Mental Accounting, Production Scale, and Consumption of Self-produced Food:

Empirical Evidence from Rural China

Jiaqi Huang, [1]Urban Economics (UEC), Wageningen University & Research (WUR), the Netherlands, [2]Agricultural Information Institute (AII), Chinese Academy of Agricultural Sciences (CAAS), P. R. China Jiaqi.huang@wur.nl; huangjiaqi@caas.cn

Gerrit Antonides, Urban Economics (UEC), Wageningen University & Research (WUR), the Netherlands gerrit.antonides@wur.nl

Christian H. Kuhlgatz, Federal Office for Agriculture (FOAG), Switzerland christian.kuhlgatz@blw.admin.ch

Fengying Nie, Agricultural Information Institute (AII), Chinese Academy of Agricultural Sciences (CAAS), P. R. China niefengying@caas.cn

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Jiaqi Huang[1 2], Gerrit Antonides[1], Christian H. Kuhlgatz[3], Fengying Nie[2]

[1] Urban Economics (UEC), Wageningen University & Research (WUR), the Netherlands

[2] Agricultural Information Institute (AII), Chinese Academy of Agricultural Sciences (CAAS), P. R. China

[3] Federal Office for Agriculture (FOAG), Switzerland

Abstract

We conducted an exploratory study on mental accounting and food budgeting of agricultural households. We hypothesized that agricultural households may have a mental account for their produced food, and reserve a certain fixed amount of self-produced food for self-consumption, implying that they may keep on consuming their own produce until they have consumed the amount set for the mental budget. Therefore below a certain level of production, the consumption of self-produced food may increase by production but not anymore when beyond the level. Furthermore, the consumption of self-produced food may insensitive to food prices both below and above this mental budget (a certain level of production). By applying a threshold regression model and using survey data from six poor rural counties of China, we tested this hypothesis for five food items, which are rice, flour, potatoes, pork, and eggs. We found that the mental accounting hypothesis only partially holds, and deviated by food items. The evidence is supportive but could not fully prove that the phenomenon of price insensitivity is exclusively due to mental accounting. Limitation of this study and possible future studies on testing the mental accounting theory on food budgeting of self-produced food are discussed.

Key words: mental accounting, food consumption, self-produced food

1 Introduction

The production and consumption decisions of agricultural households in poor regions are very likely linked, since households often act as both producers and consumers in imperfect markets (Singh, Squire, & Strauss, 1986). It is an often viable solution for agricultural households to consume at least some of their self-produced food, and this is also true in the case of rural Chinese households. Ignoring the consumption of own produce leads to significant bias in food demand estimations, as shown by Tekgüç (2012). The question of how households exactly determine the amount of food that is sold and the quantity that is kept for eating at home still remains. Given that many Chinese households in rural areas consume a considerable amount of self-produced food, affecting both their food security and the provision of food to the markets, it is of vital interest to answer this research question. This paper therefore aims to shed light on this issue by analyzing a rich household dataset stemming from rural households of six counties in China.

In agricultural household models, market prices and transaction costs play important roles in the choice of households to be self-sufficient or not (Key, Sadoulet, & Janvry, 2000; Goetz, 1992). Agricultural households will thus make a rational calculation of market prices, transaction costs, and subjective valuation of their produce. If the subjective valuation of self-produced products is higher than the market price minus transaction costs, then it is better to keep the product for self-consumption (Taylor & Adelman, 2003). However, our survey of Chinese rural households reveals a reality that is not easily set in line with this traditional economic theory. For example, households who produce and can easily sell a large amount of potatoes also tend to leave a set amount of potatoes for self-consumption and then sell the rest. Generally, it seems that agricultural households overlook the opportunity cost of self-consumption of the produced food. The psychological theory of mental accounting may explain this behavior.

Shefrin and Thaler (2004) assume that individuals categorize their income by earmarking it for specific purposes or specifying that it be used within a certain time

frame. Consumers may set spending limits representing how much they want to allocate to different expenditure categories (Mazumdar, Raj, & Sinha, 2005). The spending limit or the mental budget may serve as a reference point for monitoring the actual spending (Heath & Soll, 1996; Thaler, 1980). Just, Mancino, and Wansink (2007) point out that, because of mental accounting, households may also allocate a portion of their income specifically to buy food, and when food prices decline they may overlook the opportunity to shift the surplus "food money" to a category with another purpose. In this case, a low price of a food item may lead to overconsumption rather than substitution.

The mental accounting hypothesis may also work for agricultural households, who reserve a certain amount of self-produced food for self-consumption (similar to the mental budget for household expenses) and then sell the rest. If the mental accounting hypothesis holds, then agricultural households will track the amount of self-consumption against the planned amount of own produce for self-consumption of each type of food that they produce, similarly to the way households track their expenses against the mental budgets (Heath & Soll, 1996). The mental accounting hypothesis implies that they keep on consuming their own produce until they have consumed the amount set for the mental budget, rather than sell it to the market for extra income, even in times of increasing food prices. Therefore, the consumption of self-produced food may not be fully sensitive to price changes. Likewise, agricultural households who have already consumed their budget may not be fully sensitive to market price, and sell all of their excess produce, even in times of decreasing food prices.

