Fertilizer Subsidies and Voting Patterns: Political Economy Dimensions of Input Subsidy Programs

Nicole M. Mason
*Corresponding author
Michigan State University
Department of Agricultural, Food, and Resource Economics
and the Indaba Agricultural Policy Research Institute
446 W. Circle Dr. Rm. 207
East Lansing, MI 48824
masonn@msu.edu

T.S. Jayne
Michigan State University
Department of Agricultural, Food, and Resource Economics
446 W. Circle Dr. Rm. 207
East Lansing, MI 48824
jayne@msu.edu

Nicolas van de Walle
Cornell University
Department of Government
206 White Hall
Ithaca, NY 14853-7901
nv38@cornell.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013.

Fertilizer Subsidies and Voting Patterns:
Political Economy Dimensions of Input Subsidy Programs

Abstract: Agricultural input subsidies often have implicit or explicit political economy objectives. Using panel data from Zambia, this article empirically tests whether election outcomes affect targeting of subsidized fertilizer and whether fertilizer subsidies win votes. Results suggest that the Zambian government allocated substantially more subsidized fertilizer to households in constituencies won by the ruling party in the last election, and more so the larger its margin of victory. However, past subsidized fertilizer allocations had no statistically significant effect on the share of votes won by the incumbent president. Rather, voters rewarded the incumbent for reductions in unemployment, poverty, and income inequality.

Key words: fertilizer subsidies, political economy, voting patterns, election outcomes, fractional response, Zambia, sub-Saharan Africa

JEL codes: P16, D7, H2, H4, Q18

Acknowledgements: The authors acknowledge financial support from the United States Agency for International Development Mission in Zambia. They also wish to thank Nick Sitko, Bill Burke, Jake Ricker-Gilbert, and participants at the Future Agricultures Consortium/Institute for Poverty, Land, and Agrarian Studies International Conference on the Political Economy of Agricultural Policy in Africa, held in Pretoria, South Africa, March 18-20, 2013, for comments on an earlier version of the paper. Any views expressed or remaining errors are solely the responsibility of the authors.

**Fertilizer Subsidies and Voting Patterns:
Political Economy Dimensions of Input Subsidy Programs**

"But there is no doubt that this Farmer Input Support Programme, which is supposed to be an economic activity, has sadly been abused or mismanaged by politicians and those seeking patronage and turned into a political tool for their election campaigns… And in this election year things will be worse – it will be nothing but a campaign tool; fertiliser bought with taxpayers' money will be exchanged for votes." –Editorial, The Post Newspapers Zambia, March 13, 2011[1]

Targeted agricultural input subsidies currently receive substantial public budget and popular support in countries across sub-Saharan Africa (SSA). While the stated objectives of the subsidy programs include improving access to agricultural inputs, raising agricultural productivity and incomes, and improving household and national food security, many of the programs also have implicit or explicit political economy objectives. Although the literature on input subsidy programs in SSA is growing rapidly (see, among many others, Denning et al. 2009; Xu et al. 2009; Ricker-Gilbert, Jayne, and Chirwa 2011; Holden and Lunduka 2012a, 2012b; Chibwana, Fisher, and Shively 2012; Ricker-Gilbert, Jayne, and Shively 2013; and Mason and Jayne forthcoming), the political economy of the programs in general and the links between the programs and voting patterns in particular remain under-researched.

The few existing studies on input subsidy-voting pattern links are mainly descriptive or focus on how past election outcomes affect subsequent targeting of subsidized fertilizer (Chinsinga 2010, 2012; Banful 2011; Chapoto 2012; Holden and Lunduka 2012b; Mpesi and Muriaas 2012; Pan and Christiaensen 2012; Mason and Ricker-Gilbert 2013). For example, empirical evidence from Malawi and Zambia suggests that the fertilizer is used to reward loyalty and is targeted toward areas won by the ruling party in the last election (Mason and Ricker-Gilbert 2013). In contrast, results from Ghana suggest that the fertilizer is targeted toward opposition areas (Banful 2011). Empirical evidence from Tanzania also points to politicization of input subsidies, as households with elected officials are much more likely than other households to receive an input voucher (Pan and Christiaensen 2012).

The empirical record on input subsidy-voting pattern links is even thinner, however, when it comes to the effects of the subsidies on subsequent election outcomes. Politicians' conviction that fertilizer subsidies win votes is one likely reason for the resurgence of such programs over the last decade (Jayne, Chapoto, and Govereh 2010). A key question, then, is do fertilizer subsidies indeed win votes? Qualitative evidence from Malawi suggests that input subsidies were instrumental in Bingu wa Mutharika's landslide victory in the 2009 presidential election (Smiddy and Young 2009; Chinsinga 2010, 2012; Mpesi and Muriaas 2012). However, to our knowledge, there have been no empirical studies to date on the *ceteris paribus* effects of targeted input subsidies on voting patterns in SSA.

This article extends the previous literature using panel data from Zambia on subsidized fertilizer receipts and results from the 1996, 2001, 2006, and 2011 elections to answer two main research questions. First, what are the effects of past election outcomes on government's targeting of subsidized fertilizer? Mason and Ricker-Gilbert (2013) briefly touch on this issue but we revisit it in much greater detail here. Second, what are the effects of past subsidized fertilizer allocations on the share of votes won by the incumbent president? Zambia is an appropriate case study because the government devotes a significant share of its agricultural sector expenditures to targeted input subsidies (e.g., an average of 30% per year between 2004 and 2011 (MFNP various years)). The scale of the programs varies spatially and has increased dramatically over the last decade, e.g. from 48,000 MT of fertilizer in 2002 to 184,000 MT in 2012 (MAL 2012).

The country had several free elections during this period, and is considered one of the most robust democracies in SSA. Moreover, the conventional political wisdom in Zambia is that fertilizer subsidies are effective tools for garnering and maintaining rural votes in the era of multiparty democracy.

