.9
Skewness	1.0
Minimum	2,000.4
Maximum	14,825.0
Count	23.0

<i>Social Services Total (\$B)</i>	
Mean	4,302.4
Standard Error	359.7
Median	4,446.9
Standard Deviation	1,725.2
Sample Variance	2,976,360.0
Kurtosis	0.6
Skewness	0.6
Minimum	1,046.2
Maximum	8,392.3
Count	23.0

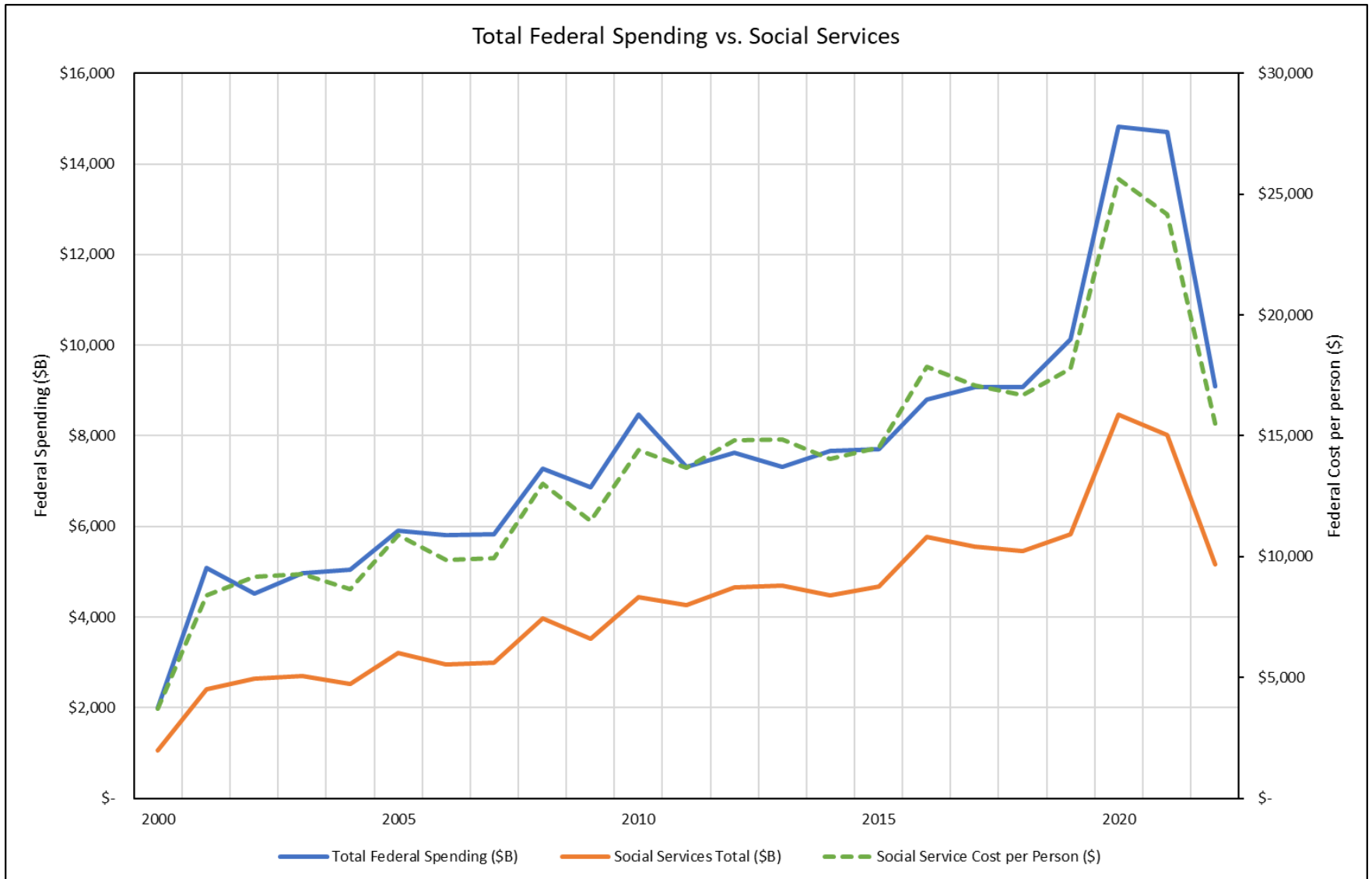
Historical Population (2000-2022)

