Input Subsidies, Cash Constraints, and Timing of Input Supply

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Is low input use by poor, smallholder farmers caused by time-inconsistent behavior or by limited ability to buy inputs? Are input subsidies the best solution to stimulate input demand or are there smarter solutions? These issues are investigated by combining survey data, stated preference questions, and randomized experiments in Malawi. The demand for fertilizer at harvest time and at planting time, farm gate shadow prices for fertilizer, and the gap between the willingness-to-accept (WTA) and willingness-to-pay (WTP) prices for a standard input package were investigated. Significant effects of timing and of cash constraints were found, suggesting the possibility that smarter designs exist, such as distribution of smaller packages from harvest time to planting time.

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

JEL codes: Q12, Q18.

In recent years, agricultural input subsidies have regained popularity in several African countries after having been condemned by the World Bank and other international institutions for several decades. These condemnations came from the perception that subsidies create policy distortions, drain government budgets, and result in debt repayment problems (Morris et al. 2007). Under the late President Bingu wa Mutharika, in 2005 Malawi was the first country to reintroduce high levels of input subsidies to improve national food self-sufficiency and reduce its dependence on food aid. In a short time, Malawi managed to turn a food deficit into a food surplus, and was considered to be a success story (Denning et al. 2009). The new twist to this subsidy program was that it was targeted poor smallholders through a coupon system. Other countries have looked to Malawi, and similar programs have arisen and expanded in Ghana, Kenya, Nigeria, Tanzania and Zambia (Dorward 2009; Minde et al. 2008). However, the cost effectiveness and sustainability of the program have been questioned, and donors supporting the Malawian program have asked for a strategy to phase out the program.

An important reason for advocating fertilizer subsidies is that rural households are very poor and typically lack sufficient cash resources to buy productive inputs, which can result in suboptimal input use. Indeed, poverty combined with liquidity constraints may generate high discount rates that can lead to low investment (Holden, Shiferaw, and Wik 1998). Time-inconsistent behavior manifested as present bias has been observed in many social experiments and may partially explain low input use and investment levels in developing countries (Duflo, Kremer, and Robinson 2011). Another reason behind the low adoption rate of improved technologies may be fixed costs that limit market access (Suri 2011). The seasonality of rain-fed agricultural production, which dominates production, makes food shortages seasonal; thus, food must be stored between harvest seasons. A large share of smallholders may be net buyers of food, and thus at planting time they face a dilemma between using scarce cash resources to buy food to meet immediate needs, or to invest in inputs for next

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year's production. Time-inconsistent behavior may cause suboptimal investment in inputs. In such a scenario, subsidies could internalize the inter-temporal externality related to suboptimal input use; such subsidies could enhance both productivity and equity.

However, one may question whether such subsidies are the most appropriate and cost-effective instrument with which to address this market failure. Duflo, Kremer, and Robinson (2011) conducted a study and social experiments in Kenya and found that poor households are willing to invest in response to small, time-limited discounts in the form of free fertilizer delivery just after harvest. Indeed, a 50% subsidy on fertilizer at planting time did not increase fertilizer use more than this harvest-time free delivery discount. These authors' finding may indicate that the distribution and sales of fertilizer just after harvest can be a more effective system than the sale of fertilizers at planting time, when households may no longer have sufficient funds remaining from the sale of the previous year's harvest. The purchase of inputs at harvest time for the next growing season may serve as a 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 the risk of productivity losses due to overdue input deliveries.

This study investigates the willingness of rural households in Malawi to allocate funds for input purchase at harvest time. Further, it examines 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 be more willing and able to spend funds on inputs relative to planting time. However, net buyers of food may still prefer to buy additional food at harvest time when food prices are at their lowest. On the other hand, net sellers may prefer to store the food and sell it later at a higher price. Therefore, it is ambiguous whether the willingness to buy inputs at harvest time would be high or higher than at planting time. While our study investigates some of the same issues that Duflo, Kremer, and Robinson (2011) studied in the Kenyan context, our study is substantially different with respect to the approaches used; it thus provides novel complementary insights. We also apply a different theoretical model, although the basic idea of present bias is the same. One important contribution of our study is an assessment of the potential bias that ignoring seasonal maize price variation can introduce into the analysis of seasonal input demand. We show that in the case of Malawi, maize prices at planting time are almost twice as much as those observed at harvest time.

Another novel contribution of this paper is that we use an experimental approach to elicit cash-constrained and cash-unconstrained shadow prices for fertilizers in a context in which actual prices paid were endogenous and dependent on unobservable household characteristics. Stated-preference questions were used to explore the propensity to spend a given budget on fertilizer versus other goods at harvest time and at planting time. Stated-preference questions were also used to assess the gap between the shares of households that were willing to sell versus willing to buy a standard input package at alternating prices varying from the full subsidy (90%) to no subsidy. The farm gate shadow prices for small amounts of fertilizer were investigated in experiments where households could choose between 5 kg fertilizer and a random amount of cash at either harvest time or at planting time.

The results showed that households were willing to allocate a significantly larger share of their budget to fertilizer purchases at planting time than at harvest time. Previous access to input subsidies was not negatively associated with fertilizer demand but was negatively associated with food demand. A large share of the households had very high shadow prices for small amounts of fertilizer when relieved of their cash constraint. However, only 20–25% of the households were willing to buy the input package at the commercial price. Further, only 10–20% of households who were hypothetically assigned possession of an input package were willing to resell the package at the commercial price. The gap between the willingness-to-accept (WTA) and willingness-to-pay (WTP) prices may be explained as a cash constraint effect rather than an "endowment effect," as the share of households that were willing to buy the package decreased rapidly as the price increased, while the share willing to sell increased much more slowly with increasing prices (Plott and Zeiler 2005, 2007; Horowitz and McConnel 2002). These findings suggest that low use is primarily caused by limited ability to buy inputs and not time-inconsistent behavior. The current

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input subsidy design should be replaced by smarter and more cost-effective designs that involve smaller packages of fertilizer and delivery of inputs at harvest time, as well as at planting time.