The article consists of two parts, each of which addresses one of the aforementioned research questions. In Part I we more closely examine the effects of past election outcomes on household-level targeting of subsidized fertilizer in Zambia, building on Banful (2011) and Mason and Ricker-Gilbert (2013). Using nationally representative household panel survey data covering the 1999/2000, 2002/2003, and 2006/07 agricultural years, we estimate correlated random effects (CRE) Tobit models in which the dependent variable is the kilograms of subsidized fertilizer allocated to a household.[2] Similar to Banful (2011), the key explanatory variables of interest capture: (a) whether or not the ruling party won the household's constituency in the last election; (b) the closeness of the race in the household's constituency; and (c) the interaction between (a) and (b). Part I extends previous work by: (i) focusing on household-level targeting of subsidized fertilizer (Banful looked at district-level targeting in Ghana); (ii) using panel data, which allows us to control for time-invariant heterogeneity via CRE techniques (Banful used cross-sectional data); (iii) exploring the effects of both presidential and parliamentary election results (Banful, and Mason and Ricker-Gilbert examined presidential election effects only); and (iv) thoroughly exploring the political economy and policy implications of the results. (Mason and Ricker-Gilbert's focus is on the crowding out of commercial hybrid seed purchases by subsidized inputs, not the political economy thereof; past election outcomes only enter their discussion to the extent that they are used as instruments for subsidized inputs.)

In Part II of the article we empirically test the conventional political wisdom that fertilizer subsidies win votes for the incumbent president. In this part of the article, we use district-level panel data and estimate CRE fractional response models (Papke and Wooldridge 2008) in which the dependent variable is the share of the district's votes won by the incumbent president in the 2006 and 2011 presidential elections.[3] The key explanatory variables of interest are various measures of the scale of the fertilizer subsidy program in the district prior to the election. Among other factors, the models control for district-level maize purchases at typically above-market prices by the government parastatal Food Reserve Agency (FRA), as both fertilizer subsidy programs and FRA activities have been scaled up markedly in Zambia over the last decade, and both initiatives have political economy objectives. Control function (CF)/instrumental variables techniques are used to test and control for the potential endogeneity of the lagged subsidized fertilizer and FRA variables in the district-level election outcome equations (Rivers and Vuong 1988; Papke and Wooldridge 2008). Thus, in addition to its subject matter contributions, the article also makes an important contribution to the agricultural economics discipline by providing a useful application of the CRE-CF fractional response model.[4]

The article also contributes to the political science literature. Part I brings additional empirical evidence to bear on current debates in that field about the degree to which states target their own supporters, swing voters, or opposition voters in their clientelistic strategies.[5] Furthermore, while there is a vast literature on vote-buying in the new democracies of SSA, where vote-buying is defined as a *quid pro quo* of cash or material goods in direct exchange for a vote, there has been little research on the electoral effectiveness of targeted government expenditures in SSA, including that of input subsidy programs. Part II of our article aims to begin to fill that gap.

From here, we begin with an overview of fertilizer subsidies and election outcomes in Zambia from 1991 to present. We then describe the methodology, data, and results for Parts I and II, respectively. This is followed by a discussion of both sets of results in the context of previous empirical evidence and debates in the agricultural economics and political science fields. Conclusions and policy implications are drawn in the final section.

Fertilizer subsidy programs and election outcomes in Zambia, 1991 to present

Fertilizer subsidy programs have been a central feature of the Government of the Republic of Zambia's (GRZ's) agricultural sector strategy in almost every year since independence. In 1991, after nearly two decades of one-party rule, Zambia held multiparty elections.[6] The newly elected president, Frederick Chiluba of the Movement for Multi-party Democracy (MMD), initiated a series of market reforms including liberalizing fertilizer marketing and eliminating universal fertilizer subsidies. Then, following Chiluba's and the MMD's landslide presidential and parliamentary victories in November 1996 (ECZ 1996), GRZ tasked the FRA with importing and running a fertilizer credit scheme beginning in the 1997/98 agricultural season (table 1).

[TABLE 1 HERE]

Under the FRA Fertilizer Credit Program, which ran through 2001/02, farmers made a down payment of roughly 10% of the full (unsubsidized) cost of the fertilizer at planting time, and were to pay the remaining 90% in cash or maize at harvest time. The fertilizer was not subsidized *per se* but repayment rates were low (e.g., 35% in 1999/2000), so defaulting farmers received the fertilizer at an effective subsidy rate of 90% (MACO, ACF, and FSRP 2002). According to program guidelines, participating farmers, who were to be members of a cooperative and cultivate at most two hectares (ha) of land, could receive 200 to 800 kg of fertilizer (FRA Agro Support Department 1999). An average of roughly 30,000 metric tons (MT) of fertilizer were distributed through the program each year (table 1).

The next elections took place in December 2001 and Chiluba was not eligible to run for a third term. The two main presidential candidates were the MMD's Levy Mwanawasa and the United Party for National Development's (UPND's) Anderson Mazoka. Mwanawasa narrowly defeated Mazoka by a margin of less than two percentage points (ECZ 2002). In response to poor loan recovery rates under the Fertilizer Credit Program and severe droughts in 2000/01 and 2001/02, Mwanawasa moved Zambia to a cash-only (no credit) input subsidy system beginning in 2002/03 with the establishment of the Fertilizer Support Program (FSP).

FSP was implemented throughout Mwanawasa's tenure as president. During his first term (2001-2006), the subsidy rate was pegged at 50% and an average of 51,000 MT of fertilizer were distributed each year (substantially more than under Chiluba's Fertilizer Credit Programme, table 1). Mwanawasa was challenged by the Patriotic Front's (PF's) Michael Sata and the United Democratic Alliance's Hakainde Hichilema in the September 2006 election but won by a comfortable margin.[7] Following his re-election victory, Mwanawasa expanded FSP to 84,000 MT and raised the subsidy rate to 60% in 2006/07 (table 1). In 2007/08, one year after the election, FSP was scaled back to 50,000 MT.

Under FSP, beneficiary farmers were to receive 400 kg of fertilizer and 20 kg of hybrid maize seed to be used to plant one hectare of maize. In practice, the quantities of subsidized inputs received varied widely across participants (Mason and Ricker-Gilbert 2013). The official eligibility criteria required participating farmers to: (i) be members of a cooperative or other farmer organization; (ii) be small-scale farmers actively involved in farming in the cooperative's coverage area; (iii) have the capacity to grow 1-5 ha of maize; (iv) be able to pay the farmer share of the input costs; (v) not be concurrently benefiting from the Food Security Pack, an agricultural input grant targeted at 'vulnerable but viable' households cultivating less than 1 ha; and (vi) not be defaulters under the Fertilizer Credit Program (MACO various years).[8]

Mwanawasa died in August 2008 after a stroke, and emergency elections held that October pitted his vice president, Rupiah Banda (MMD), against the PF's Sata and the UPND's Hichilema. Banda gained a narrow victory, defeating Sata by just two percentage points (ECZ 2008). The 2008/09 Fertilizer Support Program was already underway when Banda took office, but he renamed it the Farmer Input Support Program (FISP) in 2009/10, his first full agricultural year in office. Substantive changes were also made to the program. The official pack size was halved; the subsidy rate was raised to 75%; and traditional leaders and other community groups were involved in the selection of program beneficiaries (MACO 2009). (Under FSP, cooperative boards and local extension officers selected the beneficiaries.)

