Cash Constraints and Sticky Input Expenditures:

-Experimental Evidence from Malawi

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Abstract

The study investigated the proposal by Duflo et al. (2009) that rural households may be stochastically present-biased and face small fixed costs in input markets, causing them to under-invest in inputs. Supply of inputs at harvest time may then lead to higher investments than when inputs are supplied at planting time. Investment in inputs at harvest time can potentially serve as a commitment device (DellaVigna 2009). Experiments were run at harvest time and planting time to assess how a given budget was allocated for inputs or for food. Households were found to be willing to spend a significantly higher proportion of a given budget on inputs at planting time than at harvest time. A large gap between WTP and WTA prices still supports that input sales at harvest time may enhance input investments.

Key words: Malawi, input subsidies, cash constraints, time inconsistency, input delivery timing.

JEL Classification codes: Q12, Q18

1. Introduction

Malawi has implemented a large-scale agricultural input subsidy program since 2005 after a period with severe food shortages and the program has contributed to increased food availability, higher real wages, economic growth and poverty reduction (Dorward and Chirwa 2011). The targeted input subsidy program distributes coupons (providing more than 90% subsidy in the 2008/09 season) to about two million of about two and a half million smallholder farm households where priority should be given to poor and vulnerable households (Dorward et al. 2008; Ricker-Gilbert and Jayne 2008; 2009; MoAFS 2008).

Important reasons for the reintroduction of large-scale subsidies were that the inputs were not affordable for the poor smallholder farmers and that it was cheaper to import fertilizer than to import food. The fact that the country managed to quickly switch from being a "beggar for food" to becoming a net exporter has also been very important for the national pride. While the program contributed to national and household food security and maize export to neighboring countries, the costs of the program also rose sharply with the increasing international fertilizer and oil prices. The budgetary costs of the input subsidy program therefore increased from 50 million US$ in 2005/06 to 360 million US$ in 2008/09 or close to 15% of Malawi's total government expenditure. There is therefore a need to reduce the costs of the program without reducing the food production. This paper investigates one possible approach to reducing such costs without affecting the food production negatively.

An important reason for advocacy of fertilizer subsidies is that rural households in Malawi are very poor and typically lack cash resources to buy profitable inputs and this causes too low input use. Poverty in combination with liquidity constraints may cause high discount rates and this may lead to low investment (Holden et al. 1998). Time inconsistent behavior in form of present bias has been observed in many social experiments and may also contribute to explain low input use and investment levels in developing countries (Duflo et al. 2009).

The seasonality of rain-fed agricultural production which dominates in Malawi make food shortages seasonal and food has to be stored from one harvest season and up to the next harvest season. More than 60% of the rural households in Malawi are still net buyers of maize (the main staple food) after the introduction of the subsidy program. At planting time they may face a dilemma between using scarce cash resources to buy food to meet more immediate needs or to buy inputs to meet next year's needs. Time inconsistent behavior may then cause too low investment in inputs. The two standard approaches to deal with this problem have been to provide credit for input purchase or to subsidize the inputs. Input credit programs have had greater success in reaching net sellers than net buyers of agricultural outputs, however, as payback has often been in form of production output. Input credit programs have also faced large moral hazard problems contributing to high default rates and covariate risk has made it hard to sustain such programs in environments with substantial weather risk.

Use of subsidies could then be a way of internalizing the externality related to sub-optimal input use and such subsidies could enhance both productivity and equity. One may, however, question whether such subsidies are the most appropriate and cost-effective instrument to address this market failure. Duflo et al. (2009), based on a study and social experiments in Kenya, found that poor households are willing to invest in response to small, time-limited discounts in form of free delivery of fertilizer just after harvest. Their finding may indicate that distribution and selling of fertilizer just after harvest can be a better system than selling fertilizers at planting time when households may no longer have sufficient cash from the selling of their harvest. Buying of inputs at harvesting time for the next growing season may then serve as an commitment device

(DellaVigna 2009) and reduce the need for subsidies. It could also reduce the pressure on the input delivery system at planting time and reduce to risks of too late delivery of inputs with subsequent productivity losses.

This study investigates the willingness of rural households in Malawi to allocate funds for input purchase at harvest time and whether this willingness is as high or higher at harvest time than at planting time. Rural households do not face food shortages at harvest time and may then be more willing and able to spend funds on inputs. On the other hand, net buyers of food may still prefer to buy additional food at harvest time when food prices are at their lowest. More than 60% of rural households in Malawi are net buyers of food also after the input subsidy program has been implemented (Holden and Lunduka 2010a). It is therefore not obvious that the willingness to buy inputs at harvest time is high or higher than at planting time.

There may be reasons to worry that the large scale input subsidy program in Malawi has undermined household incentives to spend funds on inputs. On the other hand, access to subsidized inputs is constrained and the subsidized prices therefore do not reflect the true shadow prices of inputs for the households. A novel contribution of this paper was to use an experimental approach to elicit shadow prices for fertilizers in a context where actual prices paid were endogenous and dependent on unobservable household characteristics.

