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Deciphering rural households' biomass consumption patterns: evidence from ethnic minority region in western China

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> Contributed presentation at the 60th AARES Annual Conference, Canberra, ACT, 2-5 February 2016

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Deciphering rural households' biomass consumption patterns: evidence from ethnic minority region in western China

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AARES 60th national conference Canberra, Feb 2016

Introduction

- Traditional biomass (e.g. fuelwood, straw, residues, manure) plays an important role in providing energy for cooking and heating, in particular to poor households in developing countries (IEA, 2012).
- Biomass-based energy is still today the largest source of renewable energy, accounting for roughly 10% of world total primary energy supply.
- In China, biomass was still used by about two-thirds of rural households and accounted for 60 to 71% of rural household's fuel consumption in late1990s (Jiang and O'Neill, 2004), albeit its share gradually declined to just 47.2% by 2005 (Zhou et al.,2008).
- Whereas traditional biomass is generally considered inefficient and has a number of associated disadvantages such as time-consuming biomass harvesting, exacerbated deforestation and indoor pollutions.

Introduction (cont.)

- Although challenges of energy sustainability in rural China have been extensively documented in the existing literature, the empirical studies dealing with rural households' energy consumption features at individual household level is scant;
- Even less is known about the influences of sociocultural backgrounds on household's fuel consumption behaviours.
- Based on in-field rural households survey data in two western Chinese provinces of Gansu and Yunnan where ethnic minority families are widely spread, this paper attempts to examine the pattern of residential energy consumption for cooking and heating.

Household survey and data

• The survey areas



Table 1. Sample distribution

| Province | County | Village | Household |
|----------|------------|---------|-----------|
| | Shuangbai | 3 | 32 |
| | Weishan | 3 | 30 |
| | Ninglang | 3 | 30 |
| Yunnan | Shangri-La | 2 | 20 |
| | Ning'er | 3 | 30 |
| | Shizong | 3 | 30 |
| | Qiubei | 3 | 30 |
| | Lintan | 6 | 60 |
| Gansu | Zhouqu | 3 | 30 |
| | Diebu | 3 | 30 |
| Total | | 32 | 322 |

| Table | 2. | Village | characteristics |
|-------|----|---------|-----------------|
|-------|----|---------|-----------------|

| Village characteristics | Gansu | Yunnan | Total |
|--|----------|----------|----------|
| | 0.833 | 3.750 | 2.656 |
| The number of minorities | (0.389) | (2.291) | (2.309) |
| | 0.472 | 0.601 | 0.553 |
| The proportion of minority population (%) | (0.480) | (0.339) | (0.395) |
| | 937 | 2934 | 2185 |
| Village population (persons) | (562) | (1166) | (1382) |
| | 11.083 | 11.233 | 11.177 |
| The distance from village to township (km) | (10.867) | (11.694) | (11.376) |
| | 80.333 | 40.325 | 55.328 |
| The distance from village to county (km) | (26.609) | (34.358) | (36.906) |
| Obs. | 12 | 20 | 32 |

Note: The standard deviations are in parentheses.

| Variables | Gansu | Yunnan | Total |
|--|---------|----------|----------|
| Household size (normone) | 5.525 | 4.941 | 5.158 |
| Household size (persons) | (1.593) | (1.623) | (1.634) |
| If household helps as to min prity (1, yes) | 0.433 | 0.554 | 0.509 |
| If household belongs to minority (1=yes) | (0.498) | (0.498) | (0.501) |
| Household hand advection (warma) | 4.875 | 5.676 | 5.377 |
| Household head education (years) | (3.282) | (3.383) | (3.363) |
| Average education of household members (vers) | 4.436 | 5.182 | 4.904 |
| Average education of nousehold members (years) | (2.418) | (2.271) | (2.351) |
| Household hand age (vans) | 45.150 | 46.153 | 45.780 |
| Household liead age (yeas) | (9.444) | (8.979) | (9.153) |
| Average age of household members (veers) | 33.535 | 33.438 | 33.474 |
| Average age of nousenoid members (years) | (9.059) | (8.903) | (8.947) |
| Total household income (10000 yuan) | 3.881 | 8.075 | 6.512 |
| Total household meonie (10000 yuan) | (3.784) | (7.366) | (6.588) |
| Total household income per capita (10000 yuan) | 0.754 | 1.743 | 1.375 |
| Total household meone per capita (10000 yuan) | (0.753) | (1.811) | (1.579) |
| Off form in some ratio | 0.480 | 0.333 | 0.388 |
| | (0.340) | (0.298) | (0.322) |
| A grigultural land groas (mu) | 8.886 | 15.700 | 13.161 |
| Agriculturar failu areas (iliu) | (7.045) | (16.181) | (13.901) |
| Obs. | 120 | 202 | 322 |