On the eve of the September 2011 elections, Banda dramatically scaled up FISP from 100,000 MT in 2009/10 to 178,000 MT in 2010/11 (table 1). The move proved insufficient to secure a victory, however, and Michael Sata (PF) defeated him by nearly seven percentage points. For the first time in 20 years, a party other than the MMD became the ruling party in Zambia. Since Sata's election, the scale of FISP has been similar to that during Banda's last year in office.

Reviewing the timing of presidential elections and fertilizer subsidy program changes in Zambia over the last two decades, most major changes have come in the wake of the elections, not in the run-up thereto. For example, Chiluba created the Fertilizer Credit Program *after* his re-election in 1996; Mwanawasa established FSP *after* he was elected in 2001, then scaled it up at the beginning of his second term (although promises to do so may have been made prior to the election); and Banda transformed FSP into FISP *after* he was elected. A key exception to this pattern is the massive expansion of FISP in 2010, just before Banda was up for re-election.

Although the links between election outcomes and fertilizer subsidies are the focus of this article, it is also important to note (and to control for in our models) the significant ethnic and regional dimensions of voting patterns in Zambia. For example, as shown in table 2 for the 2006 and 2011 elections, certain provinces and ethnic groups have consistently supported the MMD while others have swung their support from election to election. In general, support for the PF has been strongest in Zambia's urban centers (e.g., in Lusaka and Copperbelt Provinces), while the MMD has fared better in rural areas. We revisit table 2 and discuss the subsidized fertilizer columns later in the article.

[TABLE 2 HERE]

Part I: The effects of past election outcomes on subsidized fertilizer targeting

The goal of this part of the article is to estimate the *ceteris paribus* effects of past presidential and parliamentary election outcomes on the targeting of subsidized fertilizer to smallholder households in Zambia.[9]

Conceptual framework

Our starting point is a reduced form model of government behavior:

$$(1)\ \ govtfert = govtfert\left[\boldsymbol{elect}, \boldsymbol{z}, w, E(p)\right]$$

We hypothesize that the quantity of GRZ-subsidized fertilizer allocated to a given household (*govtfert*) is influenced, *inter alia*, by past election outcomes in the household's area (***elect***). For example, government may systematically target subsidized fertilizer to areas where it received strong support in the last election. This would be consistent with Cox and McCubbins' (1986) ‘core supporter’ model of redistributive politics. Alternatively, government may target subsidized fertilizer to areas with large numbers of swing voters or areas that were hotly contested in the previous election, as predicted by the ‘swing voter’ model of Lindbeck and Weibull (1993), and Dixit and Londregan (1996, 1998). There is empirical evidence in the political science literature to support both the core supporter and swing voter models (see, for example, Nichter (2008), Dunning and Stokes (2010), and Hicken (2011) for the core supporter model, and Magaloni (2006), Stokes (2007), and Briggs (2012) for the swing voter model). Banful’s (2011) results, on the other hand, suggest that the Ghanaian government targeted subsidized fertilizer vouchers to opposition strongholds. Ultimately, which model of subsidized fertilizer targeting prevails in Zambia is an empirical question.

Past election outcomes are not the only factors likely to affect targeting of subsidized fertilizer. As detailed in the previous section, input subsidy programs in Zambia have official targeting criteria, although the actual targeting criteria may be different in practice. Recall that the official targeting criteria require beneficiaries to be members of a farmer group or cooperative, to have the capacity to cultivate a certain area of maize, and to be able to pay back the loan or to pay the farmer share of the input costs up front. We therefore hypothesize that farmer/household characteristics related to cooperative membership, landholding size, and income/wealth, as well as other household, community, and regional characteristics ($\boldsymbol{z}$) affect GRZ targeting of subsidized fertilizer. Government might also choose to target subsidized fertilizer to areas based on the market price of fertilizer (w) and/or the expected producer price of maize ($E(p)$).

Empirical model and estimation strategy

Most households in our sample (89%) receive no government-subsidized fertilizer, and among recipients, the quantity received is roughly continuous. Given this corner solution nature of the dependent variable, the empirical model corresponding to Eq. (1) is specified as an unobserved effects Tobit model and estimated using household panel survey data covering the 1999/2000, 2002/03, and 2006/07 agricultural years:

$$(2)\quad govtfert_{it} = \max(0, \alpha + \boldsymbol{elect}_{kt}\boldsymbol{\beta} + \boldsymbol{z}_{it}\boldsymbol{\delta} + \theta w_{it} + \gamma p_{it-1} + c_{1i} + e_{1t} + u_{1it})$$

$$D(u_{1it} \mid \boldsymbol{elect}_{kt}, \boldsymbol{z}_{it}, w_{it}, p_{it-1}, c_{1i}, e_{1t}) = Normal(0, \sigma^2_{u_1})$$

In Eq. (2), i indexes the household, t indexes the agricultural year, and k indexes the constituency. $govtfert_{it}$ is the kg of subsidized fertilizer allocated to the household and it is measured in two ways. One is as the total kg of subsidized fertilizer allocated from *all* government fertilizer subsidy programs in place in Zambia during the study period, i.e., the Fertilizer Credit Program for t=1999/2000 and the Fertilizer Support Program and the Food Security Pack Program in t=2002/03 and 2006/07. The second excludes Food Security Pack Program fertilizer in t=2002/03 and 2006/07 because it is a grant-based program and is targeted at a different group of households, and so the factors affecting its allocation may be different from the other programs.

