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Cash Transfers and Multiplier Effect: Lessons from the Grain Subsidy Program in China

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Abstract

This study examines the multiplier effects of the grain subsidy program in China, which is a large food self-sufficiency project that is implemented as a cash transfer program. Income multiplier effects have not been examined in the evaluation of the grain subsidy program although increasing the income of farmers is the original goal of this project. A large number of household-level observations are employed to measure the program's income multiplier. Results show that the grain subsidy program has an unrealized high income multiplier, and the income promotion effect of the transferred subsidies is from agricultural production derived by intensifying various input uses for each unit of land. The multiplier effect can be particularly utilized by households with good education and poor farmers in less developed regions. Hence, to maximize the income multiplier effect, the grain subsidy distribution method should consider these criteria instead of retaining the prevalent standard that is based on contracted land areas.

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1. Introduction

The income promotion effects of cash transfer programs need to be measured during program evaluation. In the last two decades, the number of cash transfer programs has increased; these programs channel cash to poor people in both undeveloped and middle-income countries, such as Brazil, Mexico, Colombia, Jamaica, Indonesia, Bangladesh, Mongolia, Pakistan, Malawi, and China (Sadoulet et al., 2001; Dolberg, 2012; Huang et al., 2011). Most of these programs aim to mitigate the lack of capital for farm households to improve their living standards by generating durable outcomes, such as enhancing the human capital, adoption of new production technology, and relaxation of liquidity constraints. The major motivations of cash transfer programs with regard to poverty and health problems are partly induced by liquidity constraints in either production or consumption in developing countries. Hence, the multiplier effects of the transferred cash are observed in a comprehensive standard that measures the success of such programs because the aforementioned problems can be mitigated or eliminated by income promotion. Cash transfer programs may have negative effects on work effort (Cox and Jimenez, 1992; Cox et al., 1998; Sadoulet et al., 2001); however, given that liquidity constraints are usually encountered by small farm households in developing countries, these programs might have positive effects on improving income by relaxing the liquidity constraints that cause households to have under-employed and ill-allocated productive assets. Measuring the full income multiplier effect is difficult because the transferred cash has both short- and long-term indirect effects, and both types of effects can contribute to income generation. If the transferred cash is invested in agricultural and off-farm activities, the effects are visible in the short term. Otherwise, more time is needed to observe the effects of subsidies invested in programs for education, nutrition, and equipment adoption because the effects of these programs require much time to be accumulated and learned. In any case, measuring the multiplier effects of the transferred cash helps achieve the direct targets of cash transfer programs, such as poverty reduction, health care improvement, and food production.

This study is an addition to the limited number of studies on cash transfer program evaluation. The multiplier effects of China's grain subsidy program on the income

of farm households were analyzed. The grain subsidy program was launched in 2004 to achieve food self-sufficiency. As mentioned by the central government, the original target of the policy (Gale et al., 2005) is to improve the income of rural households. However, this subject has yet to be investigated. Several studies have shown that small farm households in China usually face incomplete credit markets (Feder et al., 1990; Rozelle et al., 1999; Simtowe and Zeller, 2006; Uchida et al., 2009; Yi and Sun, 2014). Thus, the multiplier effects of grain subsidy are considered as the shadow values of liquidity constraints that face households and were selected in this study to measure the income effect of the subsidy program. Therefore, the money received from the grain subsidy program is expected to provide farmers with liquidities and allow them to adjust their production to achieve large income promotion effects.

The focus of most studies on China's grain subsidy program is the effect on grain supply (Gale et al., 2005; Yu and Jensen, 2010; Huang et al., 2011; Yu and Jensen, 2014; Yi and Sun, 2014). The effect of grain subsidy on income increment has not been examined, and this study aims to address this gap. Existing studies can be classified into two groups based on the assumption of whether grain subsidies distort production decisions, which are also critical in determining the multiplier effects of the program by providing increased liquidity. Gale et al. (2005) pointed out that grain subsidy has minimal impact on grain production because subsidies are not large enough and are not related to production decisions. Huang et al. (2011) utilized micro-survey data and reported that a subsidy program does not encourage grain production in terms of grain-sown areas and fertilizer use. Meanwhile, Meng (2012) found that grain subsidy prevents farmers from engaging in migratory work and thus increases labor inputs in grain production. Yu and Jensen (2010, 2014) showed that implementing the grain subsidy program would increase grain production and improve the income of farmers if grain subsidy disbursement is coupled with grain production. Yu et al. (2012) reported that grain subsidies and the elimination of agricultural taxes increase grain area and yield. Yi and Sun (2014) explicitly claimed that under the current subsidy distribution method based on contracted land areas, providing liquidities to liquidity-constrained households is possibly the only channel to increase grain-planting areas; their empirical

test supported this hypothesis. Overall, the above mentioned empirical studies show that China's grain subsidy program could have potentially large multiplier effects if rural households have liquidity constraints. Examination of the multiplier effects of the grain subsidy program may thus provide evidence on the distortion caused by the subsidies in the production decisions of farmers.

In this study, a unique survey dataset was utilized to evaluate the short-term multiplier effect of China's grain subsidy program. A large income multiplier for the grain subsidy program was found. The sources of the indirect effects of grain subsidy were identified by decomposing the total income. The results show that the decision of subsidized farmers to utilize more inputs, such as fertilizers and capital, results in income increments. Aside from the total income growth caused by the subsidy program, the conditions under which farming households realize the largest multiplier effects from the transferred cash were also evaluated. Liquidity-constrained households with high education or living in the northeast utilize the transferred cash more efficiently and consequently exhibit more income increments. These findings provide guidelines for the efficient distribution of subsidies to maximize the income promotion effects.

The rest of the paper is organized as follows. Sections 2 and 3 describe the grain subsidy program in China and introduce the data utilized for the estimations. Section 4 introduces the empirical estimation models. Sections 5 and 6 present the empirical results and the conclusion, respectively.