In addition to tracking consumption against the set budget and insensitivity to price changes, deviations from the planned consumption of their produce during the year, due to overconsumption or underconsumption, may lead to compensation by consuming less, resp. more, in the remaining part of the year. Finally, non-fungibility may occur, that is the reluctance of households to consume from different budgets if one particular budget is exhausted (Thaler, 1999). In the farmer context, non-fungibility implies a reluctance to consume excess produce from another type of food, if they are short of produce in a particular budget. For example, if they are short of rice, they are reluctant

to consume excess produce of flour. In general, this assumption would result in less substitution from different food categories, and insensitivity to cross-prices in food demand.

The assumptions presented here are strong, and it might be the case that households do not act completely in accordance with the mental accounting hypotheses. For example, their consumption of own produce may be dependent on own production until the consumption budget level has been reached. However, even when the consumption budget has not been reached, they may be sensitive to market price to some extent. That is, even when their consumption needs are not yet satisfied, they may realize that, in case of a price increase, it may be more beneficial to sell their produce than to consume. In such a case, the mental accounting process may hold only partially, leading to some relaxation of the hypotheses. We aim to study several mental accounting hypotheses, concerning the food budget, and sensitivity to own production and market price, in the current research.

We applied a threshold regression model (Hansen, 2000) to analyze how market food price, transaction costs, and production scale change will influence the amount of self-produced food left for self-consumption. The reason for using the threshold regression model is that there might be a production scale threshold that may influence the amount of food kept for self-consumption, in line with the mental accounting hypothesis of a set budget for self-consumption. This model is estimated for consumption of five self-produced food items, which are rice, flour, potatoes, pork, and eggs, since we found they are commonly produced food items and four of them have a prominent overconsumption for the sampled producers but not for non-producers, which raises the research question of whether they overlook the opportunity cost of produced food and set a rather fixed amount for self-consumption no matter how market price, transaction costs, and production scale change. The study uses a set of Chinese household survey data including the relevant information for estimating the demand model.

The results of this study are expected to provide new insights for both academia and practitioners in developing countries. It is assumed that the test of the mental

accounting hypothesis can raise awareness to choose agricultural and food demand models that have the least possible bias. By deriving estimates for how household characteristics influence food commercialization patterns and food intake, it should reveal crucial information for agricultural policy as well as practitioners in food assistance. Next, we explain our methods, and present and discuss our results.

2 Method

2.1 Empirical model

This study applied a threshold regression (Hansen, 2000), assuming different consumption behavior below than above a particular production threshold.. The reason for using threshold regression is that the consumption of self-produced food could be highly related with the production scale. The self-sufficiency level would be the production threshold for consumption of self-produced food. At a small scale, the amount of food left for self-consumption may increase with the increase of production scale. Once the production scale meets the self-sufficiency level, the amount of own produce for self-consumption may keep steady or even decrease with increasing production scale.

Different from a standard demand model, the explained variable is not total consumption of a certain good but the consumption per adult equivalent of a certain food from self-produce. We identify the factors that may influence consumption of self-produced food based on the theoretical framework of self-sufficient choice of agricultural households (Key, Sadoulet, & Janvry, 2000; Goetz, 1992; Taylor & Adelman, 2003). From this framework, market prices, transaction costs, and subjective valuation of their produce are the main factors in the decision to be self-sufficient or not. Since the subjective valuation of self-produced food is not available from the dataset, we only take market prices and transaction costs into account. In addition, it is broadly known from the demand models that prices of other food items (especially substitutes) and income may also influence the demand of a certain kind of food (Deaton & Muellbauer, 1980; Christensen, Jorgenson, & Lau, 1975). Therefore, we also

add log terms of market prices of substitutes and log of total food expenditure[1] as explanatory variables. Production scale is also very important as explained in the previous section, so the log of production volume is set both as an explanatory variable and a threshold variable. Considering the characteristics of consumption of agricultural households mentioned above, and applying a translog demand model on threshold regression, the empirical threshold regression model of consumption of self-produced food is proposed as follows:

$$
\begin{aligned}
lny_i = (\sum_{f=1}^{n} & \beta_{1f} lnp_{fi} + \theta_1 lnm_i + \varphi_{1q} lnq_i + \varphi_{1d} dist_i + \varphi_{1t} trans_i + \omega_{1e} edu_i \\
& + \omega_{1a} age_i + \omega_{1l} lab_i + \omega_{1n} adeq_i + \omega_{1s} ds_i + \omega_{1y} dy_i + \omega_{1sp} ds_i \\
& * lnq_i + \omega_{1yp} dy_i * lnq_i) \cdot \mathbf{1}(q_i \le \gamma) + (\sum_{f=1}^{n} \beta_{2f} lnp_{fi} + \theta_2 lnm_i \\
& + \varphi_{2q} lnq_i + \varphi_{2d} dist_i + \varphi_{2t} trans_i + \omega_{2e} edu_i + \omega_{2a} age_i + \omega_{2l} lab_i \\
& + \omega_{2n} adeq_i + \omega_{2s} ds_i + \omega_{2y} dy_i + \omega_{2sp} ds_i * lnq_i + \omega_{2yp} dy_i * lnq_i) \\
& \cdot \mathbf{1}(q_i > \gamma) + \boldsymbol{\varepsilon_i}
\end{aligned}
$$

Where

lny_i is log of the per equivalent adult consumption amount of self-produced food (a certain kind of food) per month of household *i*;

lnq_i is the log of production amount of a certain kind of food of household *i*, which is taken as the threshold variable and also explanatory variable;

γ is the threshold of the production amount of a certain kind of food estimated from the model[2];

$\cdot \mathbf{1}(\cdot)$ is an indicative function, that is, if the expression in parentheses is true, the value equals 1; otherwise, the value equals 0;

lnp_{fi} is log of price[3] of different food items (rice, flour, potatoes, pork, eggs,

[1] As an indicator of income level.