Following Banful (2011), $\boldsymbol{elect}_{kt}$ includes three variables: (i) MMD_{kt}, a binary variable equal to one if the household’s constituency was won by the ruling party (the MMD) in the last election, and zero otherwise; (ii) $spread_{kt}$, the absolute value of the percentage point spread between the MMD and the lead opposition party in the constituency in the last election; and (iii) the interaction, $MMD_{kt} \times spread_{kt}$. These variables allow us to capture whether the subsidized fertilizer is targeted to core supporter areas, swing voter areas, or opposition strongholds. For example, if the average partial effect (APE) of $spread_{kt}$ were negative and statistically significant, it would imply that more subsidized fertilizer is targeted to areas where the last election was close, as predicted by the swing voter model.[10] Alternatively, if the APE of MMD_{kt} were positive (negative) and significant, it would imply that core supporters (opposition strongholds) are targeted. The last elections corresponding to the agricultural years in the sample are those held in 1996, 2001, and 2006. Separate models are estimated using $\boldsymbol{elect}_{kt}$ based on presidential versus parliamentary election results.

$\boldsymbol{z}_{it}$ is a vector of household, community, and regional characteristics that may influence government targeting of subsidized fertilizer. Household-level characteristics include landholding size, household asset wealth separated into value of farm equipment (plows, harrows, and ox-carts) and value of livestock (cattle, sheep, goats, and pigs), the number of full-time-equivalent household members in various age groups, the age, education, and sex of the household head, and dummy variables capturing recent disease-related prime age (15-59 years) deaths in the household.[11] Community-level variables include the kilometers (km) from the center of the standard enumeration area (SEA) to the nearest district town, tarred/main road, and feeder road, and a dummy variable equal to one if the SEA is suitable for low input management maize production.[12] Regional characteristics include expected growing season rainfall and expected moisture stress, provincial dummy variables, and agro-ecological region dummy variables.[13] w_{it} is the commercial market price of fertilizer in Zambian Kwacha (ZMK) per kg. p_{it-1} is the producer price of maize in the previous year in ZMK/kg; that is, we use the lagged price as a proxy for the expected price. See table A1 in the Appendix for summary statistics for the dependent and explanatory variables in Eq. (2).

The composite error term in Eq. (2) consists of time invariant unobserved heterogeneity (c_{1i}), time fixed effects (e_{1t}), and the idiosyncratic error (u_{1it}). Year dummies are included in the model to control for e_{1t}. Eq. (2) is estimated with correlated random effects (CRE) Tobit to control for c_{1i}. The CRE approach (Mundlak 1978; Chamberlain 1984) assumes that the unobserved heterogeneity is a function of the household-level time averages of the observed explanatory variables (call these $\bar{\boldsymbol{X}}_i$), i.e., $c_{1i} = \psi + \bar{\boldsymbol{X}}_i \boldsymbol{\xi} + a_i$ where $a_i \mid \boldsymbol{X}_i \sim Normal(0, \sigma_a^2)$. Under these assumptions and strict exogeneity of the explanatory variables (conditional on c_{1i}), then we can control for c_{1i} in a Tobit model by including the household-level time averages as additional regressors. (See Wooldridge (2010) for a detailed discussion of CRE Tobit.)

All explanatory variables in our model are assumed to be strictly exogenous. This is a reasonable assumption because the variables are pre-determined when government allocates fertilizer to the household and/or are at a level of aggregation far above the household level. Strict exogeneity is also a reasonable assumption for our key explanatory variables of interest, the results of the last election ($\boldsymbol{elect}_{kt}$), because these are the outcomes of the voting decisions of tens of thousands of voters. Furthermore, as we will demonstrate in Part II of the article, there is no evidence of feedback from current subsidized fertilizer allocations to future election outcomes.

Data

The data are mainly drawn from the Supplemental Survey (SS) to the 1999/2000 Post-Harvest Survey (PHS), a three-wave, nationally-representative panel survey of smallholder households in 70 districts in Zambia covering the 1999/2000, 20002/03, and 2006/07 agricultural years. The surveys were conducted by the Central Statistical Office (CSO) and the Ministry of Agriculture and Cooperatives (MACO) in conjunction with the Food Security Research Project (FSRP). See Megill (2005) for details on the sampling frame. The first wave of the survey was conducted in two parts: an initial visit in August/September 2000 and a follow-up visit in May 2001. A total of 6,922 were interviewed in both parts of the first wave. Of those, 5,358 (77.4%) were successfully re-interviewed in the second wave of the survey in May 2004. And of those, 4,286 (80.0%) were re-interviewed in the third wave of the survey in June/July 2008. In the analysis, we use the balanced panel of households that were interviewed in all three survey waves, excluding one household with data problems (N = 4,285 households $\times$ 3 waves = 12,855). Given non-trivial rates of attrition between survey waves, there is potential for attrition bias. However, regression-based tests as described in Wooldridge (2010, p. 837) fail to reject the null of no attrition bias in all cases ($p>0.10$).

Other data used in the analysis are: (i) presidential and parliamentary election results from the Electoral Commission of Zambia (ECZ); (ii) maize producer prices from the 1998/99, 2001/02, and 2005/06 PHSs; and (iii) rainfall data from the Zambia Meteorological Department.

Results

What do the econometric results suggest about the extent to which past election outcomes influence government's targeting of subsidized fertilizer in Zambia? As shown in table 3, other factors constant, households in constituencies won by the ruling party (the MMD) in the last election receive significantly *more* subsidized fertilizer on average than households in constituencies lost by the MMD. Moreover, the amount received is increasing in the MMD's margin of victory. These general conclusions hold whether we use presidential or parliamentary election results, and whether we use subsidized fertilizer from all programs (Fertilizer Credit Program, FSP, and Food Security Pack Program) or exclude Food Security Pack Program fertilizer (table 3).[14] More specifically, controlling for other factors, the MMD government allocated an average of 16.2 to 23.2 kg more subsidized fertilizer to households in constituencies it won in the last election, compared to households in areas that it lost. This quantity is somewhat smaller if we use parliamentary election results instead of presidential ones (columns A and C vs. columns B and D), and is also somewhat smaller if we exclude Food Security Pack Program fertilizer (columns A and B vs. columns C and D). Anecdotal evidence suggests that the Food Security Pack Program is less politicized than the Fertilizer Credit Program and FSP, and the empirical results are consistent with this notion.