2. China's grain subsidy program

In 2004, the central government of China implemented a grain subsidy program to increase grain production. The goal of the program is to achieve food self-sufficiency and provide farmers with liquidities to adjust production in either agriculture or off-farm work to increase their income. The program has four elements, namely, direct, comprehensive input, high-quality seed, and agricultural machinery subsidies. The total budget of the subsidy in 2012 was 166.8 billion yuan (Chen, 2013), which has increased by more than 11 times since 2004. Out of the total budget in 2012, direct, comprehensive input, and high-quality seed subsidies accounted for 87%. Average farm

households[1] can receive a grain subsidy amount that is approximately 10% of their agricultural income (Yi and Sun, 2014).

Disbursement modes indicate how direct, comprehensive input, and high-quality seed subsidies are transferred to farmers. Except for machinery subsidy, the other three subsidies are wired to farmers' bank accounts[2]. Machinery subsidy is only provided to those who buy medium or large machines, and approximately 30% to 50% of the subsidy value is deducted from the price of these machines. Therefore, households that apply for machinery subsidy cannot freely allocate this subsidy.

Farmers receive the other three wired subsidies after a three-step implementation process. First, the State Council determines the annual subsidy budget according to regional differences in grain production. Second, provincial finance departments divide the total available budget provided by the central government according to the grain production of all the counties. Finally, local financial bureaus distribute the subsidies to farmers in accordance with specific criteria. The Ministry of Finance stated in 2007 that these criteria could involve any of the following standards: (i) amount of contracted land allocated to a household in the late 1990s; (ii) actual grain-sown areas, and (iii) taxable grain production target in a normal year (although agricultural tax was abolished in 2003).

However, these three wired subsidies are mainly allocated according to contracted land areas (Tian and Meng, 2010; Huang et al., 2011). Yi and Sun (2014) provided two main reasons why contracted land area is the most utilized standard. The reasons are the burden imposed by implementation costs to tight local government budgets and the importance of equity in rural governance. In addition, given that rural contracted land has not been adjusted since the 1990s, the prevalent criteria make the three wired

[1]We assume that an average household has 6 mu contracted land, and the subsidy standard is 67 yuan/mu.

[2]With the rapid development of information technology, everyone, from the Ministry of Finance to individual households, has a special bank account. Thus, grain subsidy can be easily distributed to farmers according to a schedule, which is usually by the time farmers are establishing planting decisions.

subsidies function as cash transfers to farmers; however, machinery subsidy is essentially different from the wired subsidies because of the distribution procedures. Hence, the focus of this study is narrowed down to the multiplier effects of the three wired subsidies (direct, comprehensive input, and high-quality seed) because they are the main parts of the grain subsidy program; they are forms of cash transfer and provide liquidities to farmers.

3. Data

A panel dataset from the Research Center for Rural Economy (RCRE), Ministry of Agriculture of China, was utilized. In 1986, the Ministry of Agriculture established an annual survey system called the Fixed Observation Points System (FOPS). Operated by RCRE, the system conducts yearly surveys of rural economic and institutional changes at both household and village levels. To represent national rural development, different weights are provided to each province or municipality according to the number of villages with various combinations of topographic and economic characteristics. The number of villages selected in each province or municipality varies from 3 to 25, and households are randomly selected in each village.

In implementing FOPS, survey assistants help farmers fill in questionnaires every year, and the surveyed farm households are revisited annually. When a farm household cannot be traced because of migration to other places, a similar household is selected for the vacancy to maintain the stability of the sample size. The questionnaire collects extensive information from farmers, such as household production, consumption, social activities, assets, and income composition. Given that most of the grain subsidy budget is allocated to main grain production areas, we included 19 provinces (municipalities) in our analysis sample. These provinces (municipalities) are Hebei, Shanxi, Inner Mongolia, Liaoning, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Shandong, Henan, Hunan, Hubei, Guangxi, Sichuan, Guizhou, Yunnan, Shaanxi, and Gansu; over 84% of grain-sown areas in the last decade are in these locations. Although FOPS provides a long panel, grain subsidy was only individually recorded in 2009 and onward. Before 2009, subsidy amount was mixed with other income information and cannot be

identified. Therefore, the observations for the later analysis covers the available two years: 2009 and 2010.

Table 1 shows a summary of the statistics of the key variables for 4573 farms. The grain subsidy received by an average household is approximately 2% of its total income. This figure is approximately 6% of the farming income, which is not negligible for small farm households in China. Comparison of the subsidies received by farmers in 2009 and 2010 indicates that the average values of the subsidies in all households were close. However, most households experienced increased subsidies from 2009 to 2010. The null hypothesis that the grain subsidy received in 2009 is greater than or equal to the amount in 2010 is thus rejected at 5% level. In addition, the total budget for the three wired grain subsidies in 2010 increased by more than 4% (approximately 4.5 billion yuan) since 2009 (Yi and Sun, 2014). A total of 12% of all households experienced no changes in grain subsidy for two reasons. First, a small number of farmers have not received grain subsidy since the implementation of the program because they have no contracted land. Second, several farmers rent out their land to tillers, and the subsidies are paid to the tenants. With regard to labor, senior residents usually participate in agricultural work in China; hence, we considered a resident as contributing to labor if his/her age is above 16. The definition of liquid assets in this article includes the value of fixed productive assets, loans, deposits, cash in hand, and investment.

Table 1 also shows the income structure of farm households in 2009 and 2010. The total income increased by 12% in one year, and this impressive increment rate of total income is significantly higher than the rate in a similar study by Sadoulet et al. (2001), which indicated that the total household income in Mexico increased by only 14% in four years. Agricultural production contributed more than 40% to the total income improvement. Although the small percentage of grain subsidy in the total income might be a source of concern, what we intend to estimate is the income multiplier effects, which can be interpreted as the efficiency of the subsidy in terms of income improvement, rather than the total amount of grain subsidy transferred. Evidence on the large multiplier effects generated by the small amount of grain subsidies could confirm that grain subsidy, despite accounting for a small proportion of the total income,

still has a large potential to improve the income of rural residents. These findings could suggest that more subsidies are needed and should be considered by grain subsidy program policymakers (Gale et al., 2005). All prices were deflated to 2000 values using the national consumer price index.

