Biomass Energy Use, Price Changes and Imperfect Labor Market in Rural China:

An Agricultural Household Model-Based Analysis

by

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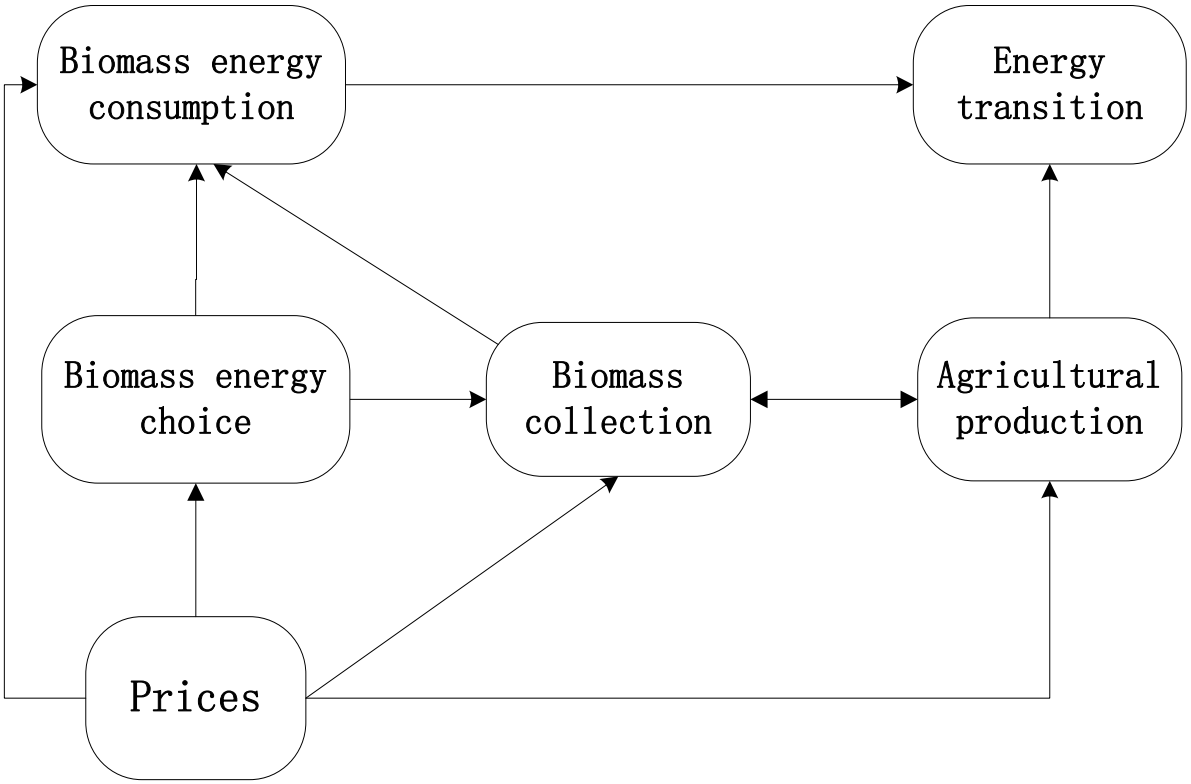
Introduction

- Biomass energy is an important energy source used in developing countries, accounting for 35% of their energy supply (Demirbas and Demirbas, 2007).

- The traditional use of biomass energy involves detrimental impacts on human health and inefficient labor allocations (Chen et al., 2006; Zhang et al., 2010).

- The widespread use of clean and more efficient biofuels based on modern technologies could significantly improve rural living standards (Zhang et al., 2009; Gosen et al, 2013).

Introduction



Source: Author's own conceptualization

Problem Statement

- Household usually plays a double role of 'producer and consumer' of domestic biomass energy (Amacher et al., 1996; Heltberg et al., 2000; Mishra, 2008).