<i>US Population</i>	
Mean	310,166,122
Standard Error	3,384,688
Median	311,591,919
Standard Deviation	16,232,395
Kurtosis	-1
Skewness	0
Range	51,125,146
Minimum	282,162,411
Maximum	333,287,557
Count	23

Projected Population (2024-2060)

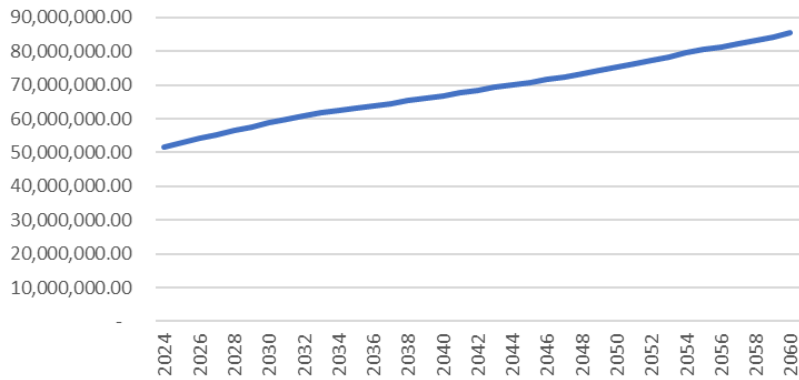
<i>US Population</i>	
Mean	375,438,382
Standard Error	3,009,575
Median	376,746,115
Standard Deviation	18,306,529
Sample Variance	3.E+14
Kurtosis	-1
Skewness	0
Minimum	341,963,408
Maximum	404,483,055
Count	37

Data Summary: Federal Spending



Projection Data: Example of Rationale for Internally Created Data

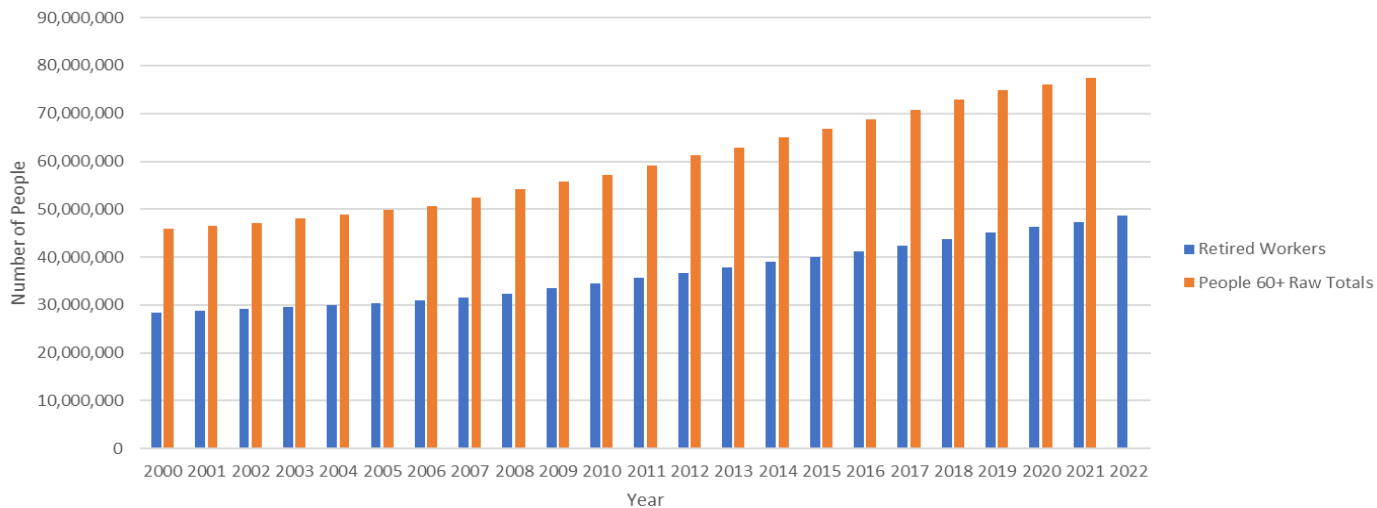
Chart 2 Retired Persons Collecting Social Security Projections