4. Evaluation Design

The income multiplier effects of the grain subsidy program were estimated. The strategy utilized to identify the multiplier effects of grain subsidy is similar to the method employed by Sadoulet et al. (2001). An unrestricted model was first employed to measure the multipliers in a period of two years, and the difference was evaluated. Then, the multiplier effects of grain subsidy on various income sources and for each specific subset of the population, such as liquidity conditions and household characteristics, were estimated. The conclusion could help improve the efficiency of farm households and increase the income of farmers.

4.1. Overall multiplier effect

To estimate the income multipliers, we assumed that income is decided by various household assets, characteristics, markets, as normally performed in literature (e.g., Sadoulet et al. (2001) and Xu et al. (2012)). We let $y_{i,t}$ be household i's income in year t, $Z_{i,t}$ is the household's assets, characteristics, and market, and $T_{i,t}$ is the level of grain subsidy received. Hence, the income equation in year t is as follows.

$$y_{i,t} = Z_{i,t}\beta_t + T_{i,t}\gamma_t + \alpha_i + \varepsilon_{i,t}, \tag{1}$$

where β is the coefficient vector for the control variables, α_i represents an unobservable individual effect that is assumed as fixed over the years, and $\varepsilon_{i,t}$ is the error term. Unobservable term α can be interpreted as household managerial capability, production tradition, risk preference, or land quality. In Equation (1), the grain subsidy income multiplier is γ. According to subscript t of the estimated coefficients, we did not assume that the parameters for the independent variables are the same over the years (including income multipliers). Therefore, except for α, we allowed the coefficients to differ over the years in the estimation of the model (1).

However, classic estimation problems would be caused by the correlation between unobservable term α and grain subsidy level T because the grain subsidy program in China is voluntary based on the policy design. In the implementation process, grain producers have a high probability of receiving the subsidy. Grain production decision can be considered the result of land quality and personal management ability. Our data show that 96% of grain producers received grain subsidy, whereas only 56% of farm households that did not produce grain crops received the subsidy. Failing to control this type of self-selection will lead to biased estimation. To address this issue, we obtained the difference between two yearly observations (2009 and 2010) to eliminate the sources of bias. According to data availability, the difference was determined as

$$y_{i,t} - y_{i,t-1} = (Z_{i,t}\beta_t - Z_{i,t-1}\beta_{t-1}) + (T_{i,t}\gamma_t - T_{i,t-1}\gamma_{t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1})\,. \qquad (2)$$

The unobservable individual effects can be cancelled out by obtaining their difference. The estimation strategy was selected from the methods for cross-section data. One concern is the possibility that the transferred subsidies may result in changes in the unobservable characteristics of households, such as capability improvement, because of the relaxation of liquidity constraints. For the validity of the analysis, we employed conterminal observations in 2009 and 2010 and assumed that the unaltered individual effects are acceptable. In addition, the grain subsidy program has been implemented for 10 years, and the scale of such implementation is stable[3]; hence, we expect the marginal change in the individual effects caused by the subsidy to be minor or to cease in subsequent years.

Given that we allowed income multipliers to differ over the years, the coefficient difference in the two selected years can be tested in the empirical estimation. Sadoulet et al. (2001) estimated income multipliers by using two periods: before and after the cash transfer program was implemented. An issue in their research is that their conclusions were based on a strong assumption that the income multiplier effects of subsidy remain similar over time. In this regard, our estimation may challenge this assumption

[3]The percentage of farm households that participated in grain subsidy was 82.4% in 2009; the percentage in 2010 was 83.4%.

if we find a significant difference in the multipliers between two selected years.

Another issue that makes it difficult to estimate the multiplier effects of grain subsidy on the income of rural households is the presence of outliers. The income structure in Table 1 shows that livestock income could have possible serious outlier problems because of the large standard deviations. However, eliminating these outlier observations would generate efficiency losses. Thus, we employed median regressions to address this potential problem in total and livestock income estimations. More than 4,000 observations in our data satisfied the requirement of median regression, which requires a large sample. For other income sources, such as off-farm and agricultural activities, we applied robust regression.

4.2. Strategies of estimating the impact of liquidity

The bound level of liquidity constraints determines the income promotion effects of the grain subsidy program. We examined whether the influence of the grain subsidy program on income increases and if input intensities differ among farm households with and without liquidity constraints. According to Zeldes (1989), Jappelli (1990) and Jappelli et al. (1998), households are ideally classified into two groups based on their credit and loan application history; these two groups are liquidity-constrained and unconstrained households. However, insufficient information on farmers was obtained from our dataset. Several previous studies employed actual credit use as a proxy for credit access (e.g., Stephens and Barrett (2011)); others utilized the liquid assets of households to determine the possibility of farmers facing liquidity constraints (e.g., Uchida et al. (2009)), Sun et al. (2013) considered liquidity-constrained households as those that have to pay off their debt before a certain point in time, and Yi and Sun (2014) considered the share of the agricultural production cost to the total income.

We adopted the most practical method of measuring liquidity conditions, which is the use of households' liquid assets. In this study, liquid assets are defined as fixed productive assets, loans, cash in hand, and savings in 2009. Ideally, we could have included consumable durable goods; however, the dataset only provides the quantity of durable goods and not price information. The sample was then divided into two sections

at the point of 10 thousand yuan of liquid assets. The case in which a household has liquidity restrictions was defined as that in which the value of liquid assets is less than 10 thousand yuan; a household with more than 10 thousand yuan was regarded as unconstrained. In the two subsamples, the aggregate of living expenditures and agricultural costs for liquidity-constrained farmers was close to total income, whereas the aggregate for unconstrained farmers only accounted for 71% of the total income. Therefore, we believe that the method of using the value of liquid assets was successful in distinguishing households with liquidity constraints from the rest of the sample. Owing to the arbitrary standard for dividing the sample into liquidity-constrained and unconstrained groups, two other critical values were provided in the empirical analysis to divide the full sample at 5 and 15 thousand yuan of liquid assets for robustness check.