Cash constraints may limit the ability of households to purchase inputs. The experiments were designed to control for this to obtain estimates of marginal expenditure shares and unconstrained shadow prices for fertilizer inputs. In addition an experiment was conducted to assess the gap between WTP and WTA prices for an input package where this gap could be assessed.

The results showed that households were willing to allocate a significantly larger share of the given budget to fertilizer purchase and a significantly lower share to food purchase at planting time than at harvesting time. Households had high WTP prices for fertilizer when relieved from their cash constraint. Only 20-25% of the households were willing to buy the input package at the commercial price while only 10-20% of households who were lucky to win the input package were willing to resell the package at the commercial price if it first were given to them. The gap may be explained as a cash constraint rather than as an "endowment effect" (Plott and Zeiler 2005; 2007; Horowitz and McConnel 2002).

The paper is organized as follows. Part 2 gives an overview of the setting with the input subsidy program. Part 3 presents a theoretical framework followed by a description of the experimental approach in part 4. The results are presented and discussed in part 5, followed by the conclusions.

2. The setting

Malawi is a small landlocked country in Southern Africa where more than 80% of the households depend on agriculture for their livelihood. Weather risk and bad policies have contributed to severe household and national food insecurity. The last severe food shortages occurred in 2004/05 with the consequence that the newly elected president, Bingu wa Mutharika, embarked upon a comprehensive input subsidy program quite contradictory to the recommendations from IMF and the World Bank. Arguments for the subsidy program were that it is cheaper to import fertilizer than to import food. Food production in the country increased dramatically and Malawi became a net exporter of food (maize) in the following years and the program has been coined a success story (Denning et al. 2009).

The rural population in Malawi constitutes 88% of the total population and the country has one of the highest rural population densities in Africa of about 2.3 persons per ha. The average farm size is about 1.12ha. Farm sizes are smaller in the southern region of the country where population density is higher (SOAS 2008). The incidence of poverty is also higher in the southern region where 64% of the households are estimated to fall below the poverty line against 52% at the national level. Maize is the main staple crop grown by 97% of the rural households (SOAS 2008). Some households also grow cash crops such as tobacco, sugarcane and cotton but such crops are on average grown on less than 10% of the farm area while maize covers 65-70% of the farm area (Holden and Lunduka 2010a).

More than 60% of the rural households in the central and southern regions of the country are net buyers of maize even with the input subsidy program (Holden and Lunduka 2010b). Access to input subsidies has, however, reduced the food deficit of net buyers of food and more households have become self-sufficient or even net sellers (ibid.). Most of the agricultural production is rain-fed and the rainfall is uni-modal with a rainy season from December to April. This implies that the planting season is in December and harvesting season is in May-June for the main staple crop, maize.

The Government of Malawi has increased its budget share for agriculture from 6.1% in the period 200-2005 to 15.9% in 2006-2009 and is aiming to increase it further to 24% by 2015 with the implementation of the Agricultural Sector Wide Approach (ASWAp) (GoM 2010).

The Ministry of Agriculture and Food Security (MoAFS) in Malawi has developed targeting criteria for the distribution of input subsidies that emphasize targeting land-owning rural resident households and particularly poor and vulnerable households (MoAFS, 2008). The MoAFS is issuing and distributing free coupons through their local staff in collaboration with local leaders to identified beneficiary households. Households receiving the coupons can take the coupon to the nearest depot where inputs are sold and pay a small amount (MK[1]500 per 50 kg bag in the 2009/10 season) to get the inputs. In the 2008/09 season about 2 million input packages were distributed to the about 2.5 million rural households in the country, indicating coverage of close to 80% of the households. A recent study (Holden and Lunduka 2010a) has identified substantial leakages of coupons, secondary markets for coupons and cheap fertilizers, and substantial targeting errors. Access to inputs and the actual prices paid therefore depend on household characteristics, including households' social capital in terms of social networks, access to information and ability to negotiate. Wealthier households have been found to be more successful while female-headed households have been less successful in obtaining subsidized inputs (Dorward et al. 2008; Holden and Lunduka 2010a).

The costs of fertilizer subsidies to the Malawian government have increased with the increase in international fertilizer prices. In 2006/07 the fertilizers represented 40% of the agricultural budget (Dorward et al., 2008). With the very high fertilizer prices in 2008/09 the spending on fertilizer imports and the fertilizer subsidy program exceeded the initial budget by more than 100% (Logistic Unit, 2009). Table 1 gives an overview of the costs of the input subsidy program versus some benchmarks. After the 2008/09 the country has experienced shortages of foreign exchange which also have lead to fuel shortages. Tobacco is the main export crop but tobacco export is also limited by international agreements. Maize exports have to some extent compensated for the fertilizer import cost.