Background

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 inappropriate governmental policies have contributed to both severe household and national food insecurity (SOAS 2008). The last severe food shortages occurred from 2004–2005; consequently, the newly-elected president, Bingu wa Mutharika, embarked upon a comprehensive input subsidy program that was contradictory to the recommendations from the International Monetary Fund (IMF) and the World Bank. An argument by the president for the subsidy program was 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.

The rural population in Malawi constitutes 88% of the total population and the country has one of the highest rural population densities in Africa, approximately 2.3 persons per ha. The average farm size is approximately 1.12 ha. 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: 64% of the households are estimated to fall below the poverty line compared to 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; however, such crops are grown on an average of less than 10% of the farm area, while maize covers 65–70% of the total 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). However, access to input subsidies has reduced the food deficit of these 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 unimodal, with a rainy season that lasts from December to April. This implies that the planting season for the main staple crop (maize) is in December, and harvesting season is in May and June.

The Government of Malawi increased its budget share for agriculture from 6.1% over the period 2000–2005 to 15.9% from 2006–2009, and is aiming to further increase it to 24% by 2015 through the implementation of the Agricultural Sector Wide Approach (ASWAp) (GoM 2010).

The Ministry of Agriculture and Food Security (MoAFS) in Malawi has developed 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 issues and distributes free coupons to identified beneficiary households through local MoAFS staff in collaboration with local leaders. Households receiving the coupons can take them to the nearest depot where inputs are sold and pay a small amount (MK500 per 50 kg bag during the 2009/10 season) to obtain the inputs. However, the depots can be quite far from the households, and the members risk having to wait in line for a long time before they get the inputs. This implies that rural households in Malawi face higher transaction costs in the market than the typical household surveyed by Duflo, Kremer, and Robinson (2011) in Kenya. There was no easily available market that sold small amounts of fertilizers. In the 2008/09 season, approximately 2 million input packages were distributed to the roughly 2.5 million rural households in the country, which implies that the packages covered close to 80% of the households. A recent study (Holden and Lunduka 2013) has identified substantial leakage of coupons, illegal secondary markets for coupons and cheap fertilizers, and substantial targeting errors. These authors found that very few households had resold their fertilizers or fertilizer coupons. Therefore, access to inputs and the actual prices paid 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 in obtaining subsidized inputs, while female-headed households have been less successful (Dorward et al. 2008; Holden and Lunduka 2013).

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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 costs of fertilizer subsidies to the Malawian government have risen with the increase in international fertilizer prices; from 2006–2007, the fertilizers represented 40% of the agricultural budget (Dorward et al. 2008). Given the very high fertilizer prices from 2008–2009, 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 compared to some benchmarks, such as the cost of food import in a drought year and total donor assistance. Since the 2008/09 season, the country has experienced shortages of foreign exchange, which also have led to fuel shortages. Tobacco is the main export crop, but tobacco exports are also limited by international agreements. Maize exports have, to some extent, compensated for the cost of fertilizer imports.

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 through the general budget or supports the funding of particular elements of the program such as the seed component.

Malawi's late president Mutharika argued that the subsidies had come to stay when he became the chairperson of the African Union. In addition, other African countries have been looking to Malawi's experience and considered implementing similar policies; Ghana, Tanzania and Zambia are among the countries that have scaled up similar input subsidy programs. However, international fertilizer prices are again on the rise, and there is a need to keep the budgetary costs down. The main arguments for the program are that rural households cannot afford to buy inputs if they are not subsidized, and removing the subsidies would lead to new food shortages. Credit provision has been an alternative approach that also has had mixed results due to high default *rates*. Until the early 1990s, fertilizer use and maize production were stimulated through credit provision in Malawi. However, maize is a drought-sensitive crop, and droughts in 1992 and 1994, combined with political promises to write off loan debt during an election year (1994), led to widespread loan defaults and the collapse of the parastatal Smallholder Agricultural Credit Administration (SACA) in 1994 (Zeller et al. 1997). The input subsidy program was established as a substitute for the credit program that had collapsed.

This background provides the framework for this study. In particular, the study explores the alternative approach of selling inputs at harvest time to reduce the need for subsidies and provide a commitment device that can reduce the need for credit as well. However, it is an open question whether net buyers of maize should buy fertilizer or maize at harvest time when maize prices are at their lowest.

Theoretical Framework

Duflo, Kremer, and Robinson (2011) found that small investments in fertilizer generated annualized rates of return between 52% and 85% in their study in Kenya. These authors were puzzled that farmers invested so little in fertilizer 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 the authors found that these could not be large enough to provide a full explanation. Therefore, they looked for a behavioral explanation in the form of present bias; this phenomenon has also been observed in the United States in relation to investments in pension plans (Choi, Laibson, and Madrian 2008) and draws on models of procrastination in psychology and economics. Strong present bias has been observed among poor rural households in developing countries and is related to liquidity constraints and poverty

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(Holden, Shiferaw, and Wik 1998). Empirical evidence shows that the discounted utility model (Samuelson 1937) is a poor fit for the reality of inter-temporal choices (Frederick, Loewenstein, and O'Donoghue 2002).

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

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

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 on by O'Donoghue and Rabin (2001) to handle naïve expectations (overconfidence) related to future self-control. We argue that the same parameter may reflect a current period liquidity constraint; apparent irrational present bias may rather reflect a rational response to short-term constraints and needs in a stochastic environment (Holden, Shiferaw, and Wik 1998).

We employ this alternative (β, δ) preference model as a basis for analyzing the behavior of poor rural producer-consumer households who make consumption and investment decisions facing cash constraints and imperfect factor markets. Liquidity constraints among rural households could induce a relationship between the timing of investment opportunities and how much the households are willing to invest; however, such a relationship could be driven by self-control problems as suggested by Duflo, Kremer, and Robinson (2011). Such control problems could cause households to be willing to invest more if offered inputs at harvest time rather than at planting time, when the inputs are to be used but more of the cash resources have already been spent on other items. Hence, purchasing inputs at harvest time could be a self-control device leading to higher investments.