Methodology

- Average: 61% of Population over 60 collected Social Security
 - See Chart 1
- Projected number of people over 60 → multiplied by 0.61
 - See Chart 2

Chart 1 Retired Workers (People Collecting Social Security) vs. Total of People over 60



Exploratory Data Analysis and Normalization

I. Correlation Matrix	HUD Spending \$B	DOL Spending \$B	SS Spending \$B	US Population	Age 0 - 19	Age 20 - 39	Age 40 - 59
HUD Spending (\$B)	1.0000	-0.0222	0.0372	0.1181	-0.1467	-0.4721	0.4959
DOL Spending (\$B)	-0.0222	1.0000	0.7025	0.4427	-0.4125	-0.2556	-0.3410
SS Spending (\$B)	0.0372	0.7025	1.0000	0.9243	-0.9079	-0.6309	-0.6409
US Population	0.1181	0.4427	0.9243	1.0000	-0.9705	-0.7418	-0.6127
Age 0 19	-0.1467	-0.4125	-0.9079	-0.9705	1.0000	0.6621	0.6599
Age 20 39	-0.4721	-0.2556	-0.6309	-0.7418	0.6621	1.0000	0.0176
Age 40 59	0.4959	-0.3410	-0.6409	-0.6127	0.6599	0.0176	1.0000
Age 60 79	-0.0617	0.4648	0.9150	0.9600	-0.9574	-0.5514	-0.7869
Age 80 Up	0.3977	0.2790	0.6606	0.8037	-0.7450	-0.8228	-0.1917
National Disaster Damages (\$B)	0.3924	0.1308	0.3530	0.3317	-0.3661	-0.2916	-0.1926
Avg Vet%	-0.1378	-0.4725	-0.9301	-0.9942	0.9675	0.7616	0.5986

**Note: Partial correlation matrix shown for demonstration purposes. Does not include all evaluated variables*

- Summarized data using descriptive statistics
 - Identified variable with missing data
- Normalized independent variables to standard values
 - \$Billions, percent, per person, per capita, etc.
- Analyzed correlation between variables & spending
 - Identified variables with strongest relationship to spending
 - Consolidated correlated variables to reduce multicollinearity