[1] 1 US$=140 Malawi Kwacha(MK).

Table 1. Costs of the Farm Input Subsidy Program

	Year	Costs (million US$)
Cost of importing food in drought year	2004/05	110
Cost of fertilizer subsidy program	2005/06	50
Cost of fertilizer subsidy program	2006/07	91
Cost of fertilizer subsidy program	2008/09	360
Total donor assistance to Malawi	2007	500

Sources: Harrigan 2005; Dorward et al. 2008; Denning et al. 2009; Logistic Unit 2009.

The donor community sees the input subsidy program as a temporary solution to the food insecurity problems of the country and provides conditional support to the program as general budget support or through funding of particular elements of the program such as the seed component.

Malawi's president argues that the subsidies have come to stay and has become the chairman of the African Union and other African countries are looking to Malawi and consider implementing similar policies. International fertilizer prices are again on the increase, however, and there is a need to keep the budgetary costs down. The main argument for the program is that rural households cannot afford to buy the inputs if they are not subsidized and their removal will lead to new food shortages. Provision of credit has been an alternative approach that also has given mixed results due to high default rates. It is in this perspective that this study explores the alternative proposal to sell inputs at harvest time to reduce the need for subsidies and provide a commitment devise that can reduce the need for credit as well.

3. Theoretical framework

Duflo et al. (2008) found that small investments in fertilizers generated returns of 36 percent on a seasonal basis equivalent to 70 percent per year without changes in additional practices in a study in Kenya. They were puzzled that farmers invested so little in fertilizers when profits were so large and the technology is well known and divisible. One possible explanation could be fixed costs related to buying and learning about the technology but they found that these could not be large enough to provide an explanation. They therefore looked for a behavioral explanation in form of present-bias such as has been observed also in relation to investments in pension plans in the United States (Choi et al. 2008) and drew on models of procrastination in psychology and economics. Strong presence bias has been observed among poor rural households in developing countries and is related to liquidity constraints and poverty (Holden et al. 1998). Empirical evidence shows that the discounted utility model (Samuelson 1937) represents a poor fit to the reality of inter-temporal choices (Frederick et al. 2002).

Laibson (1997) and O'Donoghue and Rabin (1999) have formulated an alternative (β, δ) preference model

1) $$U_t = u_t + \beta\delta u_{t+1} + \beta\delta^2 u_{t+2} + \beta\delta^3 u_{t+3} + \ldots.$$

where the difference from the standard discounted utility model is the parameter $\beta \leq 1$ which captures self-control problems. The model has also been expanded by O'Donoghue and Rabin (2001) to handle naïve expectations (overconfidence) related to future self-control.

We take this alternative (β, δ) preference model as a basis for analyzing behavior of poor rural producer-consumer households who make consumption and investment decisions facing cash constraints and imperfections in factor markets. Self-control problems could cause the timing of offering of investment opportunities to rural households to matter for how much they are willing to invest, like suggested by Duflo et al.(2008). This could cause households to be willing to invest more if offered to buy inputs at harvest time rather than waiting and offering them to buy the inputs at planting time when the inputs are to be used but when also more of the cash resources have been spent on other items. Purchase of inputs at harvest time may be a self-control device leading to higher investments.

The model covers three points in time, first harvest time (t=1), planting time (t=2), and second harvest time (t=3). Households are offered to allocate a fixed budget, *Y*, for food consumption, *C*, input investments, *F*, or other goods expenditure, *X*, such that $Y=C+F+X$. This offer is made either at harvest time (t=1) or at planting time (t=2) and the budget offered at the two points in time is the same, $Y^1=Y^2$. For a household *i* that receives the offer at harvest time (t=1), it will allocate the budget as $Y^1=C^1+F^1+X^1$ such that it maximizes expected utility. Producer-consumer households do not have an immediate need for food at harvest time. If they prefer to spend extra funds on food at this point in time it is done in order to save the food and consume it later, e.g. at planting time. With (β,δ) preferences, the expected utility of the food expenditure at first harvest time (t=1) may be formulated as: $U^1(C^1)=\beta\delta u_2(C^1)$. On the other hand, if the offer is made at planting time, food expenditure may be for immediate consumption and the utility may be formulated as: $U^2(C^2)=u_2(C^2)$. The expected utility of the allocation of the budget for inputs when the offer is made at harvest time (t=1) and when inputs only can be used in the following planting time and yield benefits after the next harvest time (t=3), can be formulated as: $U^1(F^1)=\beta\delta^2 u_3\left\{\left(1+r^F\right)F^1\right\}$ where r^F is the expected return to input investment. When the budget offer is made at planting time the expected utility may be formulated as:

$U^2(F^2) = \beta\delta u_3\left\{\left(1+r^F\right)F^2\right\}$. Optimal budget allocations at the two points in time imply:

2) $\frac{\partial U^1(C^1)}{\partial Y^1} = \frac{\partial U^1(F^1)}{\partial Y^1}$ and $\frac{\partial U^2(C^2)}{\partial Y^2} = \frac{\partial U^2(F^2)}{\partial Y^2}$

Substituting in the expected utilities with (β, δ) preferences yields

$\frac{\beta\delta\partial u_2(C^1)}{\partial Y^1} = \frac{\beta\delta^2\partial u_3\left\{\left(1+r^F\right)F^1\right\}}{\partial Y^1}$ which reduces to

3) $\frac{\partial u_2(C^1)}{\partial Y^1} = \frac{\delta\partial u_3\left\{\left(1+r^F\right)F^1\right\}}{\partial Y^1}$

for harvest time budget allocation decisions and to

4) $\frac{\partial u_2(C^2)}{\partial Y^2} = \frac{\beta\delta\partial u_3\left\{\left(1+r^F\right)F^2\right\}}{\partial Y^2}$

for planting time budget allocation decisions.

It follows that, *ceteris paribus*, $C^1 < C^2$ and $F^1 > F^2$ if $\beta < 1$. Offering of inputs at harvest time may then be a commitment devise that enhances input expenditure and use.

But what if food prices vary systematically across seasons and typically are much lower at harvest time than at planting time such that $p^1 < p^2$? We then get

5) $\frac{\partial u_2(p^1C^1)}{\partial Y^1} = \frac{\delta\partial u_3\left\{\left(1+r^F\right)F^1\right\}}{\partial Y^1}$

6) $$\frac{\partial u_2(p^2C^2)}{\partial Y^2} = \frac{\beta\delta\partial u_3\left\{\left(1+r^F\right)F^2\right\}}{\partial Y^2}$$

It then follows that $C^1 < C^2$ and $F^1 > F^2$ only if $\beta < \frac{p^1}{p^2}$ and households with rational price expectations will allocate more of a given budget for inputs relative to food at planting time than at harvest time when $\frac{p^1}{p^2} < \beta \leq 1$.

Transaction costs in commodity markets cause selling prices to be lower than buying prices and this is likely to be the case both for food and inputs. However, transaction costs are typically relatively larger in input markets than in food markets (Binswanger and Rosenzweig 1986). Rural households are therefore likely to be hesitant to sell inputs and food that they have bought and they are not likely to do so unless they have been exposed to some form of shock because

7) $$\frac{\partial u_2(p^1C^1)}{\partial Y^1} = \frac{\delta\partial u_3\left\{\left(1+r^F\right)F^1\right\}}{\partial Y^1} > \frac{\partial u_2(p_{Fs}F^1)}{\partial Y^1}$$

where $p_{Fs} < p_{Fb}$ and represent the selling and buying prices of inputs. Such a gap between selling and buying prices is sufficient for input expenditures to be “sticky”. This could also facilitate higher input investments if inputs are offered at harvesting time when food prices are lower than if inputs only are offered at planting time when also the available cash budget may have become lower, $Y^2 < Y^1$. A severe shock may, however, destabilize the inter-temporal balance and cause households to resell the inputs at a lower price. The risk that they would do so depends on how the shock would affect a number of the parameters that become household-specific in the reformulated model:

8) $$\frac{\partial u_2(p^1C_i^1)}{\partial Y^1}=\frac{\delta_i\partial u_3\left\{\left(1+r_i^F\right)F_i^1\right\}}{\partial Y^1}$$

9) $$\frac{\partial u_2(p^2C_i^2)}{\partial Y^2}=\frac{\beta_i\delta_i\partial u_3\left\{\left(1+r_i^F\right)F_i^2\right\}}{\partial Y^2}$$

This implies that the discount factor, δ_i, the expected return to inputs, r_i^F, and the present bias parameter, β_i, are household specific and may be affected by shocks. Shocks may cause the discount rate and the present bias parameter to increase and the expected return to inputs to decrease. A possible consequence of a shock could then be distress sales of assets or inputs that were bought at harvest time and before the shock occurred and this may further affect expected returns.

The discount rate, the present bias parameter and the expected return functions cannot be directly observed but experiments are constructed to assess the existence of presence bias and whether this can be utilized to design a commitment device something which also depends on the transaction costs in the input market. It is commonly assumed that poor people have high discount rates and have a tendency towards stronger present bias and are more vulnerability to shocks and empirical evidence is also in line with this (Holden et al. 1998). Wealth accumulation substitutes for missing markets and alleviates constraint sets (Yesuf and Bluffstone 2009). This implies that risk aversion that is related to wealth also can affect input decisions as poorer households tend to be more risk averse and less able and willing to go for risky investments. Loss aversion may also cause households to be willing to take less risk when they face a downside risk versus a situation where they do not face such downside risk (Binswanger 1980; Wik et al. 2004; Yesuf and Bluffstone 2009). Risk and risk aversion may therefore also affect input demand and the responses in our experiments but this was not directly tested in our experiments. It could, however, be an interesting area for follow up research.

