Socioeconomic Expressions of Energy Poverty

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Background

Do you turn off appliances when not in use?

Do you wear layers indoors instead of using heat?

Do you use a cold rag when it's hot out instead of turning on the AC?

Research Questions

- How do poverty status in 2020 and other socioeconomic factors impact people's ability to manage their energy consumption and, consequently, their health?
- Does energy poverty status relate to demographics such as race and income status?
- Do respondents require medical attention due to extreme heat or extreme cold in their homes?

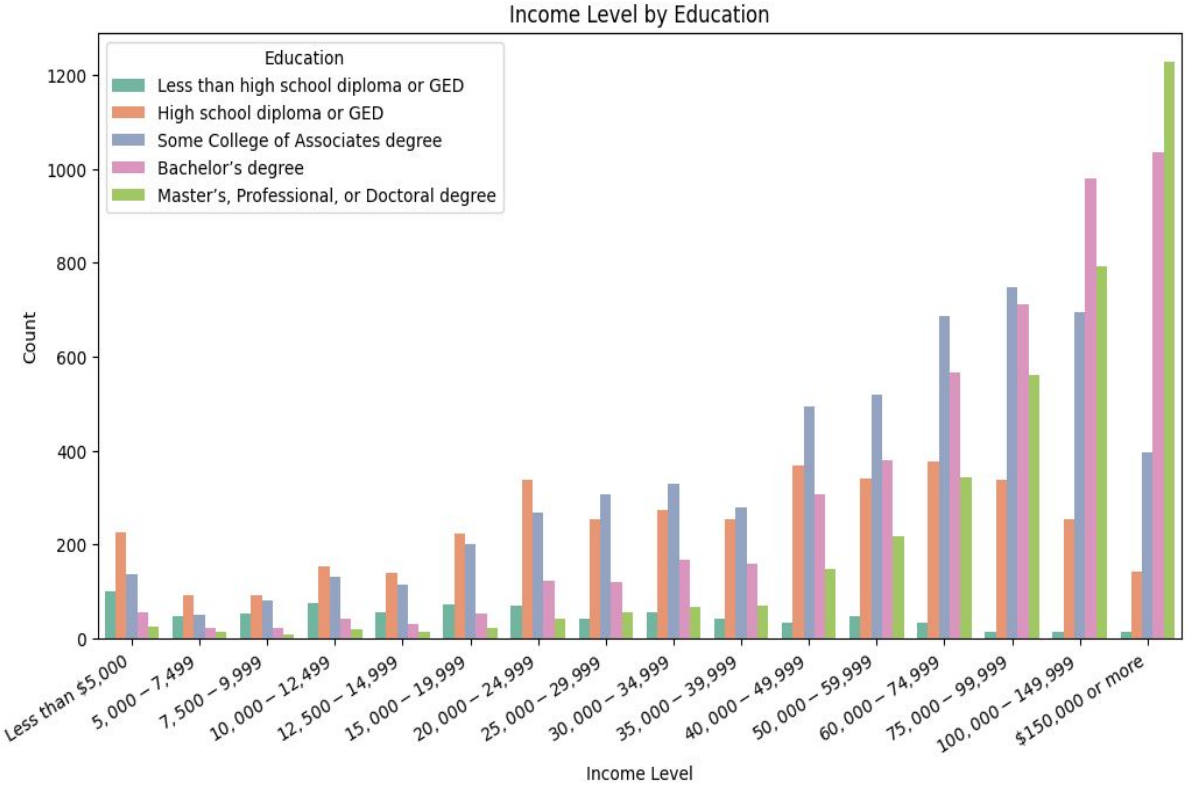
Literature

- Li et al. (2021):
  - Studied the relationship between energy poverty and energy efficiency; discovered that energy poverty reduces GDP
  - Over time, results in sharp declines in a nation's social welfare and low-income families are typically the ones who are directly affected
- Halkos and Gkampoura (2021):
  - Energy poverty was linked to energy prices, unemployment, and the number of persons at risk of poverty
  - GDP is inversely associated to energy poverty, which supports the findings of Li et al. (2021)
- Recalde et al. (2019):
  - Introduced Structural Energy Poverty Vulnerability (SEPV) index
  - Countries with lower SEPV scores experienced significantly higher rates of energy poverty and increased risk of excess winter mortality
- Pan, Biru, and Lettu (2021):
  - Energy poverty has a harmful impact on public health
  - Higher living standards lessen the effects