The model covers three points in time: the first harvest time (t = 1), planting time (t = 2), and the second harvest time (t = 3). Households are offered a fixed budget, Y, to allocate for food consumption, C, input investments, F, and other goods expenditure, X, such that $Y = p_c C + p_f F + p_x X$. 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 subject to $Y^1 = p_c C^1 + p_f F^1 + p_x X^1$ such that it maximizes expected utility. An important assumption in our model is that producer-consumer households do not have an immediate need to buy food at harvest time. If they prefer to spend extra funds on food at this point in time it is done to save the food and consume it later, for example, at planting time. With (β, δ) preferences, the expected utility of the food expenditure at first harvest time (t=1) may be formulated as $U^1(p_c^1 C^1) = \beta\delta u_2(p_c^1 C^1)$. On the other hand, if the offer is made at planting time, food expenditure may be for immediate consumption and the utility is formulated as $U^2(p_c^2 C^2) = u_2(p_c^2 C^2)$. The expected utility of the budget allocation for inputs when the allocation is made at harvest time (t=1), inputs only being available for use at the next planting time (t = 2), and yield benefits after the next harvest time (t = 3) can be formulated as $U^1(p_f^1 F^1) = \beta\delta^2 u_3\{p_f^1(1 + r^F)F^1\}$, 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 $U^2(p_f^2 F^2) = \beta\delta u_3\{p_f^2(1 + r^F)F^2\}$. Optimal budget allocations (assuming interior solutions with time-varying prices) at the two points in time imply the following conditions:

$$(2)\quad \frac{\partial U^1(p_c^1 C^1)}{\partial Y^1} = \frac{\partial U^1(p_f^1 F^1)}{\partial Y^1} \text{ and } \frac{\partial U^2(p_c^2 C^2)}{\partial Y^2} = \frac{\partial U^2(p_f^2 F^2)}{\partial Y^2}.$$

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

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

which reduces to

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

for harvest time budget allocation decisions and to

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

for planting time budget allocation decisions. Note that the β coefficient cancelled out

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for the harvest time allocation because it is assumed that food purchased at this point in time is not for immediate consumption.

It follows that, *ceteris paribus* (assuming no change in prices or the consumption of other goods), $C^1 < C^2$ and $F^1 > F^2$ if $\beta < 1$. Offering inputs for purchase at harvest time may then operate as a commitment device that increases input expenditure and use.

What if food prices vary systematically across seasons and typically are much lower at harvest time than at planting time? In terms of the model, suppose that $p_c^1 < p_c^2$ while fertilizer prices are assumed not to change. It then follows that $C^1 < C^2$ and $F^1 > F^2$ only if $\beta < \frac{p_c^1}{p_c^2}$ and $p_f^1 = p_f^2$ and households with rational price expectations and who are net buyers of food will allocate more of a given budget for inputs relative to food at planting time than at harvest time when $\frac{p_c^1}{p_c^2} < \beta \leq 1$. Likewise, net sellers would prefer to store the food crop (maize) and sell it at planting time to buy fertilizer at that point in time. We note that storage losses could be an additional explanation for the maize price gap between harvest time and planting time; that disparity could move households' optimal decisions in the direction of selling maize earlier or buying later.

What if a household expects to access cheap fertilizers through the subsidy program at planting time? This would imply that the expected fertilizer price at planting time is lower than the fertilizer price offered at harvest time, that is, $\mathrm{E}(p_f^2) < p_f^1$. Such an expectation should reduce the demand for fertilizer at harvest time and may explain higher demand at planting time. Transaction costs in commodity markets cause selling prices to be lower than buying prices; this is likely to be the case for both food and inputs. However, transaction costs are typically 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, but are not likely to make such a sale unless they have experienced some form of shock because

$$(5) \qquad \frac{\partial u_2(p_c^1 C^1)}{\partial Y^1} = \frac{\delta \partial u_3\{(1+r^F)p_{fb}F^1\}}{\partial Y^1} > \frac{\partial u_2(p_{fs}F^1)}{\partial Y^1}$$

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 situation could also facilitate greater input investment if inputs are offered at harvesting time when food prices are lower than if inputs are only offered at planting time when the available cash budget may have decreased, $Y^2 < Y^1$. However, a severe shock may destabilize the inter-temporal balance and cause households to resell the inputs at a lower price. The likelihood that they would resell inputs depends on how the shock would affect a number of the parameters that become household-specific in the reformulated model. That is, suppose that the discount factor, δ_i, the expected return to inputs, r_i^F, and the present bias parameter, β_i, are all household-specific and may be affected by shocks. Such 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 distressed sales of assets or inputs that were bought at harvest time before the shock occurred. These sales may further affect expected returns.

The discount rate, the present bias parameter and the expected return functions cannot be directly observed, but experiments were constructed to assess the existence of present bias. The results suggest that present bias can be exploited to design a commitment device that also depends on the transaction costs in the input market. It is commonly assumed that poor people have high discount rates and stronger present bias and are more vulnerable to shocks. Empirical evidence is consistent with these assumptions (Holden, Shiferaw, and Wik 1998). Wealth accumulation substitutes for missing markets and relaxes constraint sets (Yesuf and Bluffstone 2009), which implies that risk aversion related to wealth can also affect input decisions, as poorer households tend to be more risk averse and less able and willing to make risky investments. Loss aversion may also cause households to be willing to take on less risk when they face a downside risk relative to a situation where they do not face 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; however, this relationship was not directly tested in our experiments. Risk aversion, including loss

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aversion, could lead to a positive correlation between wealth variables and investment in inputs for net sellers of food (Finkelshtain and Chalfant 1991). However, higher risk aversion and higher levels of risk could also theoretically lead to higher input demand by net buyers of food (ibid.) and may imply a negative relationship between marketed surplus and input demand. We are able to assess the latter effect.

Methods and Data

The survey was administered to a random sample of 450 households across two districts in Central Malawi (Kasungu and Lilongwe) and four districts in Southern Malawi (Chiradzulu, Machinga, Thyolo, and Zomba) (Lunduka 2010). Approximately 89% of the Malawian population lives in Central and Southern Malawi, so our survey should 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 located and interviewed in the third round. The experiments were added to the survey instrument in the 2009 survey round. The two stated preference (hypothetical) "experiments" and the real experiment are outlined below.