4.3. Heterogeneous multiplier effects of grain subsidy

The factors that can facilitate the multiplier effects of the grain subsidy program were investigated by classifying households based on specific characteristics. The preceding section evaluated the overall multiplier effect. However, it does not clarify how the grain subsidy program affects income change or which types of farmers are most affected by the subsidy. In this current section, we tested whether grain subsidy has heterogeneous multiplier effects depending on human capital, labor assets, regional effects, and land assets. Identification of these characteristics could provide guidelines to improve the efficiency of grain subsidy in the income promotion of households.

Without loss of generality, suppose that we divided the sample into two sections according to a specific criterion (e.g., years of education) and the methods of dividing the sample according to the rest of the household characteristics are similar to the above. Then, we set $Q_j, \forall\ j = [1,\ 2]$, where $Q_j = 1$ if a household is in section j and 0 otherwise. After grouping the households, we added interaction terms between the section dummy variables and subsidy level to determine the difference of the multiplier effects of the grain subsidy program on households with different education levels. Thus,

we estimated the empirical model as follows:

$$y_{i,t} - y_{i,t-1} = (Z_{i,t}\beta_t - Z_{i,t-1}\beta_{t-1}) + \sum_{j=1}^{2} (T_{i,t}\gamma_{j,t} - T_{i,t-1}\gamma_{j,t-1}) \times Q_j + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) . \quad (3)$$

Equation (3) is similar to Equation (2) but employs interaction terms composed of the subsidy, and section dummy variables to replace the subsidy level variable. Hence, $\gamma_{j,t}$ is the multiplier effect of grain subsidy for group j in year t.

5. Multiplier effects of grain subsidy

5.1. Benchmark results

Table 2 presents the results of the unrestricted model in Equation (2) that allows the coefficient values for the income multiplier, market background, and household characteristics in 2009 to differ from the values in 2010. The results show that the income multipliers in the two years are similar (approximately 2.3) and not statistically different using Wald test. Both estimations of the multipliers in the two years are significantly greater than 1 and thus indicate that farmers benefited more from grain subsidy than the amount of cash transferred. A possible reason is that extra cash relaxes the liquidity constraints and can be invested in other agricultural production activities or migration for off-farm work. Aside from the multiplier effect, total household farming land area has positive effects on household income. However, the effect in 2010 is statistically higher than that in 2009. Raising pigs is one of the most important and traditional rural farming production modes, and the proportion of farming households with pigs out of the total number of households with livestock is more than 90%. In this study, number of pigs was selected as an index variable for livestock income sources. With regard to the most important off-farm income, we used the ratio of off-farm work time to total available family labor time to represent opportunity costs because only part of household-level off-farm wage is observable; this strategy has also been adopted by Sun et al. (2013) and Yi and Sun (2014). This explanatory variable was found to be significant in the two years but with significant differences over time. As indicated by the estimation presented in Table 2, the multipliers are close in the unreported models

added with control variables, such as market information including per unit land profit or dry- and paddy-farmland areas.

Given that two adjacent period observations were employed, the estimates of grain subsidy multipliers are potentially underestimated. The income multiplier effects of grain subsidy are highly possible from rectifying ill-allocated productive assets caused by liquidity constraints, and such change could be considered as short term. By contrast, grain subsidy may stimulate farming households to invest productive assets, such as human capital, livestock, and machinery, to generate long-term income multiplier effects. Ideally, long-term effects can be realized if a panel that covers a long time span is employed. The availability of our data, however, indicates that we have little hope of identifying the long-term effect of grain subsidy. Nevertheless, the study potentially underestimated the multiplier effects of grain subsidy, and consequently, we are on the safe side in terms of overestimating the income multipliers.

Several coefficients in the model (2) examined by Wald tests are not statistically different; thus, setting restrictions that require these parameters to be similar over time is acceptable. Consequently, the model (2) can be rewritten as

$$y_{i,t} - y_{i,t-1} = (Z_{i,t} - Z_{i,t-1})\,\beta + (T_{i,t} - T_{i,t-1})\,\gamma + (\varepsilon_{i,t} - \varepsilon_{i,t-1})\,. \tag{4}$$

Technically, the interpretations of these coefficients in the above equation are similar to that of the ones in the model (2) but without subscript t. Coefficients that are statistically different in 2009 and 2010 were retained as they are. Table 3 shows the results for the restricted model (4). The positive externalities on farm household total income are established through the grain subsidy program in the first column. One yuan subsidy generated a total increase of 2.3 yuan, which includes 1.3 yuan corresponding to the indirect effects on income improvement. As expected, the multiplier from the restricted model in Equation (2) is close to that of the unrestricted model in Equation(4). Hence, the restricted model was utilized in the subsequent analysis without losing flexibility.

Table 3 also shows the multiplier effects of grain subsidy on agricultural, off-farm, and livestock income to identify which source of income is most enhanced by the program. The multiplier of grain subsidy on agricultural income is 1.7, whereas that on

off-farm income is 0.5 and not statistically significant. In addition, grain subsidy does not enhance livestock income according to the estimation. The agricultural income multiplier is much smaller than the total income multiplier because the amount of grain subsidy was excluded from the agricultural income estimation. No significant difference exists between 1.7 and 1.3 as indicated by a t-test. Therefore, the effect of grain subsidy on agricultural income is consistent with that in the estimation for total income. Overall, we conclude that the indirect effects of the grain subsidy program on income improvement of farming households stem from agricultural production. In other words, liquidity-constrained farmers allocate the extra cash to agricultural investments because of high shadow values in the total income.