[2] The threshold level will be automatically estimated through the Bayesian Information Criterion in STATA 15.

[3] We calculate the market price of rice, flour, and potatoes by taking the average mean value of buying and selling price as indicated by each individual household. It is because the consumption of self-produced food of households who produce food may influenced either by selling price or buying price or both (Sadoulet & De Janvry, 1995). In order to take price information from both sides into account,

chicken, beef, mutton, and fish, respectively), of household *i*;

lnm_i is the log of total food expenditure of household *i*;

$dist_i$ and $trans_i$ are distance to market and transportation cost to sell food for household *i*, which can be proxies of transaction cost;

edu_i and age_i are average years of education of laborers, and average age of laborers, lab_i is number of laborers engaged in agriculture, and $adeq_i$ is the number of equivalent adults of household *i*;

ds_i and dy_i is dummy variables of Shaanxi province and Yunnan province respectively, $ds_i * lnq_i$ and $dy_i * lnq_i$ are cross terms of province dummy variable and log of production amount of a certain kind of food;

β_{1f}, θ_1, φ_{1q}, φ_{1d}, φ_{1t}, ω_{1e}, ω_{1a}, ω_{1l}, ω_{1n}, ω_{1s}, ω_{1y}, ω_{1sp}, ω_{1yp} and β_{1f}, θ_2, φ_{2q}, φ_{2d}, φ_{2t}, ω_{2e}, ω_{2a}, ω_{2l}, ω_{2n}, ω_{2s}, ω_{2y}, ω_{2sp}, ω_{2yp} are parameters to be estimated.

Descriptive statistics of the variables are shown in Appendix.

2.2 Data

The study used the last wave of a three-wave (2010, 2012, 2015) set of household panel data[4] gathered from six poor rural counties of three provinces (Shaanxi, Yunnan, Guizhou) in China. The six counties were first selected from the poorest group of 572 National Poor Counties based on viability. The required sample size for the survey was calculated using standard sample size calculations with each county representing a stratum. After the sample size was calculated, a two-stage clustering approach was applied. The first stage is the selection of villages using the probability-proportional-to-size (PPS) method. Following the selection of the villages, 12 households within each village were randomly selected. In each county, all selected 228 households from 19 villages were interviewed. The total sample size for each wave was 1368. The dataset included comprehensive household information on food consumption, consumption

we took the average of them.

[4] The first two waves contained too little information on consumption of self-produced food for this study.

from self-production, income, expenditure, assets, production, and demographics.

Of the 1368 households, there were 236 households producing rice, 260 producing flour, 546 producing potatoes, 743 producing pork, and 393 producing eggs in the 12 months prior to the survey. We observed a significant difference of rice/flour/potato/pork consumption between households who produced the corresponding food and households who did not produce (see Tables 1-4). But this difference was not significant for egg consumption (Table 5). For example, rice consumption of households who produce rice was significantly higher (34.53 kg/month/household) than of households who did not produce rice (19.99 kg/month/household). Chinese Food Pagoda (Chinese Nutrition Society, 2016) recommended an upper limit for consumption of grain and tuber, which is 400 grams per adult equivalent per day. For rice-producing households, the percentage of households whose rice consumption level surpassed this upper limit was 34.0%, which was significantly higher than that of non-rice-producing households (16.5%). The same trend was observed for flour, potato, and pork consumption. Flour, potato, and pork consumption of producing households was 4.66 kg/month/household, 12.25 kg/month/household, and 2.80 kg/month/household higher than that of non-producing households. The producing households whose flour, potato, and pork consumption level surpassed the corresponding upper limit was 11.2%, 24.5%, and 37.8%, respectively, which was significantly higher than that of non-producing households (7.9%, 8.8%, and 17.0%). These statistics show that overconsumption of a certain kind of food was more prevalent for the households who produced the corresponding kind of food. We estimate our demand equation for self-producing households only.

Table 1 Rice consumption of rice-producing households and non-rice-producing households

	Rice-produce-households	Non-rice-produce-households	Difference	t-stat
Number of households	236	1132		
Rice consumption per month	34.53 kg	19.99 kg	14.54 kg***	9.184
Rice consumption per adult equivalent per month	12.17 kg	7.44 kg	4.73 kg***	8.118

Rice consumption per adult equivalent per day	405.77 g	248.07 g	157.7 g***	8.118
Percentage of households whose rice consumption above the upper limit of recommended consumption of grain and tuber (400g/adult equivalent/day)	34.0%	16.5%		

Table 2 Flour consumption of flour-producing households and non-flour-producing households

	Flour-produce-households	Non-flour-produce-households	Difference	t-stat
Number of households	260	1108		
Flour consumption per month	11.96 kg	7.30 kg	4.66 kg***	4.281
Flour consumption per adult equivalent per month	4.85 kg	3.04 kg	1.81 kg***	4.260
Flour consumption per adult equivalent per day	161.71 g	101.17 g	60.54 g***	4.260
Percentage of households whose flour consumption above the upper limit of recommended consumption of grain and tuber (400g/adult equivalent/day)	11.2%	7.9%		