Experiment[1] 1: Budget Allocation Experiment

The budget allocation "experiment" took the form of hypothetical stated preference questions. The households were asked how they would allocate a cash amount of MK 10,000[2] among: a) buying fertilizer; b) buying food; c) buying other important/urgent commodities; and d) investing or saving for later use. Some of the sample households took part in this stated preference budget allocation experiment at harvest time (June) and others took part at planting time (December). The choice of locations for the planting time experiments was not random, but was determined by low-quality data in the first round survey in some locations, which required a resurvey in some of the locations. It is possible that the resurveyed villages are significantly different from the other villages. To test for this, the two groups were compared across key variables. The comparison tests are included in table A1 in the appendix. There were significant differences for some of the endowment variables. These have been included in the regressions to control for these differences; therefore, we do not think that this selection issue has affected the key results in this study.

Experiment 2: 5 kg Fertilizer Experiment

A real experiment was conducted where the households could choose between 5 kg (1/10th of a bag) basal fertilizer and a varying amount of money determined by the throw of a die. The amount of money varied between MK 200 and MK 1,500. These amounts ranged from 50% to 375% of the commercial price of the fertilizer at the time of the experiments. Households were unconstrained in their ability to choose between fertilizer and cash; that is, they did not have pay out of pocket for the fertilizer, which allows us to estimate unconstrained farm gate shadow prices for fertilizer.

Experiment 3: WTA/WTP Input Package Experiment

This was again a hypothetical (stated preference) experiment in which the WTA and WTP questions were randomly allocated to households through a coin toss.[3] The thought experiment involved asking randomly selected households whether they would resell an input package that they had received for free. The input package consisted of one bag of basal fertilizer, one bag of urea, and one bag of hybrid maize seeds. The households were asked whether they would accept or reject a randomized resale price (WTA price). The other group of households was asked whether they would be willing to buy such a package at a randomized price (WTP price). The WTA and WTP prices were determined by throwing a die. The price range for the package ranged from

[1] We use a wide definition of "experiment" here. A conventional dictionary (Macmillian Dictionary 2013) defines an experiment as "a scientific test to find out what happens to someone or something in particular conditions". One could also call our first and third "experiments" as forms of "thought experiments" as they are only hypothetical. Collins American English Dictionary (2013) defines a thought experiment as, "a test in which one imagines the practical outcomes of a hypothesis when physical proof may not be available". Stated preference questions may therefore be seen as thought experiments.

[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 costs about MK 9,000.

[3] See appendix 2 for the formulation of the questions asked to households.

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MK 1,000 (full subsidy) to MK 9,000 (no subsidy). This range was based on the price and subsidy rates decided by the Malawian government for the 2009/10 growing season. The experiment was to establish whether there is a gap between WTP and WTA prices when households' cash constraints affect the WTP. However, the cash constraint effect may be confounded with an "endowment effect," so we must be careful in our interpretation of the result (Plott and Zeiler 2005, 2007; Horowitz and McConnell 2002). However, we do not expect the endowment effect to vary with the randomly determined package price. A significant cash constraint should imply that as the price increases, the share of households that are willing to buy the package falls much more rapidly than the share of households that are willing to sell it rises. The experiment investigates the incentives to buy or resell an input package when prices are known and given exogenously.

There is a risk of hypothetical bias in these stated preference experiments, but we think that this is less of a problem in a private good setting with which the respondents are very familiar than for the public and environmental good settings in which such contingent valuation methods have primarily been used (Bohm 1972; Harrison and List 2004; Levitt and List 2009; List and Gallet 2001; Posavac 1998).

Analysis of Experimental Data

To assess the factors affecting budget allocation priorities in the budget allocation experiment (experiment 1), Tobit models were used because there were many zero responses for each commodity (demands for fertilizer and food). The fertilizer and food demands were regressed on an aggregate variable capturing fertilizer subsidy access in the previous four years (a count of the number of years with access), maize price in the nearest market at the time of the survey experiment, a dummy for planting time observations, distance to the nearest large market, marketed surplus of maize in the previous season (2008/09), household wealth variables, farm size and other household characteristics, and district dummies. For sensitivity analysis, a number of control variables were included that are related to access to fertilizer in the informal markets.

To further investigate factors that are correlated with households' choices between cash and fertilizer, the data from the 5 kg fertilizer experiment (experiment 2) were regressed on: the random cash price; the location and time-specific maize prices; the timing dummy for the experiment; the distance to market; access to subsidies and informal input markets; household characteristics, including asset wealth, land and livestock endowments; and geographical location (village). We also included the interaction between the timing of the experiment and the random cash price in one specification (logit 3) and predicted its outcome across observations in the non-linear logit model (figure 2). Furthermore, we also tested two variables that were meant to capture households' exposure to shocks and a credit market participation variable, but these were not significant. Credit was not available for the purchase of farm inputs, which possibly explains the lack of a significant effect. Although several of the variables are potentially endogenous and correlated with unobserved heterogeneity, we do not have access to good instruments. Therefore, we resorted to iteratively running models by adding more of the suspect variables stepwise to assess their effects on the sign and significance of the key variables. Random effects logit models with village fixed effects were the model class chosen for this process. A similar econometric analysis was also performed for the experiments assessing the WTA and WTP for the input package (experiment 3). For the WTA model in table 6, village fixed effects for 16 villages had to be replaced by 8 Traditional Authority (TA) fixed effects because of convergence problems with the limited sample size. The basic findings from the experiments are presented in the next section.

Experimental Results and Discussion

Experiment 1

Summary statistics by type of expenditure and time of the experiment are presented in table 2. The allocation for fertilizer was significantly higher at planting time than at harvest time, while the opposite was the case for food. Econometric analyses (Tobit models with district dummies) of the factors associated with household budget allocation for fertilizers and food are presented in table 3. The numbers in the table are the average partial effects.

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Table 2. Allocation of a Budget of MK 10,000 by Type of Expenditure and Time of Experiment

Time of Experiment		*Fertilizer*	*Food*	*Other Needs*	*Save-Invest*
Harvest time	Mean	4,331	2,450	1,642	1,578
	Standard error	176	128	112	133
	Sample size	280	280	280	280
Planting time	Mean	6,606	1,491	1,280	623
	Standard error	366	243	231	159
	Sample size	80	80	80	80

Source: Authors' own data.