Our estimation of the grain subsidy multiplier effects is in line with that in the research of Xu et al. (2012). Their study reported that the effects of agricultural tax reductions are similar to the effects of the introduction of subsidies in China and that the reduction of agricultural taxes helped increase farming income by increasing grain production responses via increased labor inputs and planting areas. At the multiplier level of 2.3, the aggregate contributions of grain subsidy to total income in 2010, including the total amount of subsidies and indirect effects, was 4%. This share is approximately half of the income effects of taxation reform reported by Xu et al. (2012). The reduced income effects could be the result of less liquidity constraints after rapid rural economic development from 2002 to 2010. Our finding that the major income increments stem from agriculture rather than from off-farm work is also consistent with that of Xu et al. (2012).

5.2. Liquidity constraints

By using the pool sample, we found that grain subsidies have a significant multiplier effect on total income and that the main increments in income originate from farming activities. However, our hypothesis for the liquidity constraints of farm households was not verified directly. We are interested in understanding how the liquidity conditions of farm households affect the grain subsidy program in relation to income increase. In this section, we tested whether grain subsidy generates heterogeneous income multi-

plier effects and how the program has changed the farming activities of households by providing more liquidities.

By using the restricted model provided by Equation (4), we found that the income multiplier effect of the grain subsidy program is statistically significant (greater than 1) for households with less liquid assets (Table 4, column (3)). However, the unconstrained group, defined as having liquid assets more than 10 thousand yuan, does not exhibit a significant multiplier effect because the coefficient of subsidy, 1.4, is not significantly different from 1 as determined by the t-test. The results of using 5 and 15 thousand yuan of liquid assets as critical values to split the sample are also shown in Table 4. The multiplier effects of the subsidy program for liquidity-constrained farmers are similar in the different classification methods (Table 4, column (1), (3) and (5)), whereas the subsidy program does not have a multiplier effect for unconstrained households (Table 4, column (2), (4) and (6)). We also noted that when 15 thousand yuan was utilized as a critical value to split the sample, the number of liquidity-constrained farming households became greater than that of unconstrained households. This finding indicates that the large number of potential liquidity-constrained farm households dominate in the income multiplier effect estimation of the grain subsidy program. In essence, the findings robustly reveal that liquidity-constrained households have utilized the subsidy efficiently to improve income.

The results in Table 5 confirm that grain subsidy has intensified the uses of input per unit of land for liquidity-constrained households, which could possibly increase the agricultural income. As indicated in the previous section, only agricultural income responded to the subsidy program; a question raised is how farmers change their activities to improve farming income. Related literature has emphasized the importance of fertilizers to crop growth (e.g., Zhu and Chen (2002)); hence, the effects of grain subsidy on fertilizer and labor use per unit of land and other inputs regarded as capital uses were examined in this study. Before empirical analysis, we examined the relationship between fertilizer use in liquidity-constrained farming households and that in unconstrained households through a t-test. The hypothesis that both groups employ the same amount of fertilizer per unit of land is rejected at 0.1% level. Households that

are likely to face liquidity constraints utilize less fertilizer than households that are less likely to face such constraints. Similar results were obtained for capital use.

To identify the effects of the grain subsidy program on input uses in liquidity-constrained and unconstrained households, the subsidy levels were made to interact with a dummy variable that represents a household's liquidity situation. In Table 5, the positive marginal effect of grain subsidy on fertilizer use per unit of land is 12 kg if an average liquidity-constrained household receives extra 1000 yuan subsidy. This result contradicts that of Huang et al. (2011) who found that grain subsidy does not generally stimulate fertilizer use. However, we found that grain subsidy does not intensify an unconstrained household's fertilizer use. Total capital uses, which include payments for pesticides, seeds, energy, and other materials, increased because of the grain subsidy program relaxing the liquidity constraints of liquidity-constrained households. However, labor uses exhibited no change even for the group of households with liquidity constraints. A plausible reason for this result is that the demand for hired market labor in China is low because of small farm sizes. Out of the total farming labor in our sample, 98% are from the households' respective families. In other words, farm households in China are not likely to use their subsidy to hire additional labors for agricultural production. Overall, these findings reveal the mechanism of how grain subsidy promotes agricultural income through input intensification aside from changing the cropping patterns proposed by Yi and Sun (2014). The changes in agricultural inputs clearly indicate that grain subsidy can distort the production decisions of farmers through the relaxation of liquidity constraints, which has also been mentioned by Yi and Sun (2014).

5.3. Differential multipliers of grain subsidy

This study also identified which subset of the liquidity-constrained population effectively utilize the subsidies to improve income. To simplify the estimations with various group dummy variables, we assumed that the income multipliers over the two years are similar. We believe this assumption is acceptable based on the results in Table 2 and 3.

Given the limited space, the multipliers for farm households that have specific characteristics were compiled and are shown in Table 6. Liquidity-constrained households with small farm sizes are likely to face tight liquidity constraints because only a few assets are available. However, households with better land endowments also face liquidity constraints, which indicates that the multiplier effect is also significant. The multiplier is 5.7 for small farms and 2.9 for large ones, and the difference between the two multipliers is not significant. In terms of education, the multiplier is greater for households with high education attainment (5.1) than for households with low education attainment (2.4). This finding is understandable because farmers with high education levels can learn new technology more quickly and efficiently than farmers who have low education levels. Individuals with better education generally have higher income; however, our results are based on liquidity-constrained households. With regard to the impact of labor amount, the multiplier is higher for households with more labor than those with less labor although the difference is not significant. Hence, the amount of labor is not a key factor that causes a household with less labor to have more binding liquidity constraints as described in Sadoulet et al. (2001). A possible reason is that even though more labor means more income sources, it also means more living expenditures in rural areas in developing countries. In other words, more labor in a family does not necessarily improve the household's liquidity condition.