Data Overview

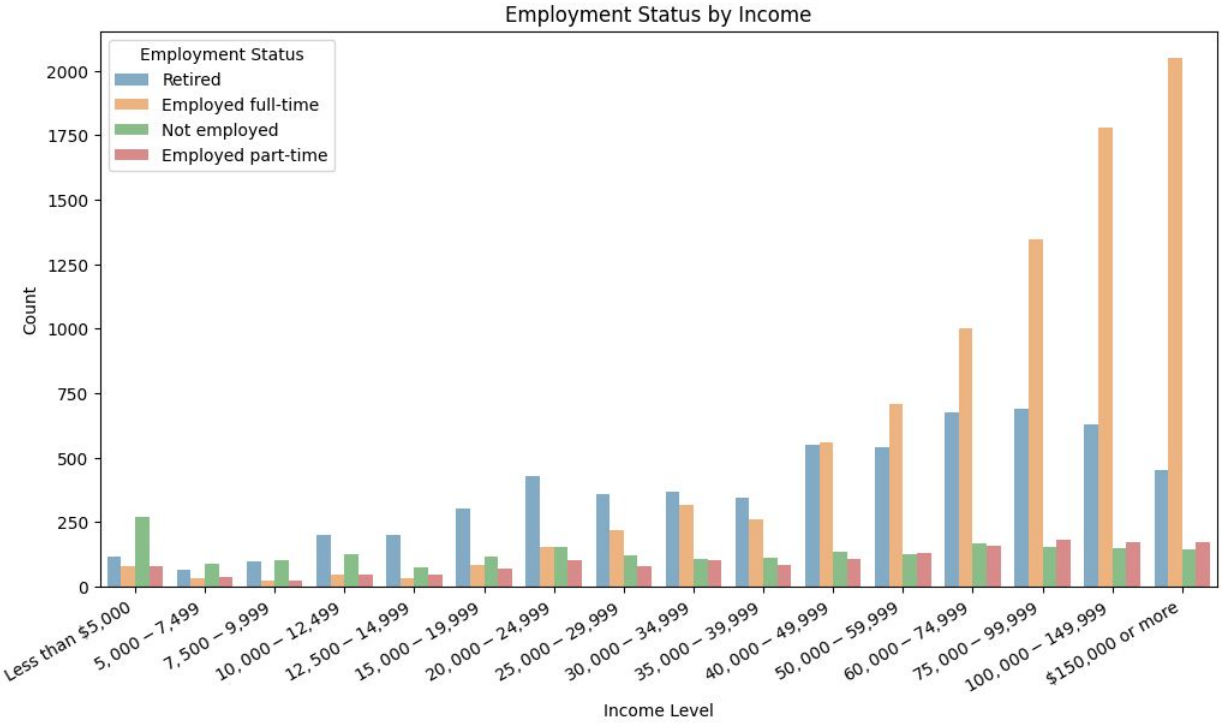
- US Energy Information Administration's (EIA)
- Residential Energy Consumption Survey (RECS)
  - Survey conducted every 5 years
  - 700 variables
  - ~18,500 households surveyed
  - 2020 Survey