4. Experimental methods and data

The survey covered a random sample of 450 households in two districts in Central Malawi (Kasungu and Lilongwe) and four districts in Southern Malawi (Chiradzulu, Machinga, Thyolo, and Zomba) (Lunduka, 2010). About 89% of the Malawian population lives in Central and Southern Malawi. Our survey should therefore be fairly representative of a large share of the population. The data were collected in three rounds, in 2006, 2007 and 2009. Only 378 of the initial 450 households were found and interviewed in the third round. The experiments were added to the survey instrument in the 2009 survey round.

The budget allocation experiment was hypothetical. The households were asked to allocate a cash amount of MK 10 000[2] that they were free to decide on how to use among a) buying fertilizer, b) buying food, c) buying other important/urgent commodities, d) investing or saving for later use. The households were exposed to this experiment either at harvest time (June) or at planting time (December) for a part of the sample.

A real experiment was conducted where the households had the choice between 5 kg (1/10th of a bag) basal fertilizer and a varying amount of money determined by the throw of a dice. The amount of money varied between MK 200 and 1500. These amounts range from 50 to 375 percent of the commercial price of fertilizer at the time of the experiments.

The next experiment involved randomly allocating the households with an input package for maize production consisting of one bag of basal fertilizer, one bag of urea, and one bag of hybrid

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[2] The daily wage in unskilled rural employment was about MK 300 at the time of the survey. An input package of 2 bags of fertilizer and seeds costed about MK 9 000.

maize seeds, or if they were not lucky to "win" the package, they were offered the opportunity to buy the same package. The allocation of the package for free was determined by the toss of a coin. The lucky winners were then offered the possibility of reselling the package at an amount determined by throwing a dice. Similarly, those that were not lucky were offered to buy the package at an amount determined by throwing the dice. The price range for the package was from MK1000 (full subsidy) to MK9000 (no subsidy) based on the price and subsidy rates decided by the Malawian government for the 2009/10 growing season. The experiment should establish whether there is a gap between WTP and WTA prices when households' cash constraints are affecting the WTP prices unlike in the real experiment where the households had the choice between 5 kg fertilizer and a randomized amount of cash. However, the cash constraint effect may be confounded with an "endowment effect" such that we have to be careful with the interpretation here (Plott and Zeiler, 2005; 2007; Horowitz and McConnell, 2002). In any case the experiment investigates the incentives to resell an input package when prices are known and exogenously given. A gap between WTA and WTP prices implies a lower probability that inputs are resold when they first have been acquired.

To assess factors affecting budget allocation priorities Tobit models were used because there were substantial number of zero responses for each commodity (demands for fertilizer and food). To further investigate factors that affect households' choices between cash and fertilizer the data from the price experiment were regressed on household characteristics, and geographical location (district). Random effects logit models were used for this. Similar econometric analysis was also made for the WTA and WTP for the input package.

5. Experimental results and discussion

The basic findings from the experiments are presented in this section. In the hypothetical budget allocation experiment households were asked how they would allocate a cash amount of MK 10 000 that they were free to decide on how to use among; a) buying fertilizer; b) buying food; c) buying other important/urgent commodities; and d) saving and investing in business. Summary statistics by type of expenditure and time of the experiment are summarized in Table 2. It can be seen that the allocation for fertilizer was significantly higher at planting time than at harvest time while the opposite was the case for food. Econometric analyses of the determinants of household allocation for fertilizers and food are analyzed with Tobit models with district fixed and random effects in Table 3 below.

We see also from the regression analyses in Table 3 that the willingness to allocate money for fertilizer out of a given budget in December (planting time) was significantly higher than at harvest time in June-July. The difference was a large as about 30% of the total budget. The willingness to allocate money for food was significantly lower at planting time in December than at harvest time in June-July. This could be because food prices are lower at harvest time than at planting time.

Significant wealth effects are also observed. Households with better quality houses and higher asset values allocated significantly more cash for fertilizer. This is in line with the general theory that poverty can reduce the willingness and ability to invest and result in higher discount rates as immediate needs are given higher priority. There was a weak indication that households with smaller farm sizes were willing to allocate a larger share of the budget for fertilizers as farm size was negative and significant at 10% level in one of the models. Land shortage may increase the need to intensify farm production by use of more fertilizer.

