Waipapa Taumata Rau
University of Auckland

ACE2025

The "She-Power" in the Household: The Managerial Advantage of Women in China's Energy Poverty and Its Boundary

09 July 2025

Fangyuan Liu

1. Introduction

1.1 Background

Energy is central to human development, yet energy poverty remains a critical global challenge(Pachauri & Spreng, 2004; Sovacool, 2012).

Women often bear the brunt of energy poverty due to traditional gender roles (e.g., cooking, heating, household management), leading to time poverty and health risks (Cecelski, 2000; World Health Organization, 2018).Meanwhile, females are more proficient at managing household expenditures and burning fuel efficiently than males (Koomson et al., 2023).

In the context of China's rapid economic growth and ambitious carbon neutrality goals, understanding the micro-level dynamics of energy access is crucial(Zhang et al., 2019; Sun & Li, 2023).

1. Introduction

1.2 Motivation

Rising Social Status of Women in China

Topics related to women's rights and gender equality have attracted increasing public and policy attention in recent years. In recent years, as the status of women in China has risen, the emergence of the localized term "She-power" (她力量) reflects a societal focus on female agency.

Alignment with the United Nations Sustainable Development Goals (SDGs)

This research focuses on gender equality (SDG 5) and affordable and clean energy (SDG 7).

Practical Significance

Studying women's energy poverty can promote fair and inclusive energy policies, ultimately contributing to overall social well-being.

1. Introduction

1.3 Research Gap

Most studies focus on general household energy poverty, often ignoring the importance of women in household management, especially when women are the **financial managers** of their families.

Therefore, it is necessary to analyze gender-based energy poverty at the micro household level in China

1.4 Research Questions

Q1: Does the gender of a household's financial manager significantly affect the household's level of energy poverty in China?

Q2: What factors may amplify or mitigate this difference?

2. Theoretical Framework & Hypotheses

Builds on the "Prudent Housekeeper" hypothesis and literature on gender, risk preferences, and household decision-making.

H1: Households managed by women are less likely to experience energy poverty ("managerial dividend")

H2: Family care burden diminish the female managerial advantage (the “double burden”)

H3: Educational attainment amplifies the female managerial advantage (“empowerment effect”)

3. Data & Variables

3.1 Data source

China Family Panel Studies (CFPS), 2014,2016,2018,2020,2022

National Bureau of Statistics of China,China Electric Power Statistical Yearbook,China Electricity Council (CEC),WIND Database,EPS Database,China Meteorological Yearbook

3.2 Variables

Dependent variable

EPI (Energy Poverty Index)

Main independent variable

Female (gender of financial respondent, proxy for household manager)

Controls Variables

Individual Level: age, weekly working hours, annual personal income,annual personal income,life satisfaction,marital status,highest education level,Self-rated health

Household Level: Urban/rural classification, per capita household income, household size, children, elderly

Provincial Level: Per capita GDP, residential electricity price,average minimum temperature, average maximum temperature, Average years of education for females in the region, urbanization rate, share of clean energy

3. Variables & Data

3.3 Calculation of the Energy Poverty Index (EPI)

Energy Access		Energy Affordability		
X1	X2	X3	X4	X5
Electricity Access (proxied by electricity expenditure)	Cleaner fuel use	Energy expenditures as a percentage of income	Whether above the poverty line	Household energy expenditures

Entropy Method

Key Steps

1.Normalize the original data for each indicator
2.Calculate the entropy value for each indicator, reflecting its dispersion
3.Compute the degree of diversification (information utility) for each indicator
4.Assign weights to indicators: greater variation= higher weight
5.Compute the composite index as a weighted sum of all indicators

3. Variables & Data

3.4 Descriptive Statistics

Table 1. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
EPI(%)	53979	15.33	22.388	0	99.695
female	53979	0.47	0.499	0	1
age	53979	49.964	14.643	16	95
wtweely	53979	28.41	28.36	0	168
pincome	53979	16545.874	33751.461	0	1000000
lifesat	53978	3.817	1.021	0	5
marital	53979	2.21	0.879	1	5
edu_level	53979	2.033	1.725	0	8
health	53979	2.906	1.2	1	5
urbantype	53979	0.521	0.5	0	1
pfincome	53979	28674.452	78950.474	0	6886000
child	53979	0.747	0.435	0	1
elderly	53979	0.111	0.314	0	1
pcgdp	53979	59834.462	30193.837	25101	189988
elepriresi	53979	555.935	58.371	404	729.12
urbanrate	53979	0.609	0.12	0.315	0.893
cleanenergyshare	53979	0.239	0.234	0.01	0.982
mintemp	53979	-11.282	9.59	-34.6	11.5
maxtemp	53979	38.681	20.301	26.2	344
yfemedu	53979	8.917	0.831	4.539	11.999