Table 3 Potato consumption of potato-producing households and non-potato-producing households

	Potato-produce-households	Non-potato-produce-households	Difference	t-stat
Number of households	546	822		
Potato consumption per month	24.53 kg	12.29 kg	12.25 kg***	9.292
Potato consumption per adult equivalent per month	9.79 kg	4.80 kg	4.99 kg***	8.299
Potato consumption per adult equivalent per day	326.33 g	159.92 g	166.42 g***	8.299
Percentage of households whose potato consumption above the upper limit of recommended consumption of grain and tuber (400g/adult equivalent/day)	24.5%	8.8%		

Table 4 Pork consumption of pork-producing households and non-pork-producing households

	Pork-produce-households	Non-pork-produce-households	Difference	t-stat
Number of households	743	625		

Pork consumption per month	6.50 kg	3.71 kg	2.80 kg***	5.624
Pork consumption per adult equivalent per month	2.35 kg	1.43 kg	0.92 kg***	5.599
Pork consumption per adult equivalent per day	78.17 g	47.65 g	30.52 g***	5.599
Percentage of households whose pork consumption above the upper limit of recommended consumption of meat (75g/adult equivalent/day)	37.8%	17.0%		

Table 5 Egg consumption of egg-producing households and non-egg-producing households

	Egg-produce-households	Non-egg-produce-households	Difference	t-stat
Number of households	393	975		
Egg consumption per month	2.09 kg	1.93 kg	0.16 kg	0.944
Egg consumption per adult equivalent per month	0.84 kg	0.76 kg	0.07 kg	0.969
Egg consumption per adult equivalent per day	27.92 g	25.44 g	2.48 g	0.969
Percentage of households whose egg consumption above the upper limit of recommended consumption of eggs (50g/adult equivalent/day)	12.7%	13.5%		

3 Results

Tables 6 and 7 show the empirical results of OLS regression without taking log of production as a threshold. We summarise the results for rice, flour, and potatoes in Table 6, since they were considered as staple food, including the log of price of rice, flour, and potatoes in each of the rice, flour, and potato regressions as explanatory variables. Results for pork and eggs are summarised in Table 7 since they were both animal-sourced food.

There were significant effects of log of price on corresponding consumption of self-produced food. For example, the effect of log of rice price on consumption of self-produced rice was -0.6921, and the price effects for flour, potatoes, eggs are -0.5747, -0.3342, and -0.2972. Egg price effect on consumption of self-produced eggs was not significant.

Production effects on consumption of self-produced food was significant for potatoes (0.1671), pork (0.0898), and eggs (0.1417), meaning that if production of

potatoes, pork, and eggs increased by 1%, the consumption of self-produced potatoes, pork, and eggs will increase by 0.1671%, 0.0898%, and 0.1417%, respectively.

Transportation costs and distance to markets, which are taken as proxies of transaction cost, having no significant effect on consumption of self-produced food for each of the food items.

Education of laborers had a significant negative effect on consumption of self-produced potatoes (-0.0511), but not for other food items. Age of laborers had a significant positive effect on consumption of self-produced rice (0.0109). Number of laborers in agriculture had a significant positive effect on consumption of self-produced eggs (0.0748). Number of adult equivalent had significant negative effects on consumption of self-produced potatoes (-0.1952), pork (-0.1582), and eggs (-0.2300), which means that households have more adult equivalents tend to consume less self-produced potatoes, pork, and eggs. This result is plausible, since the self-produced goods have to be shared among the family.

Consumption of self-produced was also significantly influenced by provinces.

Table 6 Regression of per adult equivalent own-produced rice/flour/potato consumption without threshold

	Rice		Flour		Potato	
	Coef.	t	Coef.	t	Coef.	t
Log-price of rice	-0.6921**	-2.10	0.3161	0.70	0.0544	0.19
Log-price of flour	0.4325	1.11	-0.5747**	-2.18	0.4500*	1.86
Log-price of potatoes	0.4269*	1.78	0.3406*	1.80	-0.3342***	-2.63
Log of total expenditures on food	0.0550	0.77	0.0347	0.53	0.1172**	2.26
Log of production of rice	0.1528	1.58	-	-	-	-
Log of production of flour	-	-	0.0950	1.12	-	-
Log of production of potato	-	-	-	-	0.1671***	3.14
Transportation costs of rice	0.0014	0.56	-	-	-	-
Transportation costs of flour	-	-	-0.0009	-0.23	-	-
Transportation costs of potato	-	-	-	-	-0.0001	-0.06
Distance to the market	-0.0014	-0.15	0.0009	0.11	-0.0093	-1.44
Education of laborers	-0.0339	-1.39	-0.0109	-0.53	-0.0511***	-3.05
Age of laborers	0.0109*	1.90	0.0039	0.82	0.0013	0.37
Number of laborers in agriculture	-0.0032	-0.05	0.0506	0.84	0.0407	0.80
Number of adult equivalents	-0.0401	-0.59	-0.0767	-1.44	-0.1952***	-4.26