Table 2. Allocation of a budget of MK10000 by type of expenditure and time of experiment

Time of experiment		Fertilizer	Food	Other needs	Save-Invest
Harvest time	Mean	4295	2453	1660	1592
	Standard error	175	128	113	133
	Sample size	280	280	280	280
Planting time	Mean	6563	1510	1296	630
	Standard error	368	246	233	161
	Sample size	79	79	79	79

Table 3. Determinants of preferences for cash allocation for fertilizer versus for food purchase

	Fertilizer	**Fertilizer**	**Food**	**Food**
	Tobit FE	Tobit RE	Tobit FE	Tobit RE
Sex of household head	-764.337	-687.772	467.864	325.096
1=Male	(466.93)	(471.07)	(442.62)	(435.59)
Age of household head	5.155	3.255	16.786	20.124*
	(12.74)	(12.87)	(11.77)	(11.67)
Education of household head	-3.978	-13.579	75.582	90.943*
	(55.38)	(56.00)	(51.82)	(51.22)
Male labor force	-5.402	-2.376	143.88	131.412
	(184.27)	(185.98)	(173.54)	(174.03)
Female labor force	-288.516	-271.198	258.526	237.836
	(259.15)	(261.42)	(240.79)	(240.66)
Number of children	36.521	25.317	-25.654	-3.996
	(125.88)	(127.07)	(118.02)	(117.92)
Quality of house	189.232***	171.256**	-110.244*	-87.779
	(71.51)	(71.65)	(66.8)	(63.42)
Value of assets	0.024*	0.025**	-0.02	-0.023*
	(0.01)	(0.01)	(0.01)	(0.01)
Tropical livestock units	153.458	154.448	-179.843	-172.627
	(134.68)	(135.56)	(137.46)	(136.11)
Farm size, ha	-355.437*	-333.911	-2.137	-38.862
	(207.91)	(209.07)	(207.46)	(205.57)

Planting time sample	3158.241**	2973.820****	-703.682	-1506.842****
	(1264.25)	(810.56)	(1183.85)	-438.66
Zomba	393.888		105.355	
	(601.16)		(550.8)	
Chiradzulu	258.717		174.888	
	(728.75)		(668.59)	
Machinga	786.018		-19.367	
	(710.67)		(650.58)	
Kasungu	577.093		-987.958	
	(1324.12)		(1231.86)	
Lilongwe	2688.630****		-755.839	
	(630.03)		(588.18)	
Constant	2237.240**	3284.361***	1321.053	881.817
	(1099.29)	(1062.01)	(1017.71)	(909.9)
Sigma_u		772.114***		0.000
Constant		(293.77)		(251.36)
Sigma_e	3118.604****	3149.101****	2823.361****	2838.961****
Constant	(130.97)	(133.43)	(139.62)	(140.45)
Prob > chi2	0.000	0.002	0.010	0.004
Number of observations	344	344	344	344
Left censored observations	41	41	107	107

Note: Standard errors in parentheses. Significance levels: *:10%, **:5%, ***:1%, ****:0.1%. Models with district fixed effects and random effects.

We may ask whether the lower willingness to spend the given budget on fertilizer at harvest time than at planting time could be due to the lower food prices at harvest time. While we cannot test this directly, we have assessed the food prices at harvest time vs. at planting time in the previous two years as price expectations may be formed on the basis of these relative price changes. The prices are summarized in Table 4.

Table 4. Average monthly maize prices at harvest time and planting time by year

Month	2007	2008
June (Harvest time)	14.55	37.91
December (Planting time)	30.01	63.35

Source: MoAFS (2009)

It can be seen that maize prices were much higher (near double) at planting time as compared to at harvest time. This should give a good reason for net buyers of food to buy the additional maize requirement at harvest time rather than later and this effect dominates the eventual effect of present bias causing low fertilizer demand at planting time.

The results from the real experiment for the choice between 5 kg fertilizer and randomized amounts of cash varying between MK 200 and 1500 are summarized in Figure 1 and Table 5. We see that the preference for fertilizer was reduced from above 90 percent for the two lowest amounts of money to about 40 percent for the two highest amounts of money where we recall that the highest price is 375% of the commercial price of fertilizer at the time of the experiment. This illustrates that there is a substantial demand for small amounts of fertilizer among many households where they are willing to forsake cash that they have available. The input subsidy program appears not to have undermined the valuation of these inputs. The high prices also indicate that few households are willing to resell inputs unless the price offered is raised high above the commercial price for fertilizer. The results may also indicate that input demand could be stimulated by offering fertilizers in smaller bags than the standard 50 kg bags. Repacking and selling in small bags could potentially be a lucrative business.

The logit model (Table 5) assessing the factors correlated with the choices in the real experiment revealed that households with more male labor force and higher asset endowment and smaller farm size were significantly more likely to prefer fertilizer rather than cash, *ceteris paribus*. This indicates that poverty in labor and assets reduces the shadow price of fertilizer while land scarcity increases the shadow price of fertilizer. Offering the experiment at planting time rather than at harvest time also increased the probability that households preferred fertilizer rather than cash. This is consistent with the finding in the hypothetical budget allocation experiment.