[TABLE 3 HERE]

The significant interaction effect between MMD's winning the constituency and the absolute value of the percentage point spread between the MMD and the lead opposition party in the constituency means that households in constituencies won by the MMD receive 0.5 to 0.6 kg more subsidized fertilizer on average for each percentage point increase in the MMD's margin of victory, *ceteris paribus*. To put the magnitude of the interaction effect in perspective, consider the following example. The MMD's constituency-level margin of victory in the 2006 presidential election was 59.1 percentage points at the 75th percentile and 18.9 percentage points at the 25th percentile. Based on model A in table 3 and holding other factors constant, households in constituencies that the MMD won by 59.1 percentage points would receive an average of 33.1 kg more subsidized fertilizer than households in constituencies that the MMD won by only 18.9 percentage points.[15]

The results in table 3 also shed light on other factors affecting GRZ's targeting of subsidized fertilizer. For example, significantly less subsidized fertilizer is allocated to households living farther away from district towns, tarred/main roads, and feeder roads. Moreover, GRZ systematically targets subsidized fertilizer to households with larger landholdings and/or greater livestock wealth.

There are also noteworthy results regarding factors that do *not* systematically affect subsidized fertilizer targeting, *ceteris paribus*. Among these are the sex and age of the household head, the number of household members in different age categories, and the household's value of farm equipment. We also tested for significant ethnic dimensions to targeting and for systematic targeting of subsidized fertilizer to households with more social capital (e.g., kinship ties to the village headman, more years lived in the village, and members that are civil servants and therefore may have links to the local extension officer that plays a key role in selecting and allocating inputs to subsidy beneficiaries). However, these variables have no statistically significant effects ($p>0.10$) on subsidized fertilizer allocation after controlling for other factors including time-constant unobserved heterogeneity.

In general, the results suggest significant political dimensions to subsidized fertilizer targeting in Zambia, with the fertilizer used to reward loyalty among the ruling party's base. The results also suggest that government systematically targets the fertilizer toward wealthier households (in terms of land or livestock holdings). Mason, Jayne, and Mofya-Mukuka (forthcoming) generally confirm these results using data from the 2008 presidential election and cross-sectional household survey data on FISP receipt during the 2010/11 agricultural year.

Part II: The effects of past subsidized fertilizer allocations on election outcomes

Past election outcomes affect subsidized fertilizer allocations in Zambia but is the converse also true? The goal of this part of the article is to estimate the *ceteris paribus* effects of past subsidized fertilizer allocations on the share of votes won by the incumbent president.

Conceptual framework

The incumbent and his government, in conjunction with Ministry of Agriculture and Livestock (MAL) officials, are the ones who determine the spatial distribution of subsidized fertilizer (e.g., at district and sub-district levels). Voters in areas that receive more subsidized fertilizer or where more households participate in the subsidy program may reward the incumbent at the voting booth. In addition to targeted fertilizer subsidies, maize purchases by the FRA at typically above-market prices are the other major tool used by the ruling party to garner and maintain rural votes (among other objectives).[16] The level of FRA purchases in an area may therefore also influence voting patterns. Moreover, the political science literature suggests (and table 2 shows) strong regional, ethnic, and urban vs. rural dimensions to voting patterns in Zambia (Posner and Simon 2002). The previous literature also indicates that Zambian voters consider economic conditions (e.g., poverty and unemployment rates) when casting their ballots (ibid). In 2003 and 2005, Zambians interviewed by Afrobarometer highlighted unemployment as the most important political issue in the country, while agriculture emerged as the most important one in 2009 (Mpesi and Muriaas 2012).

Based on these observations and building on Cerda and Vergara's (2008) model of the effects of government subsidies (broadly defined) on presidential elections in Chile, we hypothesize that the share of votes won by the incumbent (*sMMD*) is a function of the scale of the fertilizer subsidy program (*subfert*), the scale of FRA maize purchases (*FRA*), demographic characteristics of the population in general and of registered voters in particular (***v***), and economic conditions (***econ***):

$$(3)\quad sMMD = sMMD(subfert, FRA, \boldsymbol{v}, \boldsymbol{econ})$$

Empirical model and estimation strategy

The dependent variable in Eq. (3) (*sMMD)* is a proportion (also known as a 'fractional response') and cannot be less than zero or greater than one. We therefore specify the empirical model corresponding to Eq. (3) as an unobserved effects fractional response model (Papke and Wooldridge 2008) and estimate it using district-level panel data covering the 2006 and 2011 presidential elections:

$$(4)\quad E(sMMD_{dt} \mid subfert_{dt-1}, FRA_{dt-1}, \boldsymbol{v}_{dt}, \boldsymbol{v}_{pt}, \boldsymbol{econ}_{pt}, e_{2t}, c_{2d}) = \Phi(\alpha + \beta_1 subfert_{dt-1} + \beta_2 FRA_{dt-1} + \boldsymbol{v}_{dt}\boldsymbol{\delta}_1 + \boldsymbol{v}_{pt}\boldsymbol{\delta}_2 + \boldsymbol{econ}_{pt}\boldsymbol{\gamma} + e_{2t} + c_{2d})$$

In Eq. (4), *d* indexes the district (*d*=1, …, 72), *p* indexes the province (*p*=1,…,9), and *t* indexes the election year (*t*=2006 or 2011). $sMMD_{dt}$ is the share of votes won by the incumbent (the MMD candidates Levy Mwanawasa in 2006 and Rupiah Banda in 2011). $subfert_{dt-1}$ is a measure of the scale of the fertilizer subsidy program in the district in the agricultural year prior to the election. (Both elections took place in September and subsidized fertilizer distributions typically do not commence until September/October and extend through at least December.) Three specifications are used for $subfert_{dt-1}$. The first is the percentage of smallholder households that received subsidized fertilizer – a measure of the coverage of the program. The second is the mean kg of subsidized fertilizer received per smallholder household, and the third is the total allocation of FSP/FISP fertilizer to the district (in MT).[17] FRA_{dt-1} is the MT of maize purchased by the FRA in the maize marketing year prior to the election.[18]

$\boldsymbol{v}_{dt}$ and $\boldsymbol{v}_{pt}$ are vectors of district- and provincial-level demographic characteristics. Building on Cerda and Vergara's model (2008), $\boldsymbol{v}_{dt}$ includes the total population, the percentage of the population that is female, the percentage of the population in various age groups (15-49, 50-64, and 65 and above), the number of registered voters, and the percentage of registered voters that is female. $\boldsymbol{v}_{pt}$ includes the provincial percentage of the population that is rural (district-level data are not available), and a vector of provincial dummies. The provincial dummies capture, *inter alia*, differences in the dominant ethnic group in each province (recall the important ethnic and regional dimensions of voting patterns in Zambia per table 2), and also capture other time-constant differences among provinces.[19] Provincial dummy × year dummy interactions are included to control for time-varying provincial-level effects. $\boldsymbol{econ}_{pt}$ includes the provincial labor force, unemployment rate, poverty rate, and Gini coefficient as a measure of income inequality.[20] See table A3 in the Appendix for summary statistics for the dependent and explanatory variables in Eq. (4).