Table 3. Household socio-economic characteristics

Note: The standard deviations are in parentheses.

Table 4.1 Household Energy consumption

| Household energy | Gansu | Yunnan | Total | Obs. |
|---------------------------------|------------------------|------------------------|------------------------|------|
| Fuelwood (kg) | 1912.613 (2264.410) | 2113.400 (2694.496) | 2035.044 (2531.490) | 205 |
| Coal (kg) | 1916.196 (3117.347) | 1360.000 (1307.648) | 1846.672 (2950.967) | 64 |
| Electricity (kwh) | 808.808 (408.860) | 1170.259 (937.984) | 1035.137 (801.702) | 321 |
| If household use biogas (1=yes) | 0.033 | 0.223 | 0.152 | 49 |
| Coal price per kg | 1.073 (0.122) | 1.209 (0.229) | 1.158 (0.206) | 64 |
| Electricity price per kwh | 0.517 (0.017) | 0.517 (0.101) | 0.517 (0.081) | 321 |
| Obs. | 120 | 202 | 322 | |

Note: 1.The standard deviations in parentheses.

2. The coal and electricity price is averaged at village level .

Table 4.2Biomass use description in Yunnan and Gansu

| | | | | | Fuelwood co | onsumption | |
|---------------------|----------------------|----------------------|---------------------|---------|-------------|-------------|------|
| Samp | le | Consumption(kg) | Expenditure(yuan) | Use (%) | alloca | ation | Obs. |
| | | | | | Cooking (%) | Heating (%) | |
| Diamag | Gansu | 1912.61 (2264.41) | 183.38 (774.23) | | 86.25 | 37.50 | 80 |
| consuming | Yunnan | 2113.40 (2694.50) | 295.16 (1038.84) | | 99.20 | 4.80 | 125 |
| households Total | 2035.04 (2531.49) | 251.54 (943.98) | | 94.15 | 17.56 | 205 | |
| | Gansu | 1349.73 (2047.70) | 125.17 (636.81) | 66.67 | 57.50 | 25.00 | 120 |
| Total households | Yunnan | 1366.96 (2358.15) | 183.64 (828.40) | 61.88 | 61.39 | 2.97 | 202 |
| T | Total | 1360.53 (2244.23) | 161.85 (762.13) | 63.66 | 59.94 | 11.18 | 322 |

Note: 1.The standard deviations in parentheses.

Conceptual framework

- Biomass resources in most rural areas in many developing countries have generally not been widely commercialised yet, and there is simply no market for biomass resources transaction in rural regions.
- Among the 205 fuelwood consuming households, only 28 households reported expenditures for purchasing fuelwood.
- None of households reported selling in the market.
- The data absence prevents any attempt to simultaneously estimate a structural model including both fuelwood supply and demand.