3. Variables & Data

3.5 GIS Visualization

Fig 1. Mean Female EPI across Chinese provinces in 2022

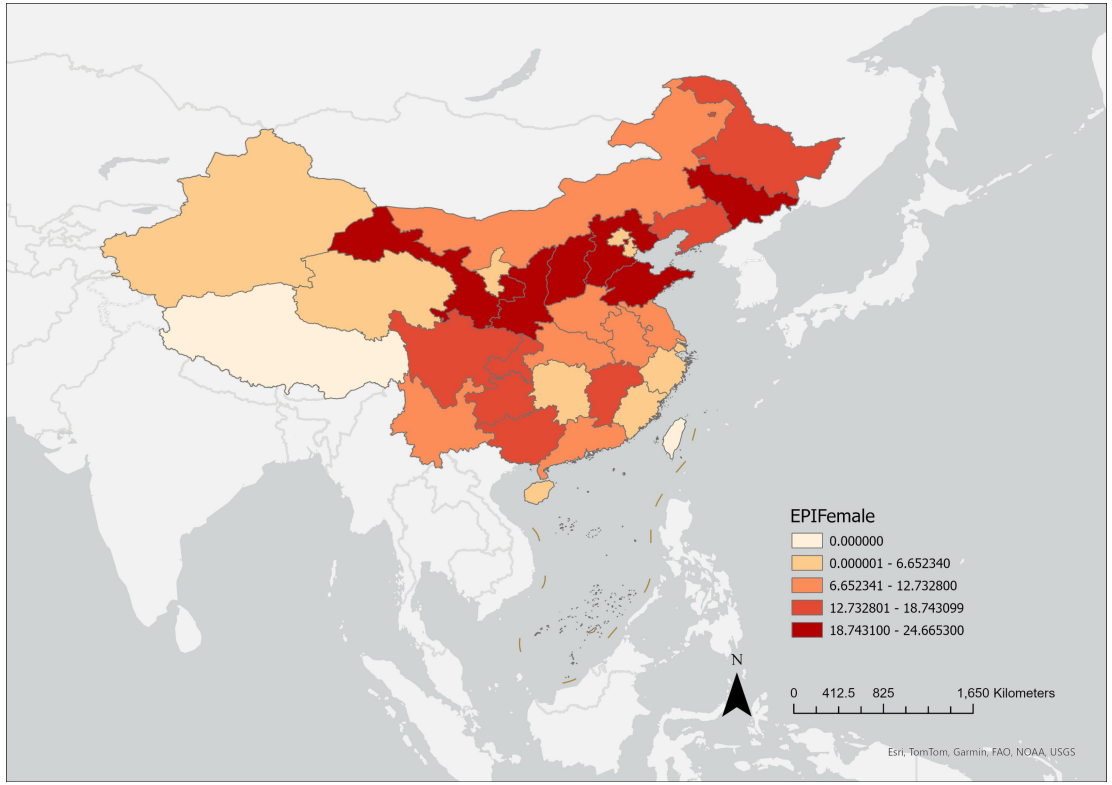
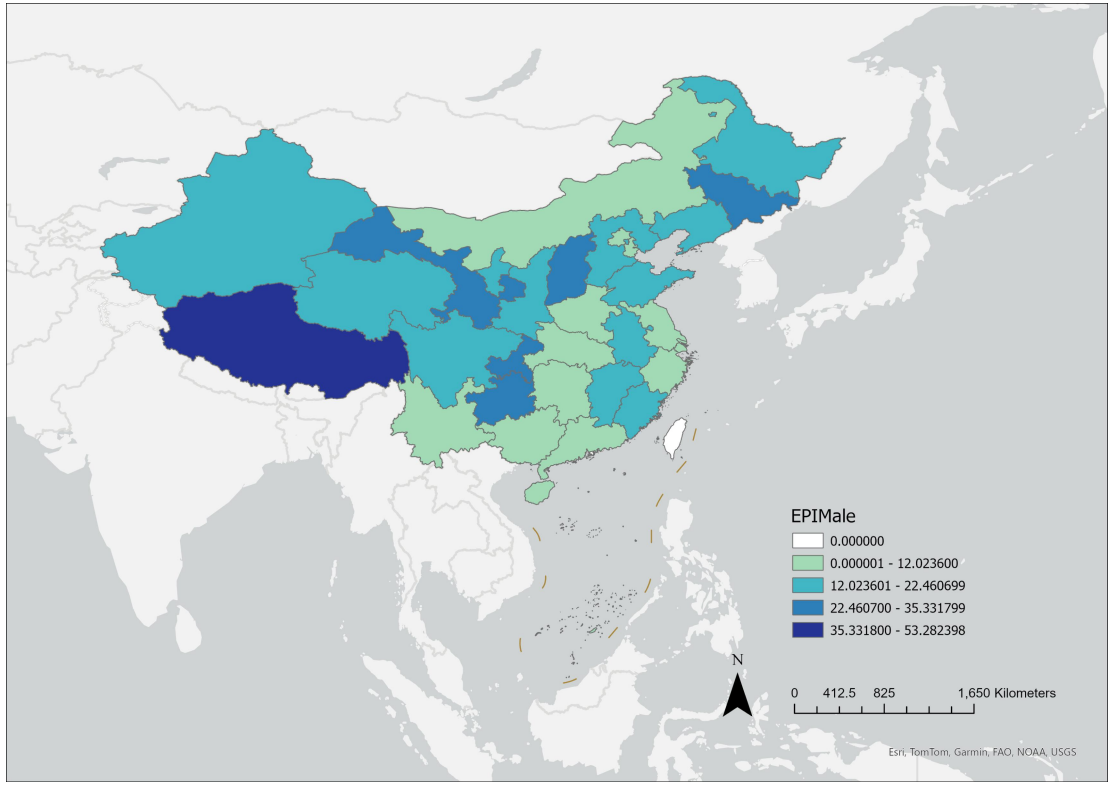