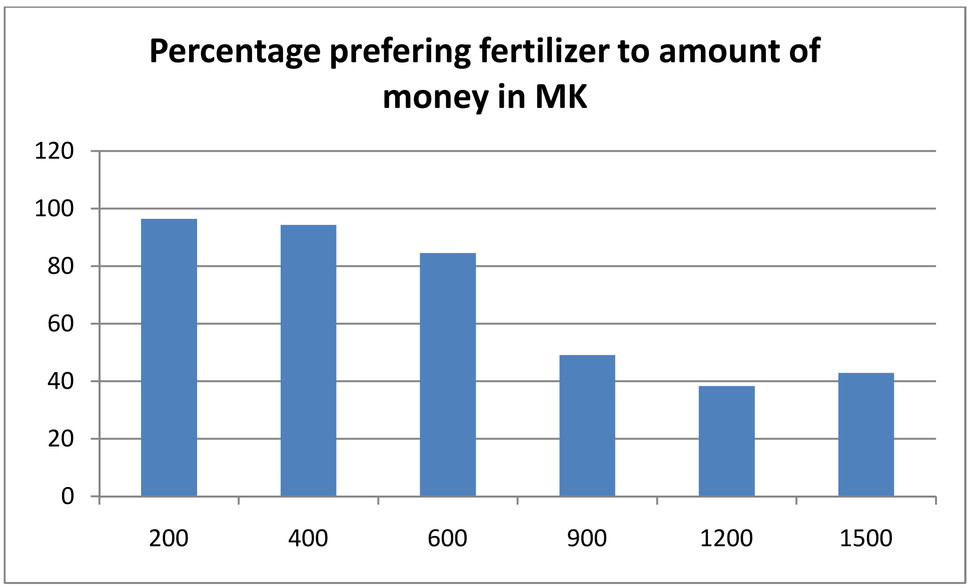

Figure 1. Choice experiment between receiving 5 kg basal fertilizer and a varying amount of cash.

Table 5. Real experiment for choice between 5 kg basal fertilizer and a random amount of cash

	Real experiment
Cash amount offered	-0.003****
	(0.0003)
Sex of household head	-0.139
1=Male, 0=Female	(0.380)
Age of household head	0.0001
	(0.010)
Education of household head	-0.042
	(0.050)
Male labor force	0.291*
	(0.150)
Female labor force	-0.129
	(0.230)
Number of children	-0.123
	(0.100)
Quality of house	0.024
	(0.060)
Value of assets	0.00004***
	(0.000015)
Tropical livestock units	0.116
	(0.090)

Farm size, ha	-0.301**
	(0.140)
Planting time dummy	1.387**
	(0.670)
District dummies:	
Zomba	1.503***
	(0.550)
Chiradzulu	0.710
	(0.570)
Machinga	-0.255
	(0.560)
Kasungu	-0.191
	(0.710)
Lilongwe	0.178
	(0.510)
Constant	2.980****
	(0.880)
Prob > chi2	0.000
Number of observations	341

Note: Standard errors in parentheses. Significance levels: *:10%, **:5%, ***:1%, ****:0.1%.

The next experiment involved randomly allocating the households with an input package for maize production consisting of one bag of basal fertilizer, one bag of urea (top dressing), and one bag of hybrid maize seeds, or if they were not lucky to “win” the package, they were offered the opportunity to buy the same package. The allocation of the package for free was determined by the toss of a coin. The lucky winners were then offered the possibility of selling the package at an amount determined by throwing a dice. The fitted values of the responses, with a 95% confidence interval, are presented as the upper line in Figure 2. The unlucky ones were offered to buy the package at an amount also determined by throwing a dice. The fitted responses to this offer with a 95% confidence interval are presented in Figure 2 (the lower line). The y-axis indicates the probability that respondents prefer the package to the cash amount offered. The cash amounts varied according to the scale on the x-axis, from MK1000 (full subsidy) to MK 9000 (no subsidy).

Figure 2 demonstrates that very few were willing to sell the package even at the highest amount of money offered which was equivalent to the commercial price of the inputs. This also indicates that households value the input package highly. Figure 2, however, also demonstrates that many households face problems buying such an input package due to their cash constraints and only slightly above 20 percent were willing to buy the package at the full commercial price and only about 50 percent were willing to buy it at a 50 percent level of subsidy (half price). Although the difference between the WTA and WTP responses could partly be due to the "endowment effect", the responses in the real experiment with fertilizer should not create such an endowment effect as households were offered the choice between cash or fertilizer without being given any of these first. Their response probabilities were close to those in the WTA experiment for those who had been endowed with the input package for prices close to the commercial price of fertilizer. This should indicate that the gap between the lines in Figure 2 primarily is due to a cash constraint effect. The confidence intervals in the graph demonstrate the significance of the difference between the WTA and WTP prices.