Table 3. Determinants of Preferences for Cash Allocation for Fertilizer versus Food Purchase

Right-Hand Side Variables	Fert 1	Fert 2	Fert 3	Food 1	Food 2
Planting time dummy	2505.403**	2270.854*	2578.717	1137.928	1614.882
Distance to larger market, km	−111.796**	−108.830**	−99.241*	94.340**	103.675**
Aggregate access to subsidies		149.335	137.097	−652.108****	−646.005****
Maize price, MK/kg			−73.296		−82.567
Marketed surplus of maize			−4.385		−71.495
Offered to buy coupons in			−498.323		711.440
Bought coupons in 2008/09			775.716		−1187.688*
Offered cheap fertilizer			102.459		−27.302
Sex of household head, 1 = Male		−485.294	−679.350	228.676	299.991
Age of household head		0.892	−2.492	14.066	14.560
Education of household head		−6.255	5.605	75.878*	70.288
Male labor force		−57.644	−18.843	139.154	149.700
Female labor force		−280.266	−185.428	346.406	316.530
Consumer-worker ratio		−744.885	−503.437	−12.411	−261.252
Quality of house		155.776**	138.433*	−92.231	−71.910
Value of assets, 1000 MK		22.636*	23.599*	−19.847	−21.103
Tropical livestock units		113.374	148.763	−91.006	−202.817
Farm size, ha		−275.903	−257.106	−72.618	−16.373
Village fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	5012.491****	4603.974**	7205.193	1163.642	4564.202
Sigma constant	3124.069****	3030.007****	3008.611****	2638.271****	2646.202****
Prob > chi2	0.000	0.000	0.000	0.000	0.000
Number of obs.	346	336	318	336	318
Number of left censored obs.	40	38	35	106	103

Notes: Single asterisk (*), double asterisks (**), triple asterisks (***), and quadruple asterisks (****) denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. The dependent variables are the cash expenditure on fertilizer (first 3 models) or on food (last 2 models). Model results are from Tobit models with village fixed effects. The table presents average partial effects.

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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).

The results in table 3 demonstrate 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 and July. The difference equaled approximately 25% of the total budget. The willingness to allocate money for food was not significantly affected by the timing of the experiment, but the allocation for food was significantly (at the 0.1% level) lower for households with better access to fertilizer subsidies in the previous four years.

Significant wealth effects are also observed. Households with better quality houses and higher asset values allocated significantly more cash for fertilizer. This result is in line with the general theory that poverty can reduce the willingness and ability to invest and can result in higher discount rates, as immediate needs are given higher priority.

We may ask whether the lower willingness to buy fertilizer at harvest time than at planting time could be due to the lower food prices at harvest time. We have tested for this directly in table 3 (models Fert 3 and Food 2) by including the maize price in the nearest location. Monthly prices are collected for each of our study sites for the months in which we carried out the survey and experiments. Price change expectations may be based on observed price changes in the past. An indication of the importance of these expectations follows from table 4, which presents the average prices at harvest time and planting time during the previous two years. It can be seen that maize prices were much higher (nearly twice as high) at planting time compared to harvest time. As shown in our theoretical model, this should provide a good reason for net buyers of food to purchase their additional maize requirement at harvest time rather than later. In addition, this price effect may dominate the effect of present bias, which would otherwise reduce fertilizer demand at planting time. However, the maize price variable was not significant in table 3. The other variables that were included to capture fertilizer access were not significant. When these fertilizer access variables were included, the planting time dummy became insignificant, but the magnitude of its coefficient was not reduced. It seems that fertilizer demand has remained high for households that have accessed subsidies. This may be due to the rationing of subsidized fertilizer among those accessing it.

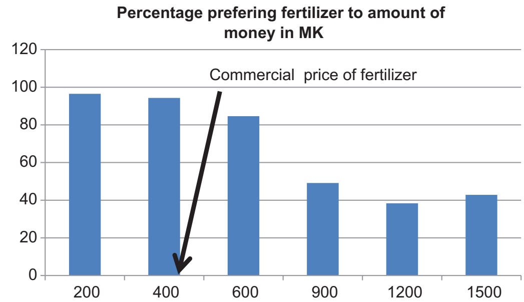

Figure 1. Choice experiment between receiving 5 kg basal fertilizer and a varying amount of cash (for color, please see figure online)

Experiment 2

The results of experiment 2 are summarized in figure 1 and table 5. Logit models were used for the analysis and the figures in the table are average partial effects. Figure 1 demonstrates that the preference for fertilizer was reduced from over 90% for the two smallest amounts of money, to approximately 40% for the two largest amounts of money. The highest price was 375% of the commercial price of fertilizer at the time of the experiment, which implies that there is a substantial demand for small amounts of fertilizer offered at the farm gate among many households, to the extent that they are willing to forsake available cash. The input subsidy program appears not to have undermined the valuation of fertilizer. The high prices also indicate that few households are willing to resell inputs unless the price offered for fertilizer moves far above the commercial price. The results may also indicate that input demand could be stimulated by offering fertilizer in bags smaller than the standard 50 kg bags. Repacking fertilizer in small bags and selling it could potentially be a lucrative business.