Shaanxi	-[5]	-	1.1052***	5.95	0.6835***	4.57
Yunnan	0.4828***	3.51	-0.3684**	-2.24	0.5226***	4.14
Rice production*Yunnan	-0.0001	-1.14	-	-	-	-
Flour production*Shaanxi	-	-	-0.0001	-0.33	-	-
Flour production*Yunnan	-	-	0.0000	-0.51	-	-
Potato production*Shaanxi	-	-	-	-	0.0001	0.98
Potato production*Yunnan	-	-	-	-	0.0000	-0.95
Constant	0.2447	0.21	-0.3018	-0.29	-0.6695	-0.85
N	236		260		546	
F value	3.19		15.84		10.17	
R-squared	0.1572		0.4933		0.2235	
BIC	649.0942		688.5894		1558.207	

Table 7 Regression of per adult equivalent own-produced pork/egg consumption without threshold

	Pork		Egg	
	Coef.	t	Coef.	t
Log-price of pork	-0.1545	-1.00	0.3603	1.44
Log-price of egg	-0.0309	-0.25	-0.2972**	-2.13
Log-price of mutton	0.0520	0.45	0.4364**	2.23
Log-price of beef	0.0380	0.54	-0.1223	-1.06
Log-price of chicken	-0.1696*	-2.10	0.2603**	2.15
Log-price of fish	0.1474	1.29	0.3190*	1.73
Log of total expenditures on food	0.1613***	4.93	0.0705	1.42
Log of production of pork	0.0898***	2.92	-	-
Log of production of egg	-	-	0.1417***	3.88
Distance to the market	0.0004	0.09	0.0008	0.12
Education of laborers	-0.0116	-1.10	0.0081	0.56
Age of laborers	0.0019	0.83	-0.0021	-0.63
Number of laborers in agriculture	0.0449	1.65	0.0748*	1.86
Number of adult equivalents	-0.1582***	-5.62	-0.2300***	-5.53
Shaanxi	-0.1522	-1.17	0.7004***	3.48
Yunnan	0.2491***	3.55	0.1513	1.44
Pork production*Shaanxi	-0.0001*	-1.86	-	-
Pork production*Yunnan	0.0000	-0.42	-	-
Egg production*Shaanxi	-	-	0.0004	0.53
Egg production*Yunnan	-	-	0.0000	0.02
Constant	-0.9766	-0.95	-4.4227	-2.80
N	743		393	
F value	9.13		6.17	

[5] In our sample, there were no households producing rice in Shaanxi province. Rice producing households were only present in Yunnan and Guizhou provinces.

R-squared	0.1792	0.2185
BIC	1608.671	918.5065

Tables 8-12 show that after applying threshold regression by taking the log of production as the threshold variable, the statistical significance of explanatory variables below and above the threshold level were different. The estimated threshold levels for rice, flour, potatoes, pork, and eggs were 500 kg, 430 kg, 1750 kg, 680 kg, and 60 kg, respectively. Computing the average rice, flour, potatoes, pork, and egg consumption of households who produced the corresponding food, we found that the annual consumption was 414.36 kg for rice[6], 143.52 kg for flour, 294.36 kg for potatoes, 78 kg for pork, and 25.08 kg for eggs, which were all lower than the estimated threshold production levels. This result shows that the explanatory variables had different effects if the production amount was larger than the threshold then if it was lower. In other words, the results were different if consumption needs had been fully satisfied than if they were not satisfied. Comparing the Bayesian Information Criterion statistics (BIC) of the OLS and threshold regressions of different food items, we found that all BICs of the threshold regressions were smaller than that of the OLS regression, meaning that the threshold regression fitted the data better than the OLS regression.

To capture the mental accounting hypothesis on allocation of self-produced food, we mainly tested whether consumption of self-produced food of households were first sensitive to food production change, and then insensitive to such change anymore when production amount is larger than a certain threshold. Also, we tested whether consumption of self-produced food was insensitive to price change both below and above the threshold of a certain production amount.

The case of rice was partially in line with our hypothesis. Below and above the production threshold of 500 kg, the log of consumption of self-produced rice were both insensitive to rice price and transportation cost and distance to market changes, which means that households will not significantly change their consumption of self-produced rice when rice price and transaction cost changed. However, our hypothesis regarding

[6] 34.53 kilograms/month*12months=414.36 kilograms. See Tables 1-5.

the production effect does not hold for rice. No significant effect from rice production on consumption of own-produced rice was observed below and above the production threshold of 500 kg.

The case of potatoes was also partially in line with our hypothesis, but reflected in a different way from rice. The assumption of consumption budget of the total production holds for potatoes. For households whose potato production was less than 1750 kg, the log of consumption of self-produced potatoes was affected by log of production of potato (0.1490) at 10% significance level. The coefficients showed that below the production threshold, the more the households produce potatoes, the more they will consume their self-produced potatoes. However, above the production threshold, the effect of log of production of potato was not significant anymore, which is consistent with the mental accounting hypotheses that the producers' potato consumption budget from their total production is rather fixed. Price effects on consumption of self-produced potatoes showed different sensitivity below and above potato production threshold. Below the threshold, the log of consumption of self-produced potatoes was affected by log of potato price at 1% significance level (-0.4535), which showed that with the increase of potato price, households will decrease their consumption of self-produced potatoes. However, above the threshold, the price effect was not significant.