The error term in the unobserved effects fractional response models consists of time invariant unobserved heterogeneity (c_{2d}), time fixed effects (e_{2t}), and an idiosyncratic error term. As in Part I, we control for the time fixed effects by including a year dummy in the model, and we control for the unobserved heterogeneity using the CRE approach. The CRE fractional response models are estimated via pooled probit quasi-maximum likelihood as described in Papke and Wooldridge (2008).[21]

As in Part I, the CRE approach requires strict exogeneity of the regressors conditional on the unobserved heterogeneity. This is a reasonable assumption for most of the explanatory variables. They are all pre-determined as of election time, and we would not expect unobserved shocks to voting patterns to affect ethnicity, rural/urban location, the age structure of the population, etc. However, previous studies and results in Part I of this article indicate that election outcomes affect subsequent (household-level) targeting of subsidized fertilizer (Banful 2011; Mason and Ricker-Gilbert 2013). Such feedback from current values of $sMMD_{dt}$ to future values of $subfert_{dt-1}$ would violate strict exogeneity. Similar concerns arise for FRA purchases current election outcomes could affect future patterns of FRA purchases. Given these concerns, we test for the endogeneity of subsidized fertilizer and FRA purchases using the control function (CF) approach as described in Papke and Wooldridge (2008).

The CF approach entails estimating reduced form CRE pooled ordinary least squares regressions in which the dependent variables are the suspected endogenous explanatory variables (SEEVs – subsidized fertilizer and FRA purchases) and the explanatory variables are all of the exogenous regressors in Eq. (4) plus at least one instrumental variable (IV) per SEEV. The reduced form CF residuals are then included as additional regressors in the structural model (Eq. 4). A *t*-test of the residuals tests the null hypothesis that the SEEV is exogenous against the alternative hypothesis that it is endogenous.

To be valid, an IV must be strongly partially correlated ($p<0.05$) with the SEEV and uncorrelated with the idiosyncratic error in the structural model. The IVs used here are the percentages of smallholder households in the district that cultivate two or more ha of land in year *t-1* for the subsidized fertilizer SEEV and in year *t-2* for the FRA SEEV.[22] As shown in table A4 in the Appendix, these IVs are significantly and positively partially correlated with the SEEVs ($p<0.03$). This is consistent with previous studies, which indicate that subsidized fertilizer is disproportionately allocated to and maize purchases by the FRA are disproportionately from households cultivating larger areas (Jayne et al. 2011; Mason, Jayne, and Myers 2012; Mofya-Mukuka et al. 2013). Moreover, it is reasonable to assume that these IVs are uncorrelated with time-varying unobserved factors affecting the share of votes won by the MMD (especially after controlling for the observed covariates in Eq. (4), including the poverty rate and income inequality, and the unobserved heterogeneity, c_{2d}). That is, one would not expect the percentage of smallholder households falling above or below the (somewhat arbitrary) two ha cultivated cutoff to affect voting patterns except through its effect on subsidized fertilizer allocations and maize sales to the FRA.

The CF residuals are not statistically significant ($p>0.10$) in Eq. (4). We therefore fail to reject the null hypotheses that subsidized fertilizer and FRA purchases are exogenous, and exclude the CF residuals from the final estimation form of Eq. (4). Standard errors for all models (i.e., those with and without the CF residuals) are obtained via bootstrapping (500 replications).

Data

The data used in this part of the article cover all 72 of Zambia's districts and come from a number of sources. The district-level share of votes won by the MMD is computed from constituency-level data from the ECZ on the total number of votes cast and the number of votes won by each candidate (ECZ 2006a, 2011a). Data on the number of registered voters and the percentage of registered voters that is female are also from ECZ (2006b, 2011b). The percentage of smallholder households receiving subsidized fertilizer and the mean kg of subsidized fertilizer received per smallholder household are calculated using nationally-representative household survey data (the 2004/05 and 2005/06 CSO/MACO Post-Harvest Surveys, and the 2009/10 and 2010/11 CSO/MACO Crop Forecast Surveys). Administrative records on district-level FSP/FISP allocations and FRA maize purchases are from MACO (various years) and FRA, respectively. District-level data on total population, the percentage of the population that is female, and the percentage of the population in various age groups are from CSO (CSO 2003). Provincial-level data on the percentage of the population that is rural, the total labor force, unemployment and poverty rates, and the Gini coefficient of income are also from CSO (CSO 2011).

Results

What do the results suggest about the extent to which fertilizer subsidies win votes for the incumbent (the MMD) in presidential elections in Zambia? Before turning to the econometric results, consider the bivariate results in table 4. Without controlling for other factors, districts won by the MMD in 2006 and/or 2011 received more subsidized fertilizer on average and had a greater percentage of smallholder households receiving the subsidy in the agricultural year prior to the election. However, examining the scale of the fertilizer subsidies and voting patterns by province in table 2, provinces won by the MMD candidate did not necessarily receive substantially more subsidized fertilizer prior to the election. The descriptive results are therefore split as to the effects of fertilizer subsidies on voting patterns.

[TABLE 4 HERE]

The econometric results, in contrast, give a resounding answer of "no" to the question of do fertilizer subsidies win votes for the incumbent. Regardless of the specification of the subsidized fertilizer variable (percentage of households receiving, mean kg per household, or total district-level allocation) and regardless of additional or different control variables included in the model, we find no evidence of statistically significant subsidized fertilizer effects on the share of votes won by the incumbent (table 5). The p-value for the APE of subsidized fertilizer is very large (in most cases greater than 0.50) in all of the models in table 5 and in the numerous specifications estimated as robustness checks.[23] Zambian voters seem to have taken Michael Sata's 2011 campaign slogan, "Don't kubeba", to heart. This means take whatever the politicians are giving you (including subsidized fertilizer) but do not let it influence your vote.