Estimating Methodology & Approach

- Ordinary Least Squares linear regression model

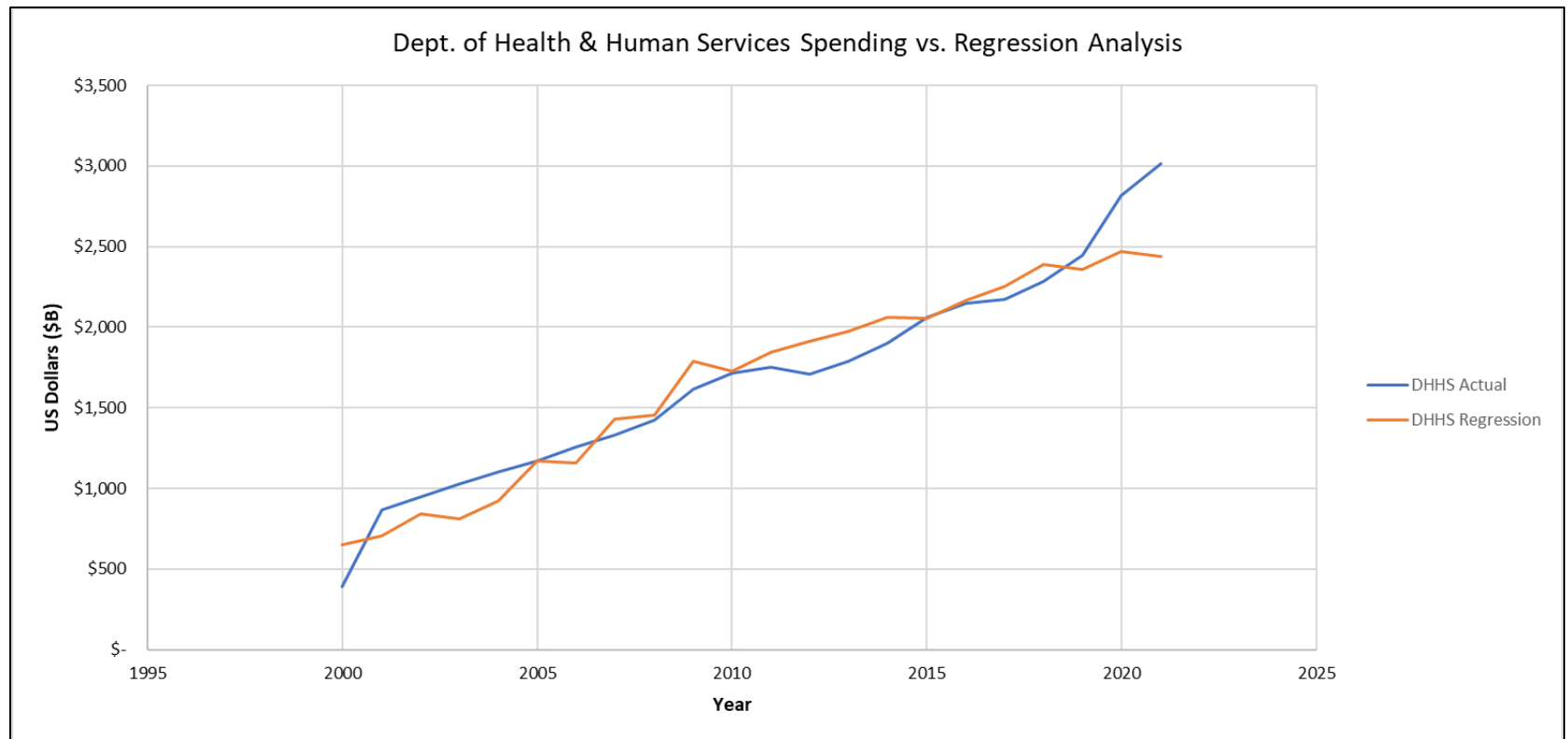
$$y_n = \sum_{i=0}^k \beta_i x_{ni} + \epsilon_n$$

Variable Definitions

- Y_n = the total social service spending (WLC)
- β_i = the relationship between population and cost
- $X_{1i,2i,\dots,ni}$ = control variables (demographics, economic conditions, etc.)
- ϵ = residual term capturing the difference between the observed data and the sample population data*

*residual term \rightarrow estimate of true error term

Regression Analysis



- Performed regression on influential control variables
 - Derived equations to use for cost projections
 - Standard error used to inform uncertainty bounds of forecasts
- Compared results against historic data