Empirical strategy

- We employ a *reduced form equation* to evaluate household energy demands in a framework of *non-separable household model* (Chen et al.,2006; Demurger and Fournier,2011; Zhang and Koji,2012).
- The economic model can be specified as follows:

$$Q_{ij}^{fw} = f(p_j^c, p_j^e, d_{ij}^{bg}, R_{ij}, I_{ij}, H_{ij})$$
(1)

• The reduced form of fuelwood demand equation can be specified as follows:

$$Log(Q_{ij}^{fw}) = \alpha + \beta_1 Log(p_j^c) + \beta_2 Log(p_j^e) + \beta_3 d_{ij}^{bg} + \beta_4 R_{ij} + \gamma_1 I_{ij} + \gamma_2 I_{ij}^2 + \gamma_3 H_{ij} + \delta Prov_{ij} + \varepsilon_{ij}$$
(2)

| Variables | Model 1: Full sample | Model 2: Low income group | Model 3: High income group |
|--|----------------------|---------------------------|----------------------------|
| Log of coal price | 6.109* | 8.371** | 0.454 |
| | (3.291) | (3.352) | (3.005) |
| Log of electricity price | 4.139 | 3.972 | 4.067* |
| Log of electricity price | (2.675) | (3.025) | (2.245) |
| If household uses biogas (ves-1) | -2.798*** | -2.298*** | -3.750*** |
| In nousehold uses blogas (yes=1) | (0.521) | (0.751) | (0.623) |
| Off-farm income ratio | -1.873** | -1.182 | -3.410** |
| on-taill meome ratio | (0.793) | (1.304) | (1.644) |
| Household total income (yuan) | 0.0480 | 0.161 | 0.159 |
| nousenou ioiui income (yuun) | (0.0822) | (0.541) | (0.152) |
| Square of household total income (yuan) | -0.00136 | -0.00241 | -0.00343 |
| Square of nousenoia total income (yuan) | (0.00162) | (0.0611) | (0.00283) |
| Agricultural land areas (mu) | 0.0137 | 0.0181 | -0.0139 |
| Agricultural fand areas (ind) | (0.0228) | (0.0253) | (0.0303) |
| Household size (persons) | 0.525 | 1.149 | 0.346 |
| riousenoid size (persons) | (0.609) | (0.865) | (1.099) |
| Square of household size (persons) | -0.0518 | -0.123 | -0.00627 |
| Square of nousehold size (persons) | (0.0538) | (0.0816) | (0.0806) |
| If household belongs to minority (1-yes) | 1.181* | 1.039* | 1.482* |
| in nousehold belongs to minority (1-yes) | (0.635) | (0.607) | (0.804) |
| Household head education (years) | 0.00454 | 0.0478 | 0.0827 |
| riousenoid nead culculon (years) | (0.0744) | (0.0949) | (0.120) |
| Household head age (yeas) | 0.0272 | 0.0682*** | -0.0519 |
| | (0.0217) | (0.0261) | (0.0421) |
| Province dummy (vunnan=1) | -1.084 | -2.198** | -0.110 |
| | (0.870) | (1.089) | (1.044) |
| Log pseudolikelihood | -707.992 | -459.086 | -235.891 |
| Prob>F value | 0.000 | 0.000 | 0.000 |
| Observations | 322 | 209 | 113 |



Conclusions

- Fuelwood turns out to be a basic energy resource for most rural households.
- Coal is a substitute for low income families, whereas electricity appeared to be a substitute only for higher income households.
- Biogas digesters significantly reduce household's demand for fuelwood.
- Larger share of off-farm income has significant negative impact on fuelwood demand.
- Ethnic minority households are more likely to rely on fuelwood for cooking and heating than their Han-ethnic counterparts.

Policy implication

- The high reliance on fuelwood poses a challenge to sustainable forest management and land use change.
- Integrated forest planning such as fast grown plantations will allow for efficient and sustainable production of biomass for residential energy use, create new employment and reduce environmental degradation.
- It proves the success of rural energy policy which promotes the generalization of energy efficient clean technology of biomass resources in rural China.
- The low-income group targeting poverty reduction schemes should take the role of offfarm ration into account along with sustainable energy implementation and periurbanisation programs in rural China.
- Achieving the double dividend target, i.e. poverty reduction and environmental quality in rural areas requires integrated rural development strategy to reconcile sustainable forestry management, clean bioenergy supply and rural development programs.

Thank you!