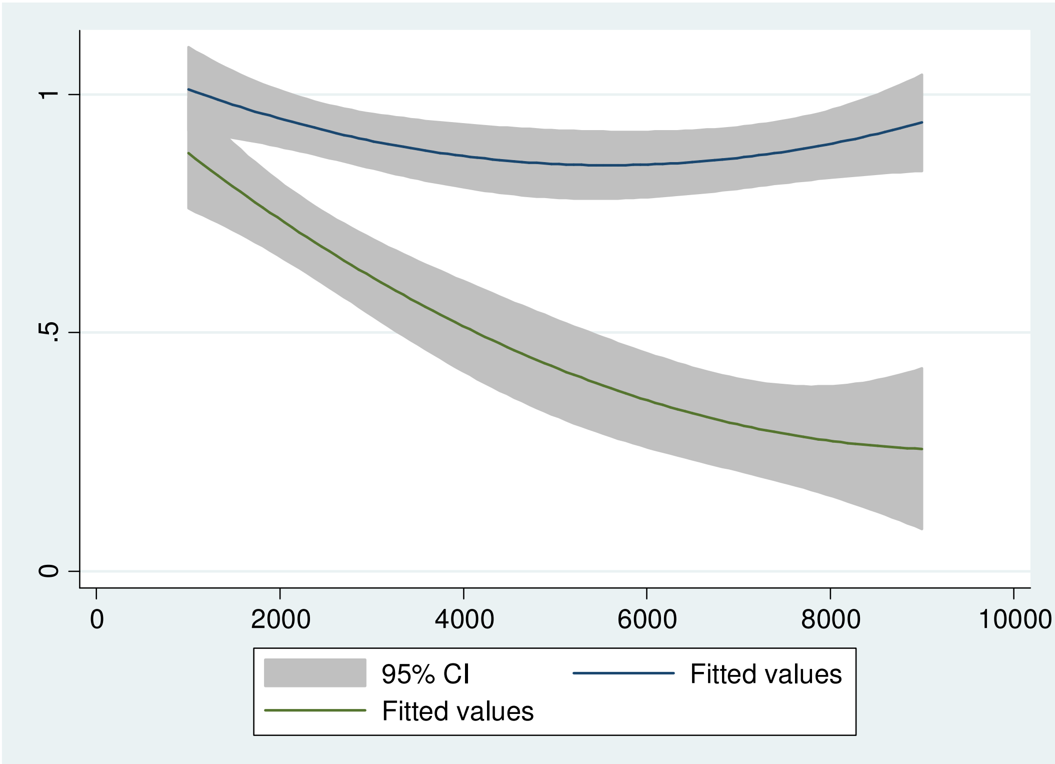

Figure 2. Ratio preferring input package to cash in WTA (upper line) and WTP (bottom line) experiments with varying cash amounts (MK).

Conclusion

Overall this study revealed that rural Malawian households value fertilizers highly even though they have been exposed to very high fertilizer subsidies over several years. More than 50 percent of the households preferred small amounts of fertilizer to a cash amount that was 50 percent higher than the current commercial price for fertilizer during our experiments carried out in 2009. Access constraints for commercial as well as subsidized fertilizer may explain these remarkably high shadow prices together with the nature of these experiments which were designed to avoid a direct effect of households' cash constraint.

The study tested out Duflo et al.'s (2009) proposal to stimulate input demand by supplying inputs at harvest time rather than at planting time. A hypothetical budget allocation experiment revealed that households were willing to allocate about 40 percent of a cash budget of MK10000 for fertilizer at harvest time while this budget share increased to about 60 percent at planting time. A real choice experiment between cash and fertilizer revealed a significantly higher share of households preferring fertilizer to cash at given prices at planting time than at harvest time. This may imply that the price difference effect due to lower food price at harvest time than at planting time dominates over the potential present bias effect.

However, the facts that households were willing to allocate a substantial budget share to input purchase at harvest time and were not likely to resell these inputs later, point in direction of a potential positive effect of this approach on input demand especially if or when the input subsidy program has to be scaled down.

On the other hand, when households were offered a full input package consisting of two bags of fertilizer and a bag of hybrid seeds, the share of households preferring the input package rather than the cash amount declined to 22 percent when the WTP price increased to MK9000, equivalent to the commercial price of the package. This demonstrates the significance of the cash constraint that households face. When households who have been offered the same package for free were asked about their WTA selling price, more than 80 percent of the households preferred to keep the package even when they were offered a WTA price of MK9000, equivalent to the commercial price. This fits well with the finding of Holden and Lunduka (2010) who found that a very small share of the households that were given subsidized fertilizers resold these inputs in the informal market. This implies that such input expenditures are "sticky" and sale of inputs at harvest time may serve as a commitment device (DellaVigna, 2009).

Due to high international fertilizer and oil prices which recently have contributed to fuel and foreign exchange shortages, Malawi may face problems sustaining the input subsidy program even though it has contributed substantially to improve national and household food security. An advantage of distributing inputs at harvest time is also that the same trucks that collect the maize can at the same time bring out the inputs and thus save on the transportation costs. One would also reduce the credit default problems that are linked to supplying inputs on credit at planting time.

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