Whole Life Cost (WLC) Model

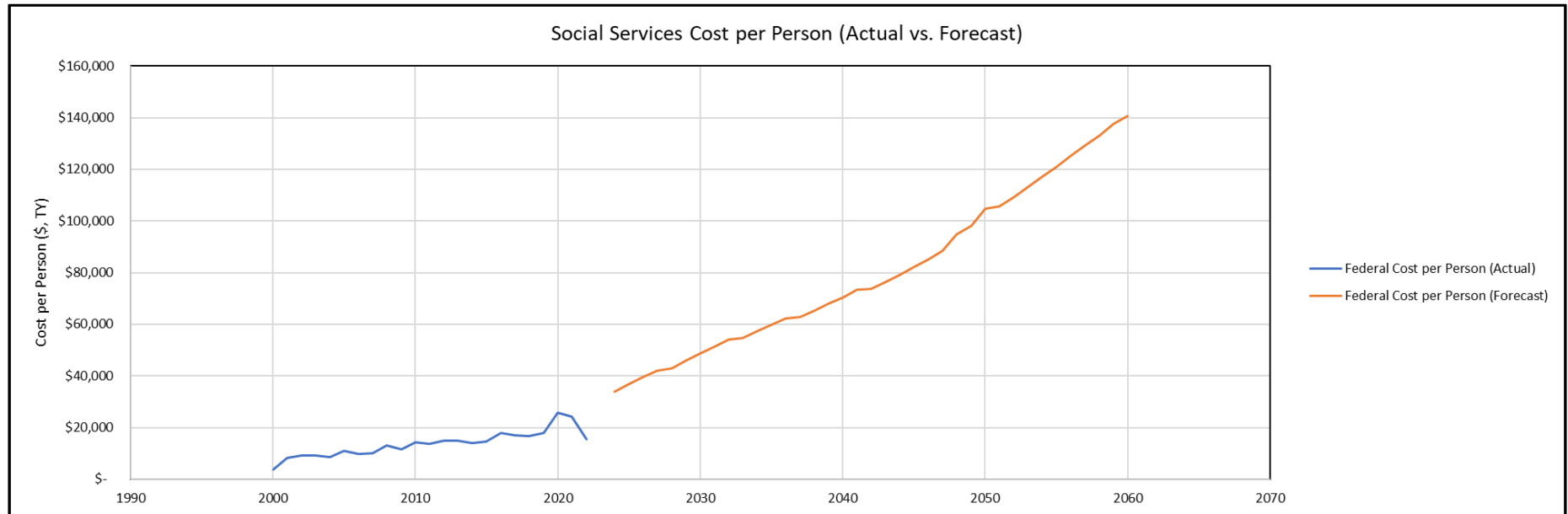
Row	WBS/CES Description	Approp	Uniqu ID	Point Estimate	Phasing Method	Equation / Throughput	Fiscal Year	Units	Start Date	Finish Date	Calcul Time P
	Summary Sections										
	WBS										
2	Total Whole Life Cost per Person			08,566.092							
3	Shelter			64,712.907							
4	Department of Housing and Urban Development	CPI		43,962.145	F	HUD_Cost\$(Age_40_59%,Life_Expectancy)/US_PoP	2023	\$B	Start_Date	EOL	
5	Federal Emergency Management Agency	CPI		20,750.761	F	Disability_Award%, GDP_per_Capita, Retired_Coll_SS_Qty)/US_PoP	2023	\$B	Start_Date	EOL	
6	Health and Wellness			48,763.210							
7	Department of Health and Human Services	CPI		09,349.210	F	DHHS_Cost\$(Unemployed%, Poverty%, Urban_Pop%)/US_PoP	2023	\$B	Start_Date	EOL	
8	Department of Agriculture	CPI		58,112.420	F	Retired_Coll_SS_Qty, CPI, Healthcare_Spend\$, Urban_Pop%)/US_PoP	2023	\$B	Start_Date	EOL	
9	Income & Retirement			24,515.789							
10	Department of Labor	CPI		55,756.772	F	DOL_Cost\$(Age_60_79%, Unemployed%)/US_PoP	2023	\$B	Start_Date	EOL	
11	Department of Veterans Affairs	CPI		75,724.289	F	Vet%, Unemployed%, Retired_Coll_SS_Qty, CPI, Poverty%)/US_PoP	2023	\$B	Start_Date	EOL	
12	Social Security Administration	CPI		06,965.273	F	DP_per_Capita, Retired_Coll_SS_Qty, Life_Expectancy, CPI)/US_PoP	2023	\$B	Start_Date	EOL	
13											
14											

- Independent variables projected based on academic research
 - Projections estimated using regression or timeseries forecast if prior studies were unavailable
- Regressions modeled in ACE to develop WLC point estimate
 - Input variable projections used in regressions to forecast future departmental spending
 - Probability distributions assigned to account for uncertainty