[TABLE 5 HERE]

If fertilizer subsidies do not win votes for the incumbent, then what factors do? An increase in FRA purchases in the district has a miniscule, statistically weak ($0.057 \leq p \leq 0.117$), positive effect on the incumbent's vote share (table 5). More specifically, a 1,000 MT increase in FRA maize purchases in the district raises the incumbent's share of the votes by about 0.25 percentage points on average. If we consider the magnitude of this effect in terms of a 1% increase in district-level FRA purchases from the mean (i.e., from 6,678 MT to 6,745 MT), then the incumbent's vote share would increase by approximately 0.02 percentage points, *ceteris paribus*.[24] Even raising FRA purchases by 50% from the mean would only increase the incumbent's vote share by 0.8 to 0.9 percentage points. FRA maize purchases, therefore, do not have a major impact on voting patterns in presidential elections.

Although fertilizer subsidies and FRA purchases have little, if any, effect on voting patterns, changes in economic conditions have statistically strong and large effects on the incumbent's vote share. Improvements in economic conditions – particularly reductions in unemployment, poverty, and income inequality – significantly raise the share of votes won by the incumbent ($p<0.01$ in all cases, table 5). A one percentage point decrease in the unemployment rate increases the incumbent's vote share by 10 percentage points on average, while one unit reductions in the poverty rate and Gini coefficient of income raise the incumbent's vote share by an average of 2.5 and 2.7 percentage points, respectively. These results are robust across model specifications.

To put the magnitudes of these effects in perspective and to enable comparison to the 1% increase in FRA purchases described above, consider the effects of 1% decreases in unemployment, poverty, and inequality from their mean levels. A 1% decrease in the unemployment rate (i.e., from 11.96% to 11.84%) raises the incumbent's vote share by approximately 0.50 percentage points. A 1% decrease in the poverty rate (i.e., from 66.22% to 65.56%) increases the incumbent's share of the votes by roughly 1.23 to 1.25 percentage points. And a 1% decrease in the Gini coefficient (i.e., from 52.46 to 51.93 when measured on a 100-point scale) raises the incumbent's vote share by approximately 1.31 percentage points. These effects are both statistically strong and large in magnitude.[25]

Given the strong estimated effects of these economic variables on the incumbent's vote share, and the potential for fertilizer subsidies and FRA purchases to *affect* poverty, inequality, and unemployment levels, the reader may be concerned that the estimated effects of subsidized fertilizer and FRA purchases are biased. Perhaps the main effects of these programs on voting patterns come *through* their impacts on poverty, inequality, and/or unemployment? Additional analyses suggest that this is not the case.[26] We estimated models similar to those in table 5 but excluding poverty, inequality, and unemployment, and including either subsidized fertilizer or FRA purchases. Subsidized fertilizer is still far from statistically significant in these models ($p>0.70$) and although the p-value for FRA purchases is smaller than in table 5 ($p<0.05$), the magnitude of the FRA effect does not substantively change from the very small magnitudes discussed above. Furthermore, the CF-based tests fail to reject the exogeneity of subsidized fertilizer and FRA purchases in the vote share equations, which also inspires confidence in the estimates in table 5.

Beyond the economic determinants, a demographic variable that significantly influences the share of votes won by the incumbent is the percentage of the population that is rural. This is consistent with the results in table 2, which show that voters in the heavily urban Copperbelt and Lusaka Provinces favored the PF candidate, Michael Sata, over the MMD incumbents in the 2006 and 2011 elections. There are also significant regional/ethnic dimensions to the 2006 and

2011 election outcomes, as evidenced by the statistically strong and large in magnitude effects of the provincial dummies (table 5).

Overall, the results suggest that agricultural input and output subsidies have little or no effect on the share of votes won by the incumbent. However, improving economic conditions have statistically strong and large in magnitude positive effects on the incumbent's vote share.

Discussion

The main findings in Part I are that under the MMD, the Zambian government used subsidized fertilizer to reward loyalty among its supporters. Significantly more subsidized fertilizer was targeted to households in constituencies won by the MMD in the last presidential and/or parliamentary election, and this quantity was increasing in the MMD's margin of victory. The main findings in Part II are that fertilizer subsidies and maize purchases by the FRA had no substantive effects on the share of votes won by the incumbent (the MMD) but that improving economic conditions (reducing unemployment, poverty, and inequality) did win votes for the incumbent.

The findings in Part I are consistent with those for Malawi (Mason and Ricker-Gilbert 2013), and both are consistent with the core supporter model of redistributive politics. However, our findings contradict those for Ghana, that significantly more fertilizer vouchers are targeted to districts *lost* by the ruling party in the last election, and that the quantity is increasing in the ruling party's margin of *loss* (Banful 2011).

Why would the Zambian incumbent party, the MMD, target subsidized fertilizer to core supporters rather than to swing voters? Political scientists argue that under certain circumstances political parties use vote buying and other forms of clientelism less to persuade citizens about their vote choice as to ensure the turnout of already persuaded supporters (Dunning and Stokes 2010; Hicken 2011). It is important to distinguish a politician's discrete act of trying to buy a single citizen's vote from a broader reiterative clientelistic relationship between a community and an incumbent political party (see Hicken (2011) for a discussion). The former is an electoral strategy and usually requires that the politician enjoy the capability of effectively monitoring the vote – otherwise, the contract is not enforceable. In such a context, with limited resources, it makes sense for the politician to focus on swing voters. In the latter case, on the other hand, the political party seeks to consolidate and maintain the political support of a broad community of citizens over time, and in a manner not uniquely related to a specific electoral exercise. This seems to be the political function of fertilizer subsidies in Zambia, in a context in which the MMD pretty clearly lacks the ability to monitor individual voting, but in which clientelism has long been a privileged mode of linkage between citizens and politicians.