The case of eggs was also almost in line with mental accounting hypothesis. Log of egg price had a significant negative effect (-0.3554) on consumption of self-produced eggs, and log of egg production had a significant positive effect (0.0986) for households whose annual egg production is less than 60 kg. But for households whose annual egg production is larger than 60 kg, effects from egg price and production were not significant anymore.

The same trend of production effect was also observed from pork. For households whose pork production was less than 680 kg, there was a significant positive effect (0.1761) of log of pork production on log of consumption of self-produced pork, but not for households whose pork production is larger than 680 kg.

The trend of price effects of pork and flour were opposite to that of potatoes and

eggs. In the case of pork, pork price did not have a significant effect for households whose pork production was less than 680 kg, but had a significant positive effect (0.7807) on consumption of self-produced pork for households whose pork production was larger than 680 kg, which means that when pork price goes up, households tend to eat more self-produced pork. In the case of flour, flour price also did not have a significant effect for households whose flour production was less than 430 kg, but had a significant negative effect (-0.7927) on consumption of self-produced flour for households whose flour production was larger than 430 kg, which means that when flour price goes up, households tend to eat less self-produced flour. It seems that when flour production is larger, and when flour price increase, households considered about the opportunity cost of produced flour, and they chose to consume less self-produced flour, and sell them to gain more cash.

To sum up, we observed evidence of self-consumption food budget from total food production for potatoes, pork, and eggs. We also observed insensitivity to market price below and above production threshold for rice, which is in accordance with the strong mental accounting hypotheses that the reserved produce for self-consumption will not be influenced by market price. For potatoes and eggs, we observed a relaxation of mental accounting, above the threshold, consumption of self-produce was not significantly influence by market price, but below the threshold, they are sensitive to market price, when price increase, they will consume less self-produce. In this case, they may think it is more beneficial to sell more self-produce even though the threshold was not reached. For pork and flour, the sensitivity of market price only happened above the threshold.

Table 8 Threshold regression model including threshold for consumption of self-produced rice

	Region1: Log of rice production <=6.2146 (Rice production<=500kg) number of households: 92		Region2: Log of rice production > 6.2146 (Rice production>500kg) number of households: 144	
	Coef.	z	Coef.	z
Log-price of rice	-0.5917	-1.23	-0.4172	-0.87

Log-price of flour	0.4078	0.59	0.5168	1.09
Log-price of potatoes	0.6303*	1.83	0.1236	0.36
Log of total expenditures on food	-0.1299	-1.12	0.1344	1.51
Log of production of rice	-0.0762	-0.40	0.0487	0.34
Transportation costs of rice	-0.0065	-0.30	0.0021	0.83
Distance to the market	-0.0133	-0.63	0.0040	0.38
Age of laborers	0.0082	0.99	0.0178**	2.24
Number of adult equivalents	-0.0143	-0.14	-0.0696	-0.97
Yunnan	0.5839***	2.91	0.1909	1.10
Constant	2.9045	1.55	-0.2797	-0.17
BIC	12.5010			

Table 9 Threshold regression model including threshold for consumption of self-produced flour

	Region1: Log of flour production <=6.0638 (Flour production<=430kg) number of households: 151		Region2: Log of flour production > 6.0638 (Flour production>430kg) number of households: 109	
	Coef.	z	Coef.	z
Log-price of rice	1.2945**	2.04	-0.6511	-1.03
Log-price of flour	-0.3952	-1.09	-0.7927**	-2.10
Log-price of potatoes	0.1005	0.36	0.5088**	2.02
Log of total expenditures on food	0.1277	1.59	-0.0595	-0.54
Log of production of flour	0.0418	0.32	-0.1563	-1.05
Transportation costs of flour	-0.0033	-0.52	-0.0012	-0.27
Distance to the market	0.0129	1.03	-0.0114	-1.01
Number of laborers in agriculture	0.1115	1.36	0.0718	0.82
Number of adult equivalents	-0.1437**	-2.19	-0.0795	-1.25
Shaanxi	1.1425***	5.47	0.6836*	1.73
Yunnan	-0.2487	-1.27	-0.8037**	-2.18
Constant	-2.4035	-1.64	4.4239	2.50
BIC	-21.1492			

Table 10 Threshold regression model including threshold for consumption of self-produced potatoes

	Region1: Log of potato production <=7.4674 (Potato production<=1750kg) number of households: 455		Region2: Log of potato production > 7.4674 (Potato production>1750kg) number of households: 91	
	Coef.	z	Coef.	z
Log-price of rice	-0.1442	-0.47	-0.1348	-0.16
Log-price of flour	0.3063	1.20	1.2610*	1.75

Log-price of potatoes	-0.4535***	-3.17	-0.2026	-0.65
Log of total expenditures on food	0.1072*	1.91	0.2061	1.51
Log of production of potato	0.1490*	1.68	-0.2405	-1.03
Transportation costs of potato	-0.0119**	-2.04	0.0004	0.32
Distance to the market	-0.0127*	-1.86	0.0040	0.19
Education of laborers	-0.0333*	-1.86	-0.1460***	-3.06
Age of laborers	0.0005	0.14	-0.0033	-0.34
Number of laborers in agriculture	0.0216	0.40	0.3168**	2.12
Number of adult equivalents	-0.1986***	-3.90	-0.3337***	-3.08
Shaanxi	0.4180**	2.18	1.4481	1.14
Yunnan	0.5425**	2.45	1.0323***	2.78
Potato production*Shaanxi	0.0008***	2.59	-0.0001	-0.20
Potato production*Yunnan	0.0000	-0.08	0.0000	0.68
Constant	0.0968	0.10	0.8430	0.28
BIC	77.3080			