Exploratory Data Analysis



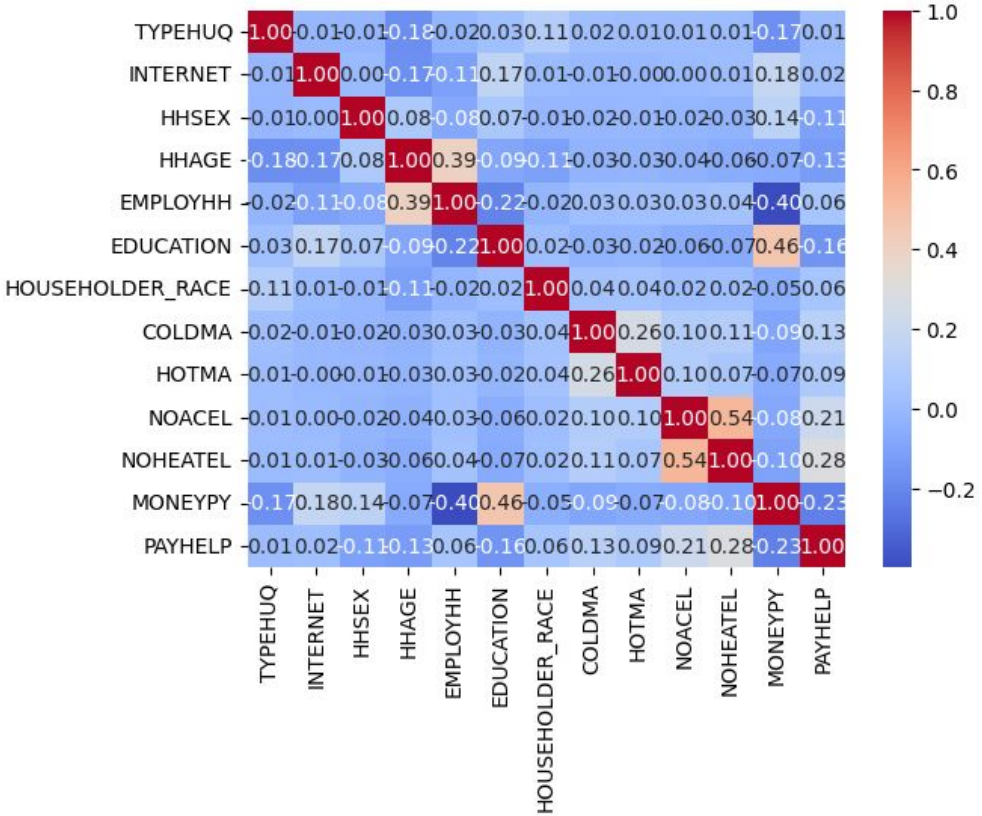
- The plot shows the correlation between education and income.
    a. Higher incomes correlated with advanced degrees.
    b. “$100,000 - $149,999”; “$150,000 or more,” are strongly correlated with “Bachelor’s,” “Master’s,” or “Doctoral” degrees.

Exploratory Data Analysis: cont.



- The plot between employment status and income.
    a. Higher incomes correlated with full-time employment.
    b. Upper incomes are strongly correlated with “Employed Full Time” and “Retired” statuses.

Correlation Matrix



Random Forest

Payhelp = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + 'TYPEHUQ' + 'INTERNET' + 'HHSEX' + 'HHAGE' + 'EMPLOYHH' + 'COLDMA' + 'HOTMA +, 'NOACEL' + 'NOHEATEL' + ϵ

Accuracy 88.78%

[[**3258**, FP: **95**, FP: **14**],

[FN: **204**, **23**, FP: **13**],

[FN: **71**, FN: **18**, **4**]]

Logistic Regression

Table 6: Results: Generalized linear model

Model:	GLM	AIC:	1672.1472
Link Function:	Logit	BIC:	-10272.9646
Dependent Variable:	['PAYHELP[No]', 'PAYHELP[Yes]']	Log-Likelihood:	-817.07
Date:	2023-12-07 21:18	LL-Null:	-910.23
No. Observations:	1629	Deviance:	1634.1
Df Model:	18	Pearson chi2:	1.61e+03
Df Residuals:	1610	Scale:	1.0000
Method:	IRLS		

	Coef.	Std.Err.	z	P> |z|	[0.025	0.975]
Intercept	-0.2442	0.3090	-0.7904	0.4293	-0.8498	0.3614
(MONEYPY)[Less than $5,000]	0.2766	0.2766	1.0001	0.3173	-0.2655	0.8186
(MONEYPY)[$5,000 - $7,499]	0.2048	0.3678	0.5569	0.5776	-0.5161	0.9258
(MONEYPY)[$7,500 - $9,999]	-0.5109	0.3700	-1.3808	0.1673	-1.2361	0.2143
(MONEYPY)[$12,500 - $14,999]	0.3755	0.3321	1.1304	0.2583	-0.2755	1.0264
(MONEYPY)[$15,000 - $19,999]	0.5219	0.3166	1.6482	0.0993	-0.0987	1.1425
(MONEYPY)[$20,000 - $24,999]	0.8487	0.3014	2.8155	0.0049	0.2579	1.4394
(MONEYPY)[$25,000 - $29,999]	1.0136	0.3057	3.3156	0.0009	0.4144	1.6128
(MONEYPY)[$30,000 - $34,999]	0.7587	0.3039	2.4967	0.0125	0.1631	1.3543
(MONEYPY)[$35,000 - $39,999]	1.1165	0.3189	3.5017	0.0005	0.4916	1.7415
(MONEYPY)[$40,000 - $49,999]	1.3453	0.3013	4.4650	0.0000	0.7548	1.9359
(MONEYPY)[$50,000 - $59,999]	1.6126	0.3134	5.1458	0.0000	0.9984	2.2268
(MONEYPY)[$60,000 - $74,999]	1.9722	0.3358	5.8731	0.0000	1.3140	2.6303
(MONEYPY)[$75,000 - $99,999]	2.5634	0.4249	6.0332	0.0000	1.7306	3.3961
(MONEYPY)[$100,000 - $149,999]	2.9280	0.5558	5.2682	0.0000	1.8387	4.0174
(MONEYPY)[$150,000 or more]	2.0196	0.5694	3.5471	0.0004	0.9036	3.1355
(HOTMA)[Yes]	0.2156	0.4007	0.5379	0.5906	-0.5698	1.0009
(COLDMA)[Yes]	-0.8172	0.2914	-2.8048	0.0050	-1.3882	-0.2461
HHAGE	0.0082	0.0042	1.9796	0.0477	0.0001	0.0164