The logit models (table 5) assessing the factors correlated with the choices in the 5 kg fertilizer experiment confirm the significance of the planting time dummy variable: it remained positive and significant even when

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Table 5. Real Experiment for Choice between 5 kg Basal Fertilizer and a Random Amount of Cash

Right-Hand Side Variables	Logit 1	Logit 2	Logit 3
Cash amount offered	−0.460****	−0.458****	−0.484****
Planting time dummy	0.349**	0.341**	0.227
*Cash amount*Planting time dummy*			0.123
Maize price, MK/kg	−0.042**	−0.046**	−0.042*
Offered to buy coupons in 2008/09		−0.001	0.002
Bought coupons in 2008/09		−0.172*	−0.171*
Offered cheap fertilizer in 2008/09		0.108*	0.111*
Aggregate access to subsidies	−0.001	0.000	−0.002
Marketed surplus of maize 2008/09	−0.038	−0.049	−0.052
Distance to larger market, km	0.006	0.007	0.006
Sex of household head, 1=Male	−0.071	−0.073	−0.070
Age of household head	0.000	0.001	0.001
Education of household head	0.004	0.007	0.007
Male labor force	0.039	0.035	0.035
Female labor force	−0.041	−0.044	−0.049
Consumer-worker ratio	−0.064	−0.037	−0.035
Quality of house	0.002	0.004	0.004
Value of assets, 1,000 MK	0.007***	0.006***	0.006**
Tropical livestock units	0.018	0.044*	0.041*
Farm size, ha	−0.043**	−0.045**	−0.042*
Village fixed effects	Yes	Yes	Yes
Prob > chi2	0.000	0.000	0.000
Number of observations	336	318	318

Notes: Single asterisk (*), double asterisks (**), triple asterisks (***), and quadruple asterisks (****) denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. The table shows the average partial effects from the logit models. The dependent variable is a dummy variable = 1 if households chose fertilizer, and = 0 if households chose the random cash amount.

we controlled for the maize price and a variable capturing market and subsidy access. The maize price variable was also significant and negative, which implies that a higher maize price was associated with a lower quantity of required fertilizer. While this seems counterintuitive for a net producer, it may be a rational response for a net buyer of maize whose maize demand is inelastic. The models also include village fixed effects (for the 16 villages in the sample).

The third model in table 5 includes an interaction variable for the cash amount offered and the planting time dummy. This variable was insignificant on average. However, this does not necessarily imply that the interaction effect is unimportant (Ai and Norton 2003). We used a Stata command provided by Norton, Wang, and Ai (2004) to graph the predicted interaction effect (see figure 2). There was a significant positive interaction effect for 29% of the observations, which means that many households were significantly more likely to choose the fertilizer at planting time when higher random amounts of cash were offered as an alternative to the 5 kg fertilizer. A small fraction (4.7%) of the sample was predicted

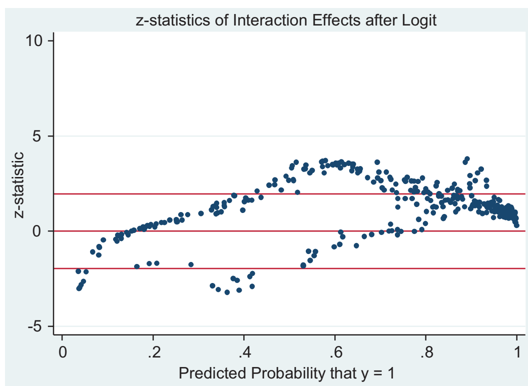

Figure 2. The interaction effect between cash amount and planting time dummy in model logit 4 in table 5. (for color, please see figure online)

to have a significant negative interaction effect.

Furthermore, table 5 reveals that households with a higher asset endowment were more likely to prefer fertilizer to cash, showing that more wealthy households are able and willing to invest in fertilizer. On the other hand, households with larger farm sizes were significantly less likely to prefer

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fertilizer over cash, *ceteris paribus*. This finding indicates that asset poverty reduces the shadow price of fertilizer but land scarcity increases the shadow price of fertilizer. Performing the experiment at planting time rather than at harvest time increased the probability that households preferred fertilizer over cash. This is consistent with the finding in experiment 1. Decisions in these two experiments did not require the households to pay any cash out of pocket. We interpret this design aspect as controlling for varying cash availability in the household. A liquidity constraint may be more severe at planting time than at harvest time, and may have resulted in different outcomes if it was binding in the experiments. Our third stated preference experiment provides some additional insights into this issue.

Experiment 3 involved randomly dividing the households into two groups (determined by a coin toss). One group was allocated 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, and then given the opportunity to resell the package at a randomized price. The other group of households was offered the opportunity to buy the same package at a randomized price. The fitted values of the responses for these two groups, along with a 95% confidence interval, are presented as the upper line in figure 3. 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 and ranged from MK 1,000 (full subsidy) to MK 9,000 (no subsidy).

Figure 3 demonstrates that very few households were willing to sell the package even at the highest amount of money offered; the highest price was equivalent to the commercial price of the inputs. This result indicates that households highly value the input package. However, figure 3 also demonstrates that many households face problems buying the input package due to cash constraints: only slightly more than 20% were willing to buy the package at the full commercial price, and approximately 50% were willing to buy it when offered a 50% subsidy (half of the commercial 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 bags should not create such an endowment effect, as households were offered the choice between cash or fertilizer without first being given either one. The response probabilities of these households were similar to the response probabilities of the households offered prices close to the commercial price for their fertilizer endowment in the WTA experiment. This similarity suggests that the gap between the lines in figure 3 is primarily driven by a cash constraint effect. The 95% confidence intervals in the graph demonstrate the statistical significance of the difference between the WTA and WTP shares.

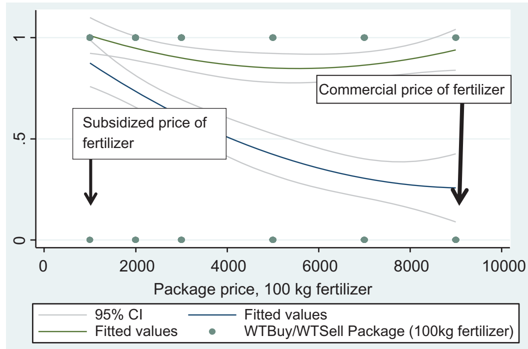

Figure 3. Ratio preferring input package to cash in the WTA (upper line) and WTP (bottom line) experiments with varying cash amounts (MK) (quadratic prediction plots with 95% confidence intervals) (for color, please see figure online)