Fig 2. Mean Male EPI across Chinese provinces in 2022



4. Methodology

4.1 Baseline model Two-way Fixed Effects Panel Model

$$EPI_{ijt} = \beta_0 + \beta_1 Female_{ijt} + \mathrm{X}_{ijt}\gamma + \mu_j + \delta_t + \varepsilon_{ijt}$$

EPI_{ijt} is the Energy Poverty Index for female i in province j at time t.

$Female_{ijt}$ is the is our key variable; 1:Female 0:Male

X_{ijt} is a vector of control variables.

u_j are province fixed effects, controlling for regional characteristics.

δ_t are year fixed effects, capturing national trends and shocks.

4. Methodology

4.2 LASSO Variable Selection

LASSO(Least Absolute Shrinkage and Selection Operator)

$$\min \left(\sum_{i=1}^{n} (y_i - X_i\beta)^2 + \alpha \sum_{j=1}^{p} |\beta_j| \right)$$

Why LASSO?

To identify most relevant control variables

Improved model parsimony and interpretability

Reduces risk of multicollinearity

Results

After several sets of parameter tests, the model performance is best when alpha=0.001 (R^2 is the largest and RMSE/MSE is the smallest)

Deleted varibales: urbanization rate,share of clean energy,elderly

4. Methodology

4.3 Main Results – Baseline Regression

Table 2. Baseline regression results

	(1) EPI	(2) EPI	(3) EPI	(4) EPI
female	-1.849***	-2.110***	-1.405***	-1.399***
	(-3.81)	(-4.18)	(-3.49)	(-3.48)
Individual control		✓	✓	✓
Household control			✓	✓
Provincial control				✓
_cons	16.20***	14.74***	19.20***	58.71**
	(71.07)	(9.27)	(17.45)	(2.32)
N	53979	53978	53978	53978

1.*t* statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
2.Multicollinearity is not a concern (mean VIF = 1.49, all VIFs < 4).

Key finding

The estimated coefficient for the Female variable is consistently significant, regardless of the inclusion of individual, household, or provincial-level control variables in the regression models

↓

H1: Households managed by women are less likely to experience energy poverty ("managerial dividend")

4. Methodology

4.4 Robustness Checks

Model/Check	Variable	Coefficient	(Std. Error)
Baseline (Two-way FE)	Female	-1.399***	(-3.48)
Only Year Fixed Effects Controlled	Female	-1.630***	(-3.55)
Only Province Fixed Effects Controlled	Female	-1.110***	(-3.19)
Random Effects Model	Female	-0.988***	(-4.66)
Excluding Four Municipalities (Beijing, Shanghai, Tianjin, Chongqing)	Female	-1.553***	(-3.72)

t statistics in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Result: This suggests that the observed "**managerial dividend**" is a stable and reliable phenomenon.