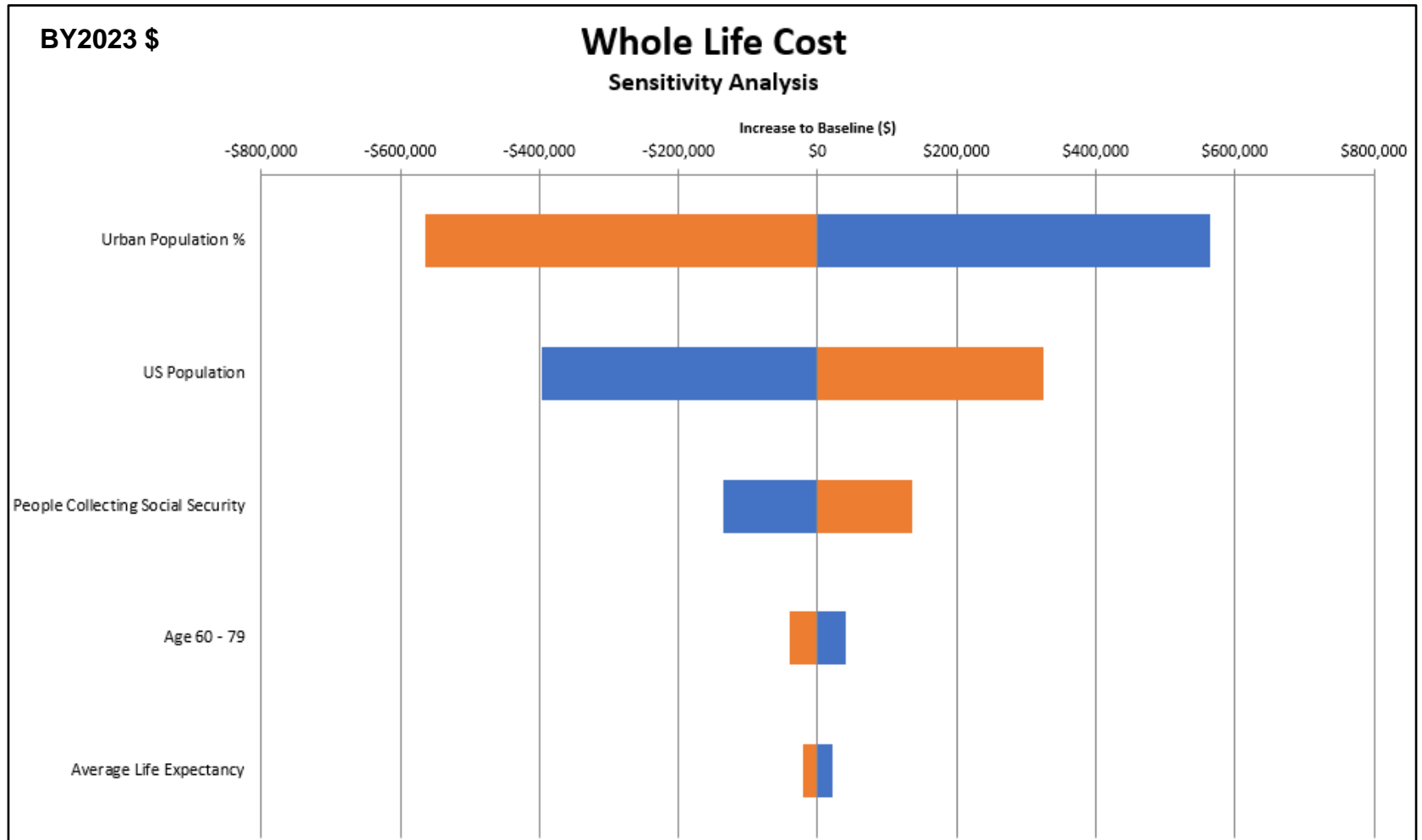
Conclusion & Supporting Rationale

Table 8.1.C Phased WBS Output BY23, \$

WBS #	WBS Element Name	FY24	FY25	FY26	...	FY58	FY59	FY60	Avg. (FY24 - FY60)
1.0	Total Whole Life Cost	\$ 42,880	\$ 44,231	\$ 45,272	...	\$ 60,853	\$ 61,676	\$ 61,979	\$ 51,168
1.1	Shelter	\$ 2,120	\$ 2,127	\$ 2,127	...	\$ 2,121	\$ 2,127	\$ 2,119	\$ 2,049
1.1.1	Department of Housing and Urban Development	\$ 1,782	\$ 1,791	\$ 1,792	...	\$ 1,736	\$ 1,743	\$ 1,733	\$ 1,701
1.1.2	Federal Emergency Management Agency	\$ 337	\$ 336	\$ 335	...	\$ 385	\$ 385	\$ 387	\$ 348
1.2	Health and Wellness	\$ 6,968	\$ 7,548	\$ 8,061	...	\$ 14,221	\$ 14,525	\$ 14,526	\$ 9,943
1.2.1	Department of Health and Human Services	\$ 6,452	\$ 6,946	\$ 7,381	...	\$ 12,606	\$ 12,861	\$ 12,838	\$ 8,992
1.2.2	Department of Agriculture	\$ 516	\$ 602	\$ 680	...	\$ 1,616	\$ 1,664	\$ 1,689	\$ 951
1.3	Income & Retirement	\$ 33,792	\$ 34,556	\$ 35,084	...	\$ 44,510	\$ 45,024	\$ 45,333	\$ 39,175
1.3.1	Department of Labor	\$ 110	\$ 128	\$ 143	...	\$ 405	\$ 416	\$ 426	\$ 253
1.3.2	Department of Veterans Affairs	\$ 4,012	\$ 4,125	\$ 4,235	...	\$ 6,546	\$ 6,605	\$ 6,605	\$ 5,495
1.3.3	Social Security Administration	\$ 29,670	\$ 30,303	\$ 30,706	...	\$ 37,559	\$ 38,003	\$ 38,302	\$ 33,428