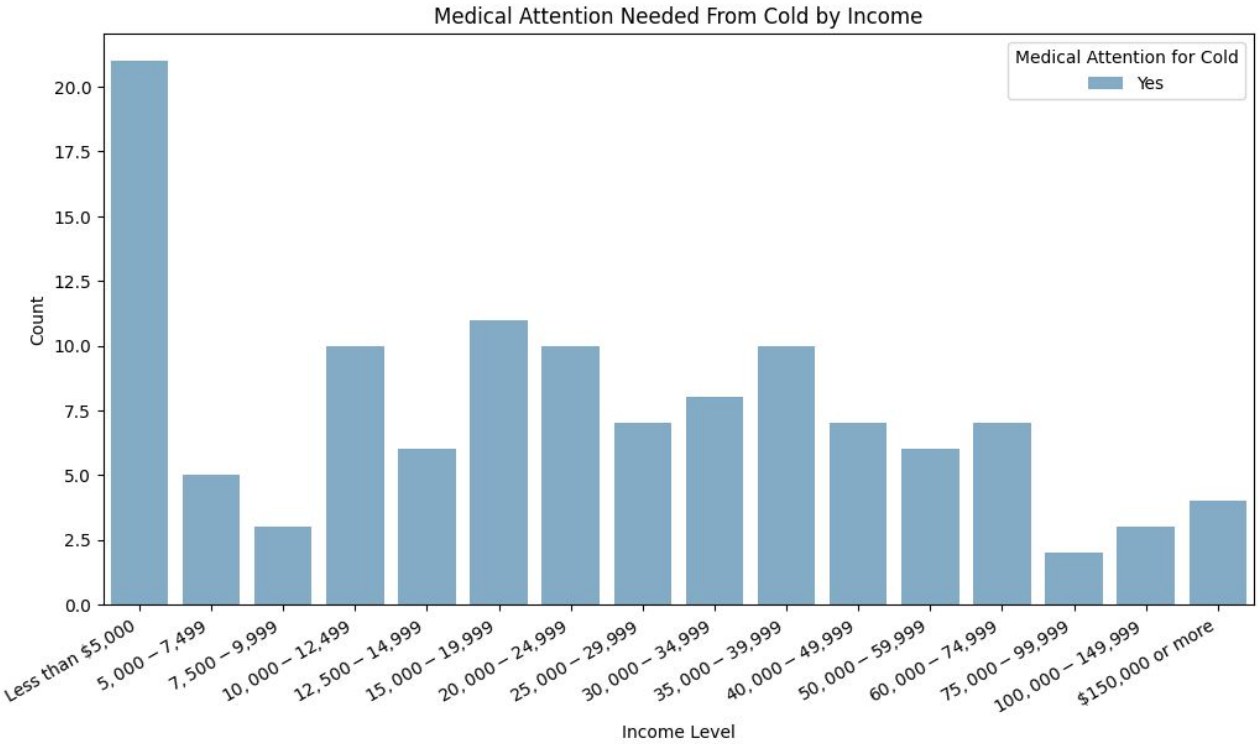
Not Large Enough

168% - 275% for "Yes"

305% - 1869% for "No"