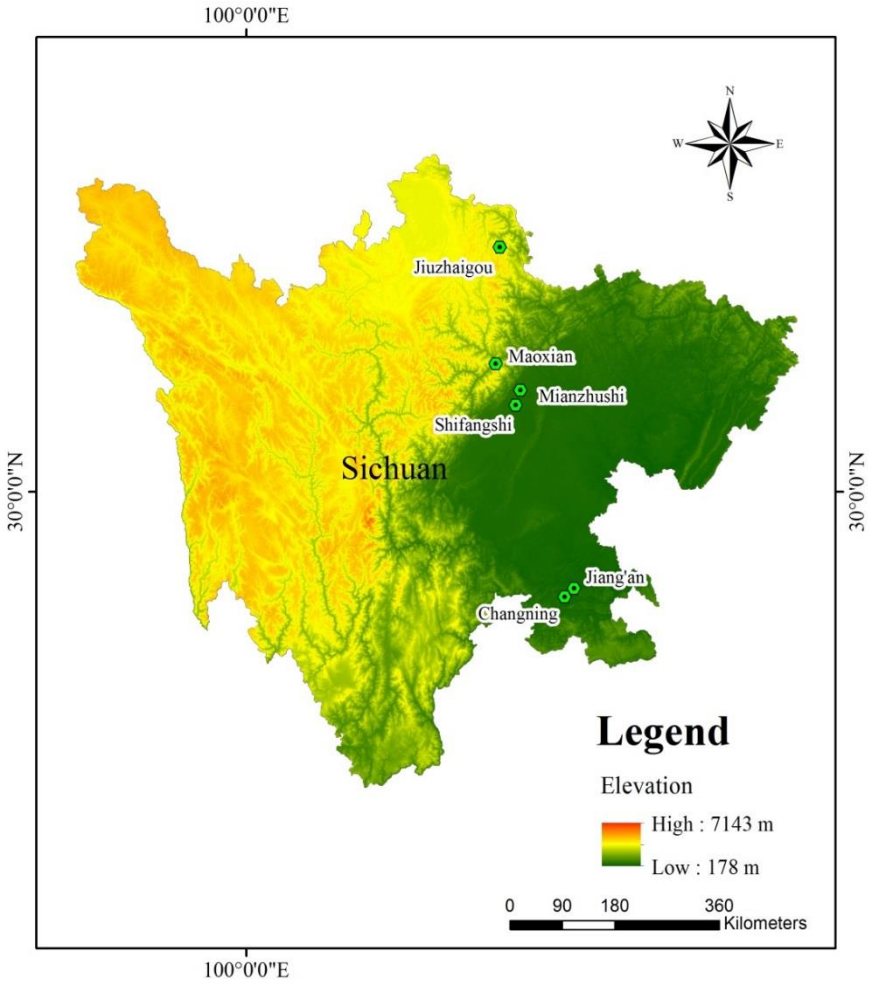
- Most research only takes into account the direct effects of exogenous price changes on both consumption and production of biomass energy.

- However, the indirect effects jointly concerning household consumption, production and labor allocation decisions for biomass energy use are rarely considered

Research Question

Do the price changes in exogenous markets (including energy market, labor market, and agricultural products market) affect household biomass energy use?