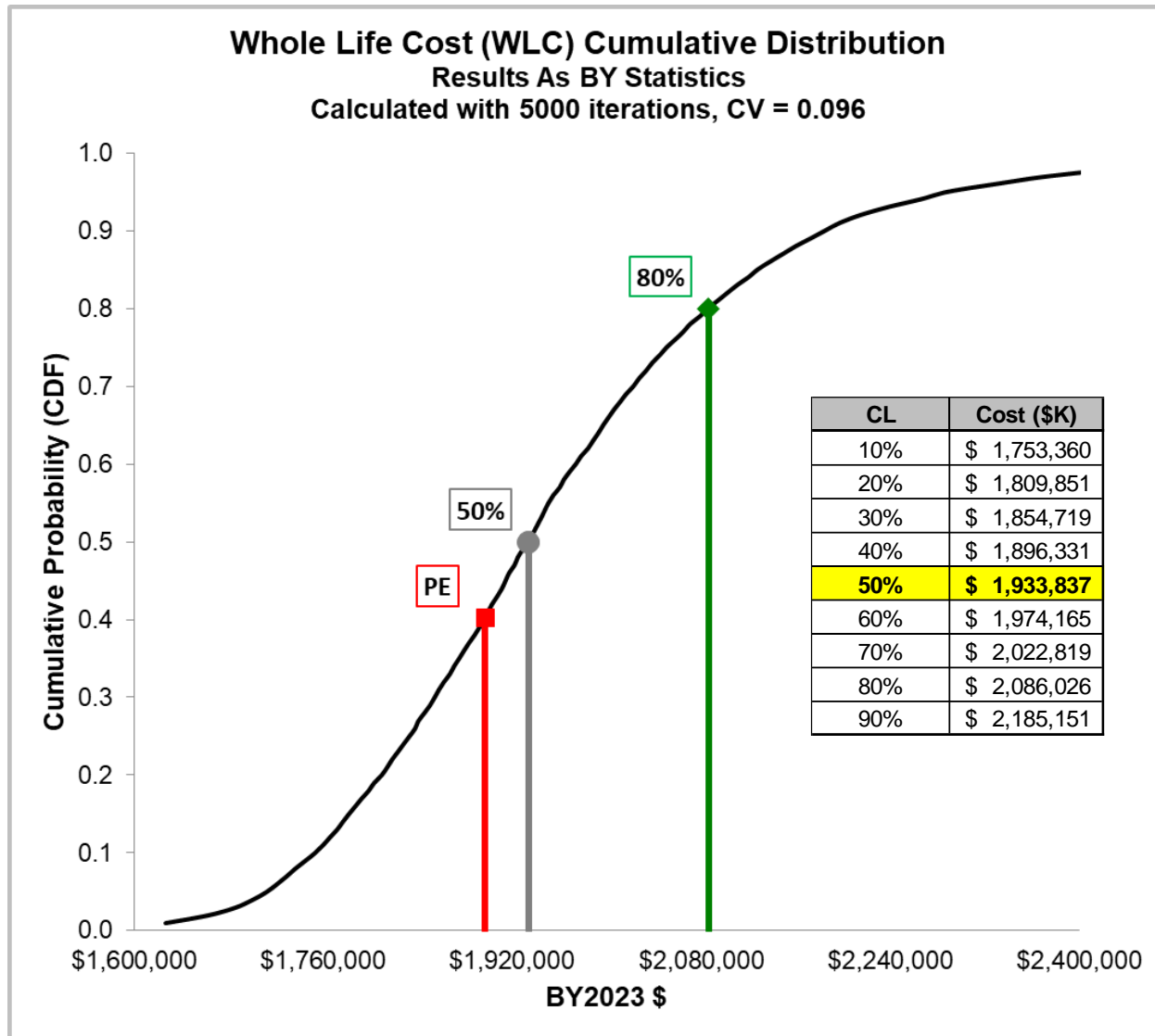


Whole Life Cost Sensitivity Analysis



110% of PE	Orange
90% of PE	Blue

Uncertainty Analysis: WLC Cumulative Distribution



Lessons Learned

Analysis Lessons Learned:

- **Each human in the US expected to cost \$51K/yr. in social services on average**
 - Increasing % population in urban environments may counter cost growth
- **Social Security costs continue to increase/majority makeup**
 - Aligns with historical data and projected population demographics
 - Growth will continue to be a challenge for future federal budgets
- **Department of Health & Human Services costs will be turbulent**
 - Generally, increases over time
 - 2nd largest portion of projected social services costs

ICEAA Challenge Lessons Learned:

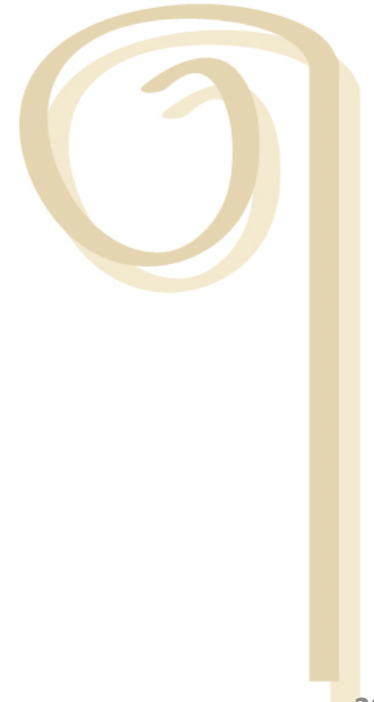
- Data/Time Constraints
- Statistically Significant Results
- Potential Improvements to Analysis
 - Further multicollinearity sensitivity analysis
 - Broaden scope to include quantifying public goods

Questions?



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- Nick Peeples
 - npeeples@augurconsulting.net



References and Guidance

Data

- Federal Spending: Treasury Department Database & Department of Agriculture Database
 - Source: <https://fiscaldata.treasury.gov/datasets/u-s-government-financial-report/statements-of-net-cost>
 - Source : <https://www.usda.gov/sites/default/files/documents/2022-budget-summary.pdf>
- Population: Census
 - Source: <https://catalog.data.gov/dataset?q=&sort=score+desc%2C+name+asc&bureauCode=006%3A07>
- Control Variables and Projection Data
 - See Workbook sheet titled “5- Input Data & Analysis” (Table 5.B and Table 5.C)

Backup