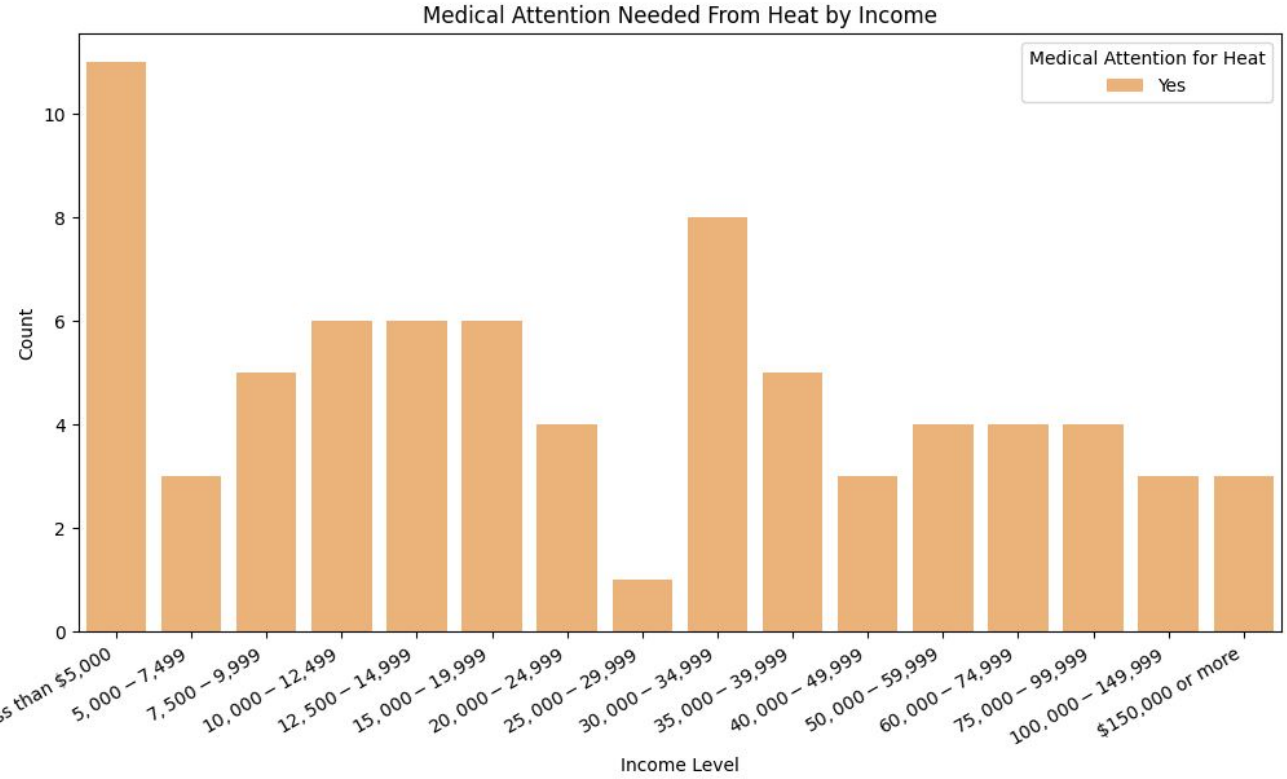
44%

Chi-Square Tests



Chi-squared statistic: 111.83 **Degrees of freedom:** 15 **P-value:** 7.16e-17

Chi-Square Tests



Chi-squared statistic: 185.85; **Degrees of freedom:** 15; **P-value:** 1.56e-31

Other Tests We Tried (but did not use)

Initial Linear Regression:

'COLDMA' = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + ϵ

Multi-Linear Regression:

'COLDMA' = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + 'NOACEL' + 'NOHEATEL' + 'HHAGE' + 'PAYHELP' + ϵ

Logistical:

'COLDMA' = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + 'NOACEL' + ϵ

'HOTMA' = α + 'EDUCATION' + 'HOUSEHOLDER_RACE' + 'NOACEL' + 'MONEYPY' + ϵ

SVM:

'PAYHELP' = α + 'MONEYPY' + 'EDUCATION' + 'EMPLOYHH' + 'TYPEHUQ' + 'NOACEL' + 'NOHEATEL + ϵ

Conclusion

- Lower incomes have higher rates of energy poverty.
- COLDMA has a stronger influence overall than HOTMA.
- This could be due to lower costs and easier access to cooling measures than the various fuels needed for heating.
- Our findings reflect conclusions from the existing literature.

Limitations and Future Steps

- Time series data (panel data)
- Examine COVID-19 effects in the RECS survey
- State or county level could be different

Thank You

References

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