Finally, the multipliers for households in the northwest and northeast areas are greater than that for households in other regions. The northwest region is the least developed area in China, and having extra cash could play an important role in income promotion. With regard to the large income multiplier for the northeast region, the average farm size of households in this region is 14.3 mu, which is almost thrice that of households in other regions. As pointed out by Yi and Sun (2014), large farm households also face severe liquidity constraints because a large farm size also means high liquidity demand for agricultural production.

6. Conclusion

This study investigated the indirect income effect of grain subsidy in China, a subject that was not provided sufficient attention in existing literature. We found that the multiplier effect of China's subsidy program is approximately 2.3, which means the indirect income effect dominates the values of direct payment from the grain subsidy program. The impressive multipliers obtained from the estimation reflect uncultured marginal income opportunities caused by the relaxation of liquidity constraints. Among the various sources of income, grain subsidy stimulates agricultural production and consequently increases agricultural income. However, the other two important income components, off-farm and livestock incomes, are not enhanced by the transferred subsidies.

As the major channels to utilize the subsidies to increase agricultural income, farmers use more fertilizers and other capitals per unit of land. Hence, the intensive marginal effects of providing liquidities help liquidity-constrained farm households improve their outputs and eventually increase cultivation benefits. The shadow values of relaxing liquidity constraints are particularly revealed by households with better education and poor farmers in the northwest and northeast areas in China. Households with small farming areas do not benefit considerably from the received subsidies because they have fewer areas to invest the extra cash provided by the program; thus, we did not find significant differences between the multipliers of small and large farms.

Two policy implications can be derived from these conclusions. First, as a dual-goal project, this study provides important information on the income effects of the grain subsidy program. Even though the magnitudes of income increments caused by the grain subsidy program are much smaller than that of the total income, the large value of the multiplier cannot be ignored in any cash transfer program in China. Hence, cash transfer programs in China are expected to succeed in increasing the income of farmers more than the amount of transferred cash. Although grain subsidy improves the income of farmers by relaxing liquidity constraints, it requires an enormous budget from the government because the current implementation process based on contracted land areas cannot identify liquidity-constrained households. Hence, the development of credit markets, such as micro loans, is urgently required to reduce the government

budget.

Second, although the subsidy program can improve the total income of liquidity-constrained rural households by providing more liquidities, the target efficiency could be enhanced if policy makers can identify farmers who can best use the subsidies, such as those in liquidity-constrained households with better education in poor regions. However, the current subsidies are distributed according to the contracted land area, which has been demonstrated to be not the most efficient means to improve the income of beneficiaries. The reason is that the multipliers are not statistically different for households with small and large farm sizes.

Again, the income multiplier effect of the grain subsidy program is only one of the two goals of this project. The tradeoff between improving farm households' income and grain production has to be considered. For example, the subsidy provided to the northwest region has an impressive income multiplier effect but is not effective for food production because this region is not one of the main grain-producing areas. In several regions, the effects of grain subsidy on income improvement and food security can be realized (e.g., in the northeast).

The limitation of this study is that the long-term income effect of the grain subsidy program was not determined because of data unavailability. Therefore, we might have underestimated the multiplier effect of grain subsidy. Future research should have a long panel to obtain both short- and long-term effects of the subsidy program. In addition, this study provides evidence that China's grain subsidy program can improve the agricultural income of farmers by affecting the planting decisions of farmers. However, this type of domestic support cannot be placed under the Green Box policy of the World Trade Organization (WTO) and needs to be carefully calculated under the WTO requirement of allowable aggregate measurement of support. Furthermore, research should be conducted on how to distribute the limited subsidy budget to maximize the income promotion effects.

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Table 1: Summary statistics

Variable	2009		2010	
	Mean	S.D.	Mean	S.D.
Income (1000 yuan)				
Total income	25.3618	27.3999	29.0907	29.5059
Farm income				
Agriculture	7.2285	8.6350	8.7880	11.0205
Livestock	3.4406	19.6343	3.4848	20.8814
Off-farm income	13.8806	17.8581	15.8829	18.9225
Other income	0.4186	1.7294	0.5238	2.0024
Grain subsidy	0.3935	0.4922	0.4112	0.5053
Other variables				
Age of household head	50.8976	9.4296	51.8896	9.4390
Average education (year)	8.1253	3.0220	8.0912	2.9487
Number of labor (age $>$ 16)	2.9141	1.1206	2.8970	1.1266
Number of pigs	1.9670	16.3832	1.6504	12.6004
Total farming land area (mu*)	7.2157	15.2682	7.0014	106168
Per unit land farming revenue (1000 yuan/mu)	0.7101	0.8438	0.8735	1.3113
Per unit land farming cost (1000 yuan/mu)	0.2246	0.2540	0.2540	0.4361
Off-farm labor share (%)	60.4125	57.9528	64.29	60.0065
Liquid assets (1000 yuan)	25.1831	66.1714	26.5873	58.1299
Social capital**	0.0754	0.2641	0.0726	0.2595
Number of households	4573		4573	

Data Sources: RCRE. * 1 hectare = 15 mu. ** we use 1 to represent a household has relatives who work as village leaders or work in local government, 0 for no such network.

Table 2: Impacts of grain subsidy on total income

	Median regression		Wald test of differences in coefficients (p-value)
	2009	2010	
Grain subsidy	2.2579***	2.4723***	0.5568
(1000 yuan)	(0.4873)	(0.4862)	
Farming revenue	2.1297***	2.5059	0.0184
(1000 yuan/mu)	(0.1697)	(0.1408)	
Farming cost	-2.2176***	-2.1071***	0.8414
(1000 yuan/mu)	(0.1697)	(0.3858)	
Off-farm labor share	7.9767***	8.7817***	0.0000
(%)	(0.2205)	(0.2128)	
Number of labor	2.5490***	2.7958***	0.0060
	(0.1538)	(0.1527)	
Average education	0.0047	-0.0148	0.5721
(year)	(0.0558)	(0.0576)	
Liquid assets	0.0058**	0.0063**	0.7504
(1000 yuan)	(0.0020)	(0.0023)	
Total farming land	0.0319**	0.0934***	0.0000
(mu)	(0.0103)	(0.0174)	
Social capital	0.2428	0.1471	0.7940
	(0.6747)	(0.6876)	
Number of pigs	0.0701***	0.0376***	0.0000
	(0.0067)	(0.0087)	
Regional effects: base = East			
South	0.2635		
	(0.4292)		
Central	-0.4358		
	(0.2875)		
North	-0.6382		
	(0.3585)		
Northwest	0.4508		
	(0.3167)		
Southwest	-0.2035		
	(0.3000)		
Northeast	-0.0934		
	(0.3523)		
Constant characteristics: parameter is $(\beta_t - \beta_{t-1})$			
Age of household head	-0.0082		
	(0.0104)		
Constant	0.0264		
	(0.7387)		
Number of households	4573		

Significance codes: * 5% level, ** 1% level, *** 0.1% level. Standard errors are in parentheses.