Table 11 Threshold regression model including threshold for consumption of self-produced pork

	Region1: Log of pork production <=6.5221 (Pork production<=680kg) number of households: 571		Region2: Log of pork production > 6.5221 (Pork production>680kg) number of households: 172	
	Coef.	z	Coef.	z
Log-price of pork	0.0277	0.16	-0.7807*	-2.51
Log-price of egg	-0.0531	-0.39	-0.1605	-0.62
Log-price of mutton	0.0717	0.54	0.1941	0.77
Log-price of beef	0.0588	0.68	-0.0156	-0.12
Log-price of chicken	-0.1922**	-2.08	-0.0302	-0.18
Log-price of fish	0.1297	1.04	0.2009	0.73
Log of total expenditures on food	0.2079***	5.67	0.0086	0.12
Log of production of pork	0.1761***	2.70	0.0453	0.44
Distance to the market	0.0025	0.51	-0.0072	-0.93
Education of laborers	-0.0058	-0.49	-0.0269	-1.17
Age of laborers	0.0016	0.62	0.0033	0.57
Number of laborers in agriculture	0.0616**	2.00	-0.0753	-1.27
Number of adult equivalents	-0.2082***	-6.65	0.0192	0.30
Shaanxi	0.0102	0.05	-0.3189	-0.84
Yunnan	0.4744***	3.31	0.2387	1.59
Pork production*Shaanxi	-0.0006	-0.93	0.0000	-0.82
Pork production*Yunnan	-0.0007**	-1.97	0.0000	-0.18
Constant	-2.3506	-1.93	1.8177	0.79
BIC	-418.4060			

Table 12 Threshold regression model including threshold for consumption of self-produced eggs

	Region1: Log of egg production <=4.0943 (Egg production<=60kg) number of households: 353		Region2: Log of egg production > 4.0943 (Egg production>60kg) number of households: 40	
	Coef.	z	Coef.	z
Log-price of pork	0.3840	1.48	-1.0297	-1.14
Log-price of egg	-0.3554**	-2.50	-0.1452	-0.20
Log-price of mutton	0.3450*	1.69	2.9817***	3.53
Log-price of beef	-0.1024	-0.88	-0.8613	-0.72
Log-price of chicken	0.2456**	1.99	1.5451***	2.73
Log-price of fish	0.2824	1.50	-0.0045	0.00
Log of total expenditures on food	0.0539	1.06	0.3727*	1.69
Log of production of egg	0.0986*	1.69	0.5477	1.60
Distance to the market	-0.0019	-0.27	0.0204	0.72
Education of laborers	0.0088	0.58	-0.1125**	-2.06
Age of laborers	-0.0031	-0.92	0.0298**	2.18
Number of laborers in agriculture	0.0823**	2.00	-0.4436**	-2.33
Number of adult equivalents	-0.2398***	-5.41	0.2003	1.41
Shaanxi	0.5628**	2.22	4.3158***	5.28
Yunnan	-0.0474	-0.33	0.6206	1.18
Egg production*Shaanxi	-0.0015	-0.19	-0.0007	-0.53
Egg production*Yunnan	0.0088	1.58	-0.0018	-1.45
Constant	-3.4918	-2.13	-18.1037	-1.97
BIC	-125.5851			

4 Conclusion and Discussion

In this study, we hypothesized that agricultural households may have a mental accounting for their produced food, and reserve a certain fixed amount of self-produced food for self-consumption. This could be reflected by a phenomenon that they keep on consuming their own produce until they have consumed the amount set for the mental budget regardless of market price change. By applying a threshold regression model and using survey data from six poor rural counties of China, we tested this hypothesis for five food items which are rice, flour, potatoes, pork, and eggs. Firstly, we found for potatoes, pork, and eggs, the consumption of self-produce only increase with production below a certain production threshold, but not significantly sensitive to production anymore above the threshold. Secondly, for rice, consumption from self-

produce is insensitive to market price both below and above production threshold. Thirdly, for potatoes and eggs, consumption from self-produce is significantly sensitive below production threshold rather than above the threshold. But for pork and flour, it is the other way round.

The empirical findings showed that mental accounting hypothesis may only partially hold for the behaviour of consumption food budget from self-produce of agricultural households, and deviated by food items. Even though some evidence of insensitivity of price change on consumption of self-produced food showed up, these evidence still could not fully prove that the insensitivity is exclusively due to mental accounting. Other reasons such as perceived safer and better quality of self-produced food, and the habit of eating self-produced food may also lead to this insensitivity. From a pilot survey conducted in January 2018 in Huize county, Yunan Province, 7 out of 11 rice producers reported that they leave a fixed amount of rice for self-consumption every year. We asked the following follow-up question: "Why do you choose to consume your own produced food rather than sell more to exchange more money?" Five households reported that they were accustomed to eating self-produced food, and two households reported that they thought the quality of their own produced rice was better than that they could buy from the market.