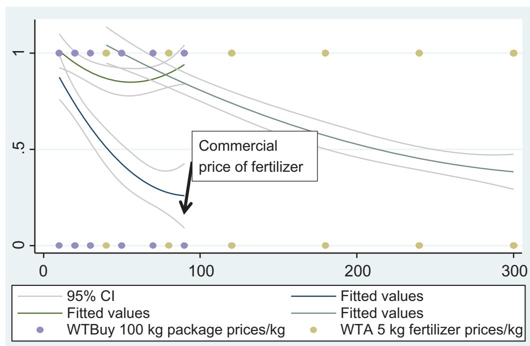

Figure 4. Fertilizer package price for real experiment versus hypothetical WTSell and WTBuy package: share of households preferring fertilizer package to money at varying prices (quadratic prediction plots with 95% confidence intervals) (for color, please see figure online)

Figure 4 combines experiment 2, which involved small amounts (5 kg) of fertilizer, with the hypothetical experiment 3. The

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x-axis shows the price in MK/kg fertilizer to allow comparison of the two experiments on the same scale (the value of seeds has not been included and is relatively small). The y-axis shows the share of households that preferred the fertilizer package at the different prices offered. We used a much wider price range for experiment 2, while the price range was from full subsidy (>90%) to no subsidy (at 2009 June-December prices) in experiment 3. The graph provides the means and 95% confidence intervals for the experiments. The graph illustrates the strong effect of a household's liquidity constraint when given the opportunity to buy the full package. It is possible that this effect would have been smaller if we had offered smaller amounts, but we did not test that particular dimension. We leave that analysis for future research.

Factors associated with the willingness to sell (WTA) and willingness to buy (WTP) the input package were investigated using logit models; the results are presented in table 6. We see that the probability of selling was not significantly associated with the random price offered when this price ranged from 90% subsidy to no subsidy (commercial price). The maize price and the planting time dummy were insignificant. Perhaps surprisingly, households that had been offered the opportunity to purchase coupons for fertilizer on the informal market were significantly (at the 1% level) more willing to sell the package. This may be driven by their expectation that they would have another opportunity to obtain cheap fertilizers. On the other hand, households that had actually bought fertilizer on the informal market were significantly less willing to sell their input package (significant at the 0.1% level). Such households apparently still had a high shadow price for fertilizer. Households that had experienced ready access to subsidized fertilizer in the past were also less likely to be willing to sell the input package (significant at the 5% level). Households located farther away from markets were less willing to sell (significant at the 1% level); male-headed households were also less willing to sell relative to female-headed households (significant at the 5% level). The marketed surplus of maize was positively correlated (significant at the 1% level) with willingness to sell the package. The quality levels of house and asset wealth variables were also positively correlated with willingness to sell the package. We were only able to apply Traditional Authority level fixed effects (as opposed to village fixed effects) in this model due to the limited sample size and perfect correlation with the dependent variable for some villages.

Table 6. Factors Associated with Willingness to Sell and Willingness to Buy Input Package

Right-Hand Side Variables	WTSell	WTBuy
Cash amount offered, 1,000MK	−0.020	−0.064****
Planting time dummy	−0.183	−0.189
Maize price, MK/kg	0.033	0.008
Offered to buy coupons in 2008/09	0.762***	−0.096
Bought coupons in 2008/09	−0.949****	−0.012
Offered cheap fertilizer in 2008/09	−0.018	0.234**
Aggregate access to subsidies	−0.064**	−0.026
Marketed surplus of maize 2008/09	0.295***	0.020
Distance to larger market, km	−0.029***	0.007
Sex of household head, 1=Male	−0.161**	−0.101
Age of household head	−0.002	−0.003
Education of household head	−0.018**	0.005
Male labor force	0.058	0.029
Female labor force	0.094	0.043
Consumer-worker ratio	−0.047	0.363**
Quality of house	0.028***	0.023
Value of assets, 1,000MK	0.006*	0.001
Tropical livestock units	0.030	−0.010
Farm size, ha	0.031	0.085
Traditional Authority fixed effects	Yes	No
Village fixed effects	No	Yes
Prob > chi2	0.000	0.000
Number of obs.	95	168

Notes: Single asterisk (*), double asterisks (**), triple asterisks (***), and quadruple asterisks (****) denote significance at the 10%, 5%, 1%, and 0.1% levels, respectively. Logit models with WTSell = 1 and WTBuy = 1 if answer is yes to given random amounts of cash, and zero otherwise. Numbers in the table are average partial effects.

The second model in table 6 shows which factors are associated with willingness to buy the package: in contrast to the previous model, the price offered for the package is highly significant and negative, while the maize price and planting time dummy were insignificant. This is in line with our cash

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constraint hypothesis that a cash constraint may be more likely to bind as the price of the package increases. The cash constraint may also be more binding at planting time in this experiment than in the previous two experiments, which could explain the insignificance. Thus, the ability of households to purchase inputs is more limited, even though their unconstrained demand and the profitability of input use are high. This may also imply that offering inputs at harvest time, as suggested by Duflo, Kremer, and Robinson (2011), and in small quantities could stimulate input demand and reduce the need to provide subsidized inputs at planting time. Those who had been offered cheap fertilizers in the previous season had a higher probability of being willing to buy the input package at the given prices (significant at the 5% level). It is possible that those exposed to such offers had been searching for them and therefore were less cash constrained. Finally, households with a higher consumer-worker ratio were significantly more likely to be willing to buy the package. Demand for inputs appears to be driven largely by consumption demand of net buyer households, as it may be cheaper to meet household food needs by buying fertilizer than by buying maize if the necessary cash is available. Overall, however, these results seem to indicate the existence of a poverty trap in a second-best world; in this setting, interventions such as input subsidies create positive welfare effects that may be partly "paid for" by the efficiency gains from increased input use. The budgetary costs are high, however, providing a good reason to experiment further with strategies to reduce these costs and enhance the efficiency of subsidies and alternative policy interventions.

Our theoretical model emphasized seasonality and the tradeoffs between short-term and medium-term needs in a setting where seasonal price changes for outputs and access to subsidized inputs affect input demand. The alternative (β, δ) preference model may capture irrational procrastination as well as rational responses to liquidity constraints; we favor the latter interpretation as being more important in our context. Our findings suggest that households have a limited ability to buy a lumpy input package. This problem is exacerbated as the package becomes more expensive. The input subsidy program may also have contributed to the lumpiness of fertilizer inputs (distributed in 50 kg bags) because it was only available through officially accepted depots that imposed additional transaction costs on households. This stands in contrast to the study of Duflo, Kremer, and Robinson (2011) in Kenya, where inputs were available in divisible amounts in nearby markets.