Table 3: Impacts of grain subsidy on income using 2009-2010 data (restricted model)

	(1) Total income (Median regression)	(2) Agricultural income (Robust regression)	(3) Off-farm income (Robust regression)	(4) Livestock income (Median regression)
Grain subsidy	2.3184***	1.6675**	0.4515	0.1264
2009-2010 (1000 yuan)	(0.4459)	(0.5764)	(0.5608)	(0.1108)
Farming revenue 2009-2010		2.3759***		
(1000 yuan/mu)		(0.3849)		
Farming revenue in 2009	2.1449***			
(1000 yuan/mu)	(0.1582)			
Farming revenue in 2010	2.5206***			
(1000 yuan/mu)	(0.1266)			
Farming cost 2009-2010	-2.1037***	-3.7236***		
(1000 yuan/mu)	(0.3436)	(1.0342)		
Off-farm labor share in 2009	8.0037***	0.2909	10.0197***	-0.1906*
(%)	(0.2178)	(0.1561)	(0.7023)	(0.0760)
Off-farm labor share in 2010	8.8058***	-0.3021*	11.4695***	0.0962
(%)	(0.2100)	(0.1426)	(0.6782)	(0.0692)
Number of labor			3.6025***	0.0246
2009-2010			(0.3187)	(0.0437)
Number of labor in 2009	2.5211***	0.0655		
	(0.1514)	(0.0999)		
Number of labor in 2010	2.7859	0.2643**		
	(0.1507)	(0.0997)		
Average education	-0.0042	0.0246	0.0412	-0.0112
2009-2010	(0.0533)	(0.0471)	(0.0834)	(0.0173)
Liquid assets	0.0059**	0.0040**		0.0008
2009-2010 (yuan)	(0.0019)	(0.0015)		(0.0007)
Liquid assets in			-0.0138	
2009 (yuan)			(0.0115)	
Liquid assets in			0.0270*	
2010 (yuan)			(0.0132)	
Total farming land		0.0531		
2009-2010 (mu)		(0.0337)		
Total farming land in 2009	0.0342**			
(mu)	(0.0101)			
Total farming land in 2010	0.1028***			
(mu)	(0.0154)			
Number of pigs in 2009	0.0696***			0.0577***
	(0.0066)			(0.0013)
Number of pigs in 2010	0.0377***			0.0432***
	(0.0086)			(0.0577)
Pig price 2009-2010				0.3004
(1000 yuan/kg)				(0.8967)
Social capital	0.1910	0.5642	-0.4027	
2009-2010	(0.6479)	(0.4341)	(1.0819)	
Social capital in 2009				0.4520*
				(0.2142)
Social capital in 2010				0.2101
				(0.2148)
Regional effects	Yes	Yes	Yes	Yes
Constant characteristics: parameter is $\beta_t - \beta_{t-1}$				
Age of household head	-0.0034	-0.0253**	-0.0203	-0.0034
	(0.0098)	(0.0076)	(0.0135)	(0.0031)
Constant	-0.3972	1.8918***	0.5779	0.1971
	(0.5765)	(0.4473)	(1.0045)	(0.1788)
Number of households	4573	4573	4573	1778†

Significance codes: * 5% level, ** 1% level, *** 0.1% level. Standard errors are in parentheses. † Livestock income estimation only uses the information of households who have livestocks.

Table 4: Impact of grain subsidy on total income based on various divisions of the sample according to liquid assets using median regression (2009-2010)