5. Mechanism Analysis

5.1 Children care

Interaction: Female× Children

Variable	Coefficient	(Std. Error)
Female	-2.920***	0.519
Child	-1.115***	0.316
Female × Child	2.049***	0.542

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls for other variables are included.

For Female without child: -2.920

For Female with child(ren): (-2.920) + (-1.115) + (2.049) = -1.986

↓ 32%

Result:While being female is associated with lower energy poverty overall, this advantage is significantly diminished for women with children, highlighting a "**child penalty**" that disproportionately affects mothers.

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H2: Childcare burden diminish the female managerial advantage (the “double burden”)

5. Mechanism Analysis

5.2 Elderly Care

Interaction: Female× Elderly

Variable	Coefficient	(Std. Error)
Female	-1.094**	0.396
Elderly	2.077***	0.466
Female × Elderly	0.020	0.675

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls for other variables are included.

Result: Interaction term not significant.

Care for the elderly does not significantly diminish the female advantage

The 'child penalty' is a unique challenge,, not all care work.

6. Heterogeneity

6.1 Urban/Rural

Variable	Coefficient	(Std. Error)
Female	-1.516**	0.505
Urbantype	-9.150***	1.016
Female × Urbantype	0.219	0.500

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls for other variables are included.

6.2 Married / Unmarried

Variable	Coefficient	(Std. Error)
Female	-3.335**	0.611
is_married	-3.254***	0.557
Female × is_married	1.267	0.770

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls for other variables are included.

Results:

Urban/rural: Although urbanization significantly and generally reduces the level of energy poverty among the population, it does not significantly change the relative gap between men and women on energy poverty

Married / Unmarried: Although women have lower levels of energy poverty than men in both non-marital and married status, we do not have sufficient statistical evidence to show that the size of this gender advantage differs before versus after marriage.

6. Heterogeneity

6.3 Education level

Variable	Coefficient	(Std. Error)
Female	-1.068**	0.453
Edu_level	-2.300***	0.216
Female × Edu_level	-0.512***	0.170

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls for other variables are included.

For Male: Edu_level ↑ EPI↓ 2.3%

For Female : Edu_level ↑ EPI↓ =2.3+0.512=2.812%

At the undergraduate (edu_level = 6) level, women have an advantage over men of about 1.068 + (0.512 * 6) = 1.068 + 3.072 = 4.14%.

Results:

Improving the level of education can significantly help both males and females to escape from energy poverty.

The benefits of education are significantly greater for women (-2.812) than for men (-2.300).For every additional bit of schooling a woman gets, she improves more in energy poverty than a man with the same level of education.

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H3: Educational attainment amplifies the female managerial advantage (“empowerment effect”)

7.Conclusion

Main Finding: A "Managerial Dividend" Exists in Female

Households with female financial managers consistently show significantly lower energy poverty across various models.

This supports our core hypothesis of a female advantage in household energy management.

Boundary: The "Child Penalty"

The presence of children is the primary factor that significantly diminishes this female advantage.

This highlights a "double burden" on mothers that directly impacts household energy poverty.

Amplifier: The "Empowerment Effect" of Education

Higher education significantly amplifies the female advantage.

The reduction in energy poverty from each additional level of education is greater for women (-2.812) than for men (-2.300).

8.Policy Recommendations

Empower Female Household Managers+Reduce the Boundaries/Constraints They Face

(1)Directly Address the "Child Penalty"

The government should invest more in public childcare and create policies to help mothers balance work and family responsibilities.

(2)Invest in Female Education

Education is key to reducing energy poverty, especially for women. Supporting women’s education should be an important part of energy and development policies.

(3)Adopt a "Gender Lens" in All Development Policies

When making policies, we should always consider gender differences. Only by focusing on gender equality can we truly reduce energy poverty and promote sustainable development.

9.Future work

9.1 Heterogeneity Analysis by Detailed Marital Status

Further investigate how different marital statuses affect female energy poverty

Move beyond simple “married/unmarried” distinction

Examine subgroups: single, cohabiting, married, divorced, widowed, etc

Consider the significant impact of marital status at the household level

9.2 Temporal and Spatial Dynamics of Female Energy Poverty

Analyze changes in female EPI over time

Explore factors driving these changes

Study spatial clustering and potential spillover effects of female energy poverty across Chinese provinces

Thank you
Q&A

Email: fangyuan.liu@auckland.ac.nz