Another concern is that due to data limitation, we were not able to observe how consumption of self-produce will change by the change production scale for the same households. We only compare the behaviour of households with different production scale. But those households may systematically different. The differences of production and price effects on consumption of self-produce captured below and above production thresholds may attribute to some unobserved systematic differences of households with smaller and bigger production scale.

Therefore, further research could focus on separating the mental accounting process from other possible explanations for fixed consumption of self-produced food. For example, as explained in the Introduction section, other characteristics of mental accounting such as compensation and non-fungibility could be further tested on the behaviour of food budgeting of agricultural households.

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Appendix

Table A1 Sample statistics of rice equation

Variables	Obs	Mean	Std. Dev.
Log of per equivalent adult consumption amount of self-produced rice per month	236	2.01	0.9040
Log-price of rice	236	1.40	0.1780
Log-price of flour	236	1.30	0.1516
Log-price of potatoes	236	0.66	0.2486
Log of total expenditures on food	236	9.27	0.8299
Log of production of rice	236	6.49	0.7332
Transportation costs of rice	236	3.34	22.8016
Distance to the market	236	6.79	6.1443
Education of laborers	236	4.92	2.4032
Age of laborers	236	42.09	12.2439
Number of laborers in agriculture	236	2.11	1.1069
Number of adult equivalent	236	3.10	1.2325
Yunnan	236	0.60	0.4916
Rice production*Yunnan	236	3.95	3.3095

Table A2 Sample statistics of flour equation

Variables	Obs	Mean	Std. Dev.
Log of per equivalent adult consumption amount of self-produced flour per month	260	0.87	1.0790
Log-price of rice	260	1.49	0.1165
Log-price of flour	260	1.20	0.2345
Log-price of potatoes	260	0.57	0.2854
Log of total expenditures on food	260	9.24	0.8029
Log of production of flour	260	5.89	0.8953
Transportation costs of flour	260	2.65	13.8822
Distance to the market	260	6.81	6.1903
Education of laborers	260	4.74	2.5488
Age of laborers	260	43.15	12.4654
Number of laborers in agriculture	260	1.89	0.9820
Number of adult equivalent	260	2.87	1.2352
Shaanxi	260	0.44	0.4976
Yunnan	260	0.39	0.4883
Flour production*Shaanxi	260	2.63	2.9967
Flour production*Yunnan	260	2.38	3.0498

Table A3 Sample statistics of potato equation

Variables	Obs	Mean	Std. Dev.
Log of per equivalent adult consumption amount of self-produced potato per month	546	1.72	1.0440
Log-price of rice	546	1.47	0.1486
Log-price of flour	546	1.22	0.2130
Log-price of potatoes	546	0.46	0.3433
Log of total expenditures on food	546	9.33	0.8212
Log of production of potato	546	6.36	1.2594
Transportation costs of potato	546	2.68	39.4282
Distance to the market	546	6.26	6.4257
Education of laborers	546	4.83	2.4760
Age of laborers	546	43.10	14.1014
Number of laborers in agriculture	546	1.84	0.9185
Number of adult equivalent	546	2.83	1.2270
Shaanxi	546	0.44	0.4966
Yunnan	546	0.33	0.4699
Potato production*Shaanxi	546	2.52	2.9072
Potato production*Yunnan	546	2.41	3.5399

Table A4 Sample statistics of pork equation

Variables	Obs	Mean	Std. Dev.
Log of per equivalent adult consumption amount of self-produced pork per month	743	0.50	0.7283
Log-price of pork	743	3.04	0.1761
Log-price of egg	743	2.68	0.2212
Log-price of mutton	743	4.30	0.3114
Log-price of beef	743	4.27	0.3615
Log-price of chicken	743	3.19	0.3308
Log-price of fish	743	2.91	0.2529
Log of total expenditures on food	743	9.28	0.7887
Log of production of pork	743	5.90	0.9642
Distance to the market	743	6.49	5.9999
Education of laborers	743	4.75	2.4613
Age of laborers	743	42.05	12.9630
Number of laborers in agriculture	743	1.96	1.0422
Number of adult equivalent	743	3.02	1.1895
Shaanxi	743	0.14	0.3513
Yunnan	743	0.46	0.4989
Pork production*Shaanxi	743	0.74	1.8555
Pork production*Yunnan	743	2.83	3.1158

Table A5 Sample statistics of egg equation

Variables	Obs	Mean	Std. Dev.
Log of per equivalent adult consumption amount of self-produced egg per month	393	-0.35	0.7690
Log-price of pork	393	3.05	0.1577
Log-price of egg	393	2.66	0.2997
Log-price of mutton	393	4.28	0.3032
Log-price of beef	393	4.29	0.3215
Log-price of chicken	393	3.19	0.3473
Log-price of fish	393	2.92	0.2319
Log of total expenditures on food	393	9.26	0.7569
Log of production of egg	393	2.81	1.1325
Distance to the market	393	6.25	5.4525
Education of laborers	393	4.66	2.5611
Age of laborers	393	43.17	13.8064
Number of laborers in agriculture	393	1.86	1.0234
Number of adult equivalent	393	2.92	1.2100
Shaanxi	393	0.17	0.3743
Yunnan	393	0.42	0.4937
Egg production*Shaanxi	393	0.47	1.1503
Egg production*Yunnan	393	1.12	1.5158