	Divide the sample at 5 thousand yuan of liquid assets		Divide the sample at 10 thousand yuan of liquid assets		Divide the sample at 15 thousand yuan of liquid assets	
	(1)	(2)	(3)	(4)	(5)	(6)
	≤ 5	> 5	≤ 10	> 10	≤ 15	> 15
Grain subsidy	4.8896***	1.6035***	3.3721***	1.3624*	2.7301***	1.3379*
2009-2010 (1000 yuan)	(1.2949)	(0.4672)	(0.9058)	(0.5345)	(0.6146)	(0.6497)
Farming revenue 2009-2010		3.1077***		2.9364***		2.9617***
(1000 yuan/mu)		(0.1462)		(0.1640)		(0.1785)
Farming revenue in 2009	0.7427*		1.5616***		1.6400***	
(1000 yuan/mu)	(0.3061)		(0.2631)		(0.2363)	
Farming revenue in 2010	2.6163***		2.4025***		2.6260***	
(1000 yuan/mu)	(0.2994)		(0.2239)		(0.1904)	
Farming cost 2009-2010		-2.3472***	-0.9799	-2.9850***	-2.5406***	-1.8002***
(1000 yuan/mu)		(1.0385)	(0.5142)	(0.5147)	(0.4666)	(0.6029)
Farming cost in 2009	-2.5527*					
(1000 yuan/mu)	(1.2363)					
Farming cost in 2010	-4.1137***					
(1000 yuan/mu)	(0.6305)					
Off-farm labor share	7.9699***		8.6023***		8.5115***	
2009-2010 (%)	(0.3535)		(0.3107)		(0.2735)	
Off-farm labor share in 2009		8.0528***		7.9848***		7.8356***
(%)		(0.2600)		(0.2941)		(0.3252)
Off-farm labor share in 2010		8.8129***		9.1836***		9.1797***
(%)		(0.2499)		(0.2839)		(0.3190)
Number of labor				3.4504***		3.2825***
2009-2010				(0.1964)		(0.2227)
Number of labor in 2009	2.1203***	2.7270***	1.7125***		2.1598***	
	(0.3055)	(0.1734)	(0.2394)		(0.2093)	
Number of labor in 2010	2.5824***	2.9581***	2.2381***		2.6457***	
	(0.2993)	(0.1737)	(0.2380)		(0.2073)	
Average education	-0.1779	0.0549	-0.0703	-0.0432	-0.0593	-0.0262
2009-2010	(0.0954)	(0.0643)	(0.0786)	(0.0775)	(0.0690)	(0.0908)
Liquid assets	0.0055	0.0051**	0.0179**	0.0057**	0.0163**	0.0062**
2009-2010 (yuan)	(0.0069)	(0.0019)	(0.0065)	(0.0020)	(0.0058)	(0.0021)
Total farming land	-0.0150		-0.0044		0.0066	
2009-2010 (mu)	(0.0498)		(0.0433)		(0.0373)	
Total farming land in 2009		0.0498***		0.0543***		0.0496***
(mu)		(0.0102)		(0.0107)		(0.0111)
Total farming land in 2010		0.1389***		0.1498***		0.1416***
(mu)		(0.0163)		(0.0176)		(0.0187)
Number of pigs	0.2563***		0.3294***			0.2443***
2009-2010	(0.0152)		(0.0147)			(0.0194)
Number of pigs in 2009		0.0638***		0.0520***	0.0057	
		(0.0070)		(0.0073)	(0.0084)	
Number of pigs in 2010		0.0237***		0.0068	0.0221	
		(0.0106)		(0.0113)	(0.0114)	
Social capital	-0.7655	-0.0004	1.4449	-0.2011	-0.2231	-0.1276
2009-2010	(1.3144)	(0.7437)	(1.1140)	(0.8383)	(0.9339)	(0.9468)
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant characteristics: parameter is $\beta_t - \beta_{t-1}$						
Age of household head	-0.0371	0.0009	-0.0199	0.0000	-0.0114	-0.0001
	(0.0188)	(0.0113)	(0.0152)	(0.0132)	(0.0132)	(0.0152)
Constant	1.0963	-0.5270	0.1216	-0.0240	-0.3886	-0.0347
	(1.1320)	(0.6586)	(0.9167)	(0.7429)	(0.7986)	(0.8447)
Number of households	1366	3207	2058	2515	2543	2030

Significance codes: * 5% level, ** 1% level, *** 0.1% level. The results reported are based on model (4).

Table 5: Input intensity effects of grain subsidy by household fixed effect model using 2009-2010 data

	Fertilizer use (kg/mu)	Labor use (number/mu)	Other capital use (1000 yuan/mu)
Low[a] value of liquid assets (dummy) ×	12.1636***	1.0421	0.0177*
grain subsidy (1000 yuan)	(3.7183)	(1.3766)	(0.0090)
High value of liquid assets (dummy) ×	2.1793	-0.4996	0.0007
grain subsidy (1000 yuan)	(1.7573)	(0.6611)	(0.0053)
Agricultural product farm gate price	0.4928	0.5717*	0.0002
(yuan/kg)	(0.3478)	(0.2269)	(0.0010)
Fertilizer price	-0.7231		
(1000 yuan/kg)	(0.4255)		
Average education	0.0071	-0.1489	0.0002
(year)	(0.1878)	(0.1356)	(0.0064)
Farming area	0.0126	-0.0150	0.0003***
(mu)	(0.0186)	(0.0156)	(0.0001)
Pesticide price			0.2017***
(1000 yuan/kg)			(0.0499)
Plastic film price			0.9083***
(1000 yuan/kg)			(0.2517)
Diesel price		-140.3722	0.1001
(1000 yuan/kg)		(109.0817)	(0.4406)
Seed price			0.0184
(1000 yuan/kg)			(0.0502)
Off-farm labor share		-1.8317**	
(%)		(0.6432)	
Number of labor		-0.5901	
		(0.4526)	
Constant	43.1818***	21.6000***	0.0561***
	(1.8582)	(1.9756)	(0.0064)
Observations	9146	9146	9146

Significance codes: * 5% level, ** 1% level, *** 0.1% level. Standard errors are in parentheses. [a] 10 thousand yuan is the critical value for the liquid assets.

Table 6: Multipliers for liquidity-constrained farm households with different characteristics using 2009-2010 data[a] (Median regression)

	Multipliers (Median regression)	Test of differences in multipliers (p-value) (Comparison object is prior multiplier)
Farming land area		
Small ($\leq$ 6 mu)	5.6972***	–
	(1.6642)	
Large ($>$ 6 mu)	2.9370**	0.1640
	(1.0672)	
Education		
Low ($\leq$ 5 years)	2.3711*	–
	(1.1476)	
High ($>$ 5 years)	5.1487***	0.0661
	(0.9995)	
Number of labor		
Low ($\leq$ 3)	3.3607*	–
	(1.4787)	
High ($>$ 3)	3.2792**	0.9648
	(1.1182)	
Area		
East	1.9017	–
	(2.3977)	
South	0.6841	0.8076
	(4.3919)	
Central	3.4449	0.5901
	(2.6345)	
North	2.4193	0.8496
	(4.7165)	
Northwest	5.9912***	0.4681
	(1.3866)	
Southwest	1.3982	0.0743
	(2.1644)	
Northeast	7.9587***	0.0258
	(1.9974)	

Significance codes: * 5% level, ** 1% level, *** 0.1% level. Standard errors are in parentheses.
[a] The results are based on 2058 liquidity-constrained households using 10 thousand yuan of liquid assets for the critical value to split the sample.