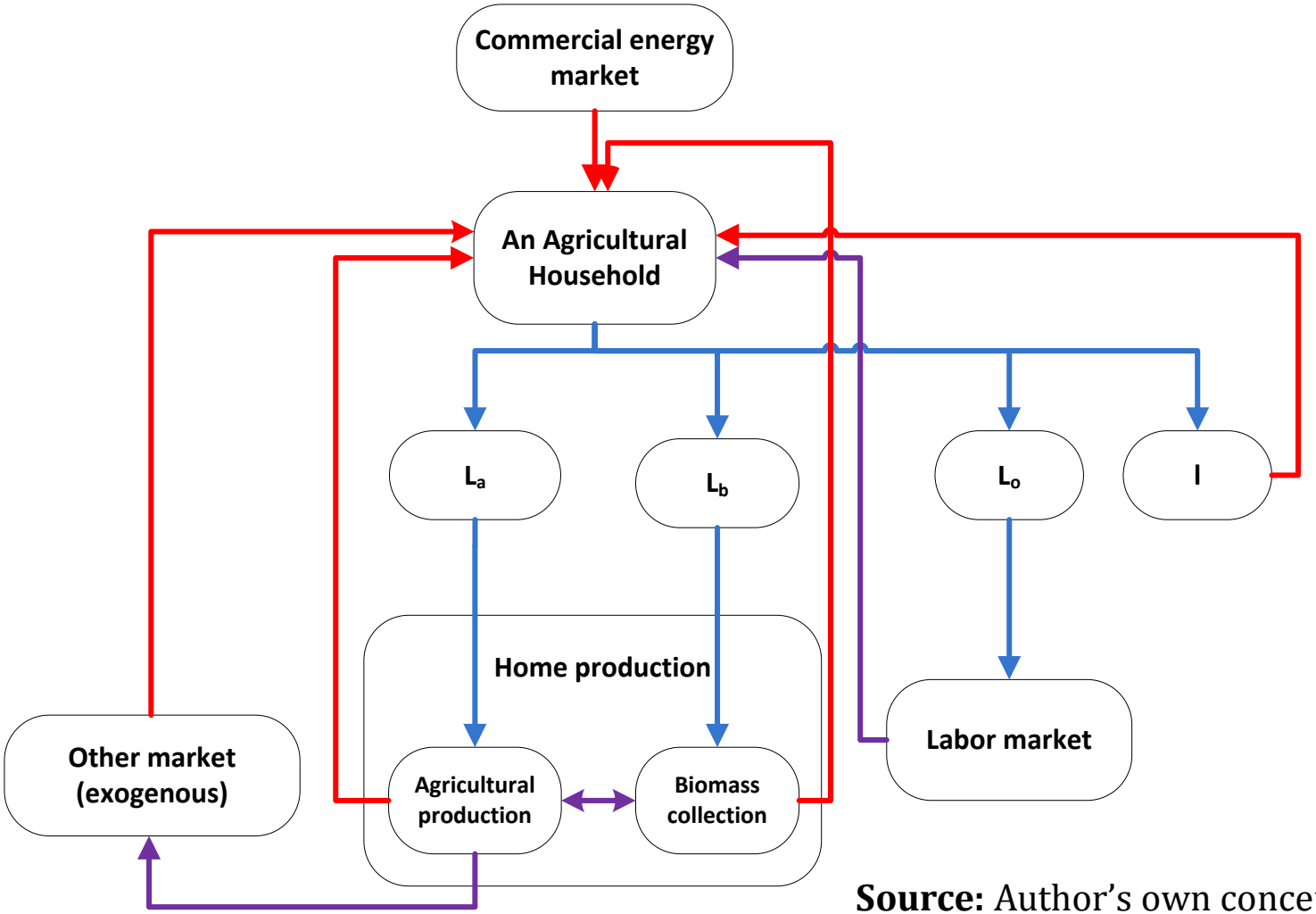
Data & Sampling



Geographic distribution of samples

- Data were obtained from a household survey conducted from August 2013 to February 2014 in Sichuan Province.
- Six counties were selected. Three towns, each with two villages were randomly selected from each county. In every village, 15-16 respondents were randomly interviewed.
- Totally, the number of the surveyed households is 556. 524 of them are typical agricultural households.

Conceptual framework



Source: Author's own conceptualization

Theoretical background

- Basic assumption: labor market is the only one market that could be constrained.

- A test for separability using Finite Mixture Model (FMM) confirmed that all housholds behave under the non-separable assumption in the labor market.