While the study by Duflo, Kremer, and Robinson (2011) assessed a situation in which a small share of households used fertilizer, even though using it was found to be profitable, we assessed a situation where the large majority of rural households used fertilizers. This difference is partly due to access to input subsidies. Our study complements the study of Duflo, Kremer, and Robinson (2011) and the broader literature on input demand and food production in risky low-income environments in three important ways. First, we investigated the demand for fertilizer and food at harvest time and planting time while accounting for the local variation in maize prices and access to input subsidies. Second, we investigated the unconstrained shadow prices for small amounts of fertilizer at harvest and planting time and how it was affected by a variety of covariates. Third, we investigated the gap between willingness to sell and willingness to buy a standard input package used in the subsidy program and showed that this gap was sharply increasing in price; this result demonstrates the effect of what we interpret as a severe liquidity constraint. Our findings do not contradict those of Duflo, Kremer, and Robinson (2011); rather, they provide complementary evidence of the great importance of the design of better agricultural policies for enhancing food security in low-income environments that face severe climate risks, food insecurity, and budget restrictions.

Conclusion

Overall, this study revealed that rural Malawian households highly value fertilizers even though they have been exposed to very high fertilizer subsidies over several years. More than 50% of the households preferred small amounts of fertilizer to a cash payment that was 50% higher than the current commercial price for fertilizer during our experiments carried out in 2009 (figure 4). Constraints in accessing both commercial and subsidized fertilizer may explain these remarkably high shadow prices. The nature

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of these experiments, which were designed to avoid a direct effect of households' cash constraint, could also be an explanatory factor; the experiments elicited demand that reflects cash-unconstrained utility maximization.

The study tested Duflo, Kremer, and Robinson's (2011) 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 more than 40% of a cash budget of MK 10,000 for fertilizer at harvest time; this budget share increased to approximately 65% when elicited at planting time. A real choice experiment between cash and fertilizer revealed that a significantly higher share of households preferred fertilizer to a given amount of cash at planting time than at harvest time. This difference could not be explained by the maize price difference at harvest time relative to the price at planting time, or by access to input subsidies; however, the gap may reflect a certain reluctance to buy inputs earlier than is necessary. However, households were willing to allocate a substantial budget share to input purchase at harvest time and were not likely to resell these inputs later, which suggests a potential positive effect of this approach on input demand. This potential effect is especially likely to be important when the input subsidy program has to be scaled down, as was the case during the 2011/12 season.

In contrast, when households were offered a full input package consisting of two bags of fertilizer and a bag of hybrid seeds, the share of households that responded as willing and able to buy the package declined to 22% when the WTP price increased to MK 9,000 (the commercial price of the package). This result demonstrates the significance of the cash constraint that households face, irrespective of season. When households who have been offered the same package for free were asked about their WTA selling price, more than 80% of the households preferred to keep the package even when they were offered a WTA price of MK 9,000 (again, equivalent to the commercial price). This result is consistent with the finding of Holden and Lunduka (2013) 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 that the 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 and other countries offering input subsidies face severe problems sustaining these programs. An advantage of distributing inputs at harvest time is that the trucks that collect the maize can deliver the inputs at the same time, thus saving transportation costs. Such a schedule would also reduce the default problems that are linked to supplying inputs on credit at planting time in a risky environment.

Finally, we find that the limited demand for fertilizer in developing countries (where people are very aware of the positive productivity of fertilizer and food security depends on fertilizer access) is not necessarily driven by irrationality. Under these conditions, which are also found in Malawi, failure to buy inputs may be the outcome of a rational response to binding constraints. That is, poor households have less freedom to act in irrational ways than do wealthy households.

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Appendix 1

Table A1. Sample Mean Comparisons for the Two Samples for Key Household Characteristic Variables

	Harvest Season Sample			Planting Season Sample			
Variable	Mean	St. error	N	Mean	St. error	N	t-test
Fertilizer expenditure*	4331	175.8	280	6606	366.3	80	−5.946***
Sex of household head	0.750	0.026	284	0.725	0.050	80	0.452
Age of household head	46.014	0.929	280	45.864	1.882	76	0.162
Education years of head	4.861	0.241	280	6.053	0.451	76	−2.299**
Number of children	2.569	0.095	281	3.000	0.184	76	−2.086**
House quality index	8.924	0.169	278	9.135	0.271	74	−0.593
Value of assets, ML	3813	866	281	6579	1632	76	−1.483
Tropical livestock units	0.433	0.063	277	0.886	0.252	76	−2.537***
Farm size	0.793	0.033	280	1.620	0.188	75	−7.150***

Note: Asterisk refers to the hypothetical budget allocation in "Experiment 1."

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Appendix 2

Format for "Experiment 3"

Choice experiment 3 Hypothetical: Assume that you may be lucky and get a fertilizer subsidy package in the form of one 50 kg bag of 23–21, one 50 kg bag of urea, and one bag of hybrid (HYV) seeds. Whether you become the lucky winner is determined by you tossing a coin:

If the coin lands on HEADS: You win, if the coin lands on TAILS you do not win, and go to **Choice experiment 3b**, Outcome of coin toss: 1 = HEADS, 0 = TAILS.

Choice experiment 3a. You got HEADS and have won the package. A person comes to you and offers to buy the whole package. The price he offers is determined by throwing a die:

Die outcome in MKw: 1 = 1, 000, 2 = 2, 000, 3 = 3, 000, 4 = 5, 000, 5 = 7, 000, 6 = 9, 000.

Choice: 1. Choose to keep the package, 2. Choose the money.

Choice experiment 3b. You have not received an input package. Would you be willing to buy the package at the following price determined by throwing a die?

Die outcome in MKw: 1 = 1, 000, 2 = 2, 000, 3 = 3, 000, 4 = 5, 000, 5 = 7, 000, 6 = 9, 000.

Choice: 1. Choose to buy the package, 2. Not willing/able to buy.

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