Theoretical background

A non-separable agricultural household model is developed to obtain the total effects of price changes on household biomass energy use (in elasticity form):

$$E(C_b / p_x)^G = E(C_b / p_x)^H + E(w^* / p_x)[E(C_b / w^*)^H + \theta_b S_l] \quad (1)$$

Direct response of biomass energy consumption to a change in the exogenous prices

Indirect effect via the endogenous variation in the shadow wage induced by the exogenous shock

Where, C_b is the consumption of biomass energy; p_x is exogenous market price; w* is the shadow wage of household labor; θ_b is the full income elasticity of biomass energy consumption; and S_l is the share of leisure consumption in shadow full income (budget).

Empirical Strategy

Two-step empirical strategy is used:

Step 1. Shadow wage estimation

Cobb-Douglas multioutput production function system (Kumbhakar, 2011)

Step 2. Joint analysis of consumption, production and labor allocation decisions

Empirical Strategy

Step 2.1 Household consumption decision

•Linear Approximation of the AIDS (LA/AIDS) model (Deaton and Muellbauer, 1980):

$$ES_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln \frac{Y}{P^*} + \sum_n \theta_{in} a_n + \varepsilon_i \qquad (2)$$

constrained to

$$\sum_i \alpha_i = 1 \quad \sum_i \beta_i = 0 \; ; \quad \sum_i \gamma_{ij} = 0 \; ; \quad \gamma_{ij} = \gamma_{ji} \qquad (3)$$

Where ES_i denotes the expenditure share of i-th commodity category; Y indicates shadow full income; p_j denotes the consumer price of commodity category j; P^* is the Stone's price index; a_n refers to household characteristics.

Empirical Strategy

Step2.2 Household labor allocation decision

• A system of translog profit function with labor cost share equations (Schneider, 2011):

$$\ln TC = \alpha_0 + \alpha_i \ln p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j + \alpha_y \ln Y_P + \mu_i \quad (4)$$

$$LS_i = \alpha_i + \gamma_{ij} \ln(\frac{w^*}{p_c}) + \gamma_{ii} \ln(\frac{w}{p_c}) + \varepsilon_i \quad (5)$$

constrained to:

$$\sum_i \alpha_i = 1 ; \sum_j \gamma_{ij} = 0 ; \gamma_{ij} = \gamma_{ji} \quad (6)$$

Where, TC : total cost; Y_p: total value of output; p_i/p_j: prices of inputs (i.e. the market wage rate w, shadow wage rate w^*, and weighted price of intermediate inputs p_c); LS_i: cost share of labor inputs (i.e. labor in home production and off-farm employed labor).

Estimation results

Table 2. Estimated elasticities

	Full income elasticity	With respect to the price of					
		Self-consumed agricultural products	Biomass energy	Commercial energy	Labor (shadow wage rate)	Other purchased goods	Labor (market wage rate)
Consumption							
Self-consumed agricultural products	2.111	-0.744	0.175	0.041	-0.008	0.640	-
Biomass energy	1.027	0.067	-0.783	0.007	0.604	0.216	-
Commercial energy	1.617	0.246	0.102	-1.163	0.396	0.530	-
Leisure	0.655	-0.001	0.096	0.004	-0.052	0.062	-
Other purchased goods	2.255	0.186	0.162	0.025	0.293	-1.177	-
Labor Supply							
Home production	-	-	-	-	-0.450	-	0.290
Off-farm employment	-	-	-	-	0.150	-	-0.186

Source: Estimation results of LA/AIDS model and the system of profit function with cost share equations

Findings

Table 3. Identified signs of the effects

	With respect to the external price of			
	Self-consumed agricultural products	Commercial energy	Other purchased goods	Labor
Indirect effect	0.026	-0.175	-0.809	0.580
Direct effect	0.078	0.018	0.227	0.129
Total effect	0.104	-0.157	-0.582	0.709

Conclusions

- The exogenous price changes have positive direct effects on household biomass energy use.
- Neglecting the indirect effects of shadow wages and considering only direct price effects will lead to inaccurate findings about household biomass energy production and consumption behaviors.

Thanks for your attention!