Our findings in Part II that voters do not reward the incumbent for increases in subsidized fertilizer quantities or coverage in their district should be understood in this context. A likely explanation for maize input and output subsidies' lack of substantive impact on the incumbent's vote share is the high concentration of the benefits of these programs. For example, during the 2010/11 agricultural year and subsequent maize marketing year, smallholder households cultivating less than two hectares of land, who constitute 73% of all smallholder households, received only 45% of the total FISP fertilizer distributed and accounted for only 22% of the total maize sold to the FRA (Mason, Jayne, and Mofya-Mukuka forthcoming). In fact, just 3% of smallholders accounted for 50% of the total maize sold to the FRA. Therefore, these programs, though large in absolute terms, do not benefit the vast majority of farmers.

The additional findings in Part II that Zambian voters reward/punish incumbents for the economic performance of the country during their term are consistent with the weight of the empirical evidence in the political science literature. Along with ethnic voting, economic or "sociotropic" voting (see Nadeau and Lewis-Beck (2001) for a useful discussion) is common in Africa's new electoral democracies including Zambia (see Bratton, Bhavani, and Chen (2011) and references therein; Posner and Simon (2002)). Using data from the 1991 and 1996 Zambian presidential elections, Posner and Simon (2002) find that deteriorating economic conditions were correlated with declining support for the incumbent president, and that dissatisfied voters tended to stay home and not vote rather than voting for the opposition.

Finally, the results in Parts I and II are consistent with each other. Given that MMD incumbents rewarded their base with subsidized fertilizer, *a priori* we would not expect subsidized fertilizer to have a significant impact on their electoral performance. The fertilizer is going to voters that would have supported the MMD even if they had not received it.

Conclusions and policy implications

Over the last decade, subsidies for fertilizer and other agricultural inputs and outputs have re-emerged as popular tools among African governments. The programs are funded by tax revenues and donor funds, and are exerting substantial pressure on public sector budgets. For example, in 2011, seven African governments including Zambia spent a total of US$2 billion subsidizing fertilizer (Ricker-Gilbert, Jayne, and Shively 2013). Although the official goals of input subsidies are typically to raise input use and crop productivity, improve food security, and/or raise incomes, the programs also have explicit or implicit political economy objectives. Nonetheless, there is a dearth of empirical evidence on the extent to which past voting patterns affect input subsidy targeting and the extent to which input subsidies win votes. This article examines these relationships using panel data from Zambia.

Consistent with and building on earlier evidence from Malawi and Zambia (Mason and Ricker-Gilbert 2013), results in this article suggest that Zambia's Movement for Multi-party Democracy (MMD) governments systematically targeted subsidized fertilizer to households in constituencies that it won in the last presidential or parliamentary election, and that the quantity of subsidized fertilizer was increasing in the MMD's margin of victory. More specifically, other factors constant, households in areas won by the MMD received an average of 16.2 to 23.2 kg more subsidized fertilizer than households in areas lost by the MMD. The quantity received increased by an average of 0.5 to 0.6 kg for each percentage point increase in the MMD's margin of victory. Rewarding the party's base with subisidized fertilizer is consistent with the core supporter model of redistributive politics (Cox and McCubbins 1986).

Although past election outcomes had a significant effect on subsidized fertilizer allocations, results suggest that fertilizer subsidies did not pay dividends to the MMD at the voting booth. While increases in subsidized fertilizer had no statistically significant effect on the district-level share of votes won by the incumbent president, Zambian voters did increase their support to the incumbent in response to improvements in economic conditions. More specifically, a one percentage point decrease in the unemployment rate raised the incumbent's share of the votes by 10 percentage points on average while similar declines in the poverty rate and income inequality (Gini coefficient) increased the incumbent's vote share by 2.5 and 2.7 percentage points, respectively. Such patterns of "economic voting" are consistent with numerous empirical and theoretical studies in the political science literature. Results in this article also suggest very small, if any, increases in support for the incumbent in response to increases in maize purchases at typically above-market prices by the parastatal Food Reserve Agency. To our knowledge, this article is the first to empirically estimate the electoral effectiveness of government transfers in Africa, including that of agricultural input and output subsidies.

Four main policy implications emerge from the empirical findings. First, in an ideal world, the subsidized fertilizer allocation process would not be politicized, particularly given that the programs are financed by taxpayer and donor funds, and not by specific political parties. While it is unlikely that input subsidy programs could be fully depoliticized, there may be ways to reduce the scope for the programs to be used for political patronage. For example, currently in Zambia, there are no transparent procedures for allocating subsidized inputs and allocations at district- and sub-district levels are not audited, leaving them subject to considerable political manipulation. Establishing and enforcing through audits clear rules and guidelines for the allocation of subsidized inputs across and within districts could help to reduce the latitude for political manipulation. Selecting beneficiaries in open public forums may also reduce politicization (Chirwa, Matita, and Dorward 2010). Moreover, moving from the current system of subsidized inputs distribution, wherein the inputs are essentially distributed through a government marketing channel that operates in parallel to rather than through private sector outlets, to an electronic voucher (e-voucher) system wherein beneficiaries redeem their vouchers at private retailers, could also help to attenuate the politicization of the program. This would particularly be the case if voucher targeting were rules-based, transparent, and audited, and if all private agro-dealers (as opposed to a few selected by government in politically favored areas) were allowed to participate.

Second, the politicized targeting of subsidized fertilizer in Zambia is likely reducing the capacity of the program to achieve its stated objectives, namely increasing access to inputs, raising maize production and productivity, and improving food security and incomes (Pan and Christiaensen 2012). Revising the targeting, design, and implementation of the program to explicitly achieve these goals rather than to reward the ruling party's supporters could help the government to get 'more bang for its buck' (Jayne et al. 2011; Burke, Jayne, and Sitko 2012; Burke, Jayne, and Black 2012; Mofya-Mukuka et al. 2013).

Third, as currently structured and implemented, fertilizer subsidy programs have had no significant effect on voting patterns in Zambia. The MMD rewarded its supporters with subsidized fertilizer but this did not ultimately win it more votes. What did win the incumbent more votes was improving economic conditions – namely reducing unemployment, poverty, and income inequality. Government officials will be reluctant to do away with agricultural input subsidies altogether. But our results suggest that if the input subsidy programs were redesigned to improve their effectiveness as poverty- and inequality-reduction and employment-creation tools, then there may be significant payoffs come election time. Targeting the subsidized inputs to poor households (e.g., those cultivating smaller areas – Mofya-Mukuka et al. (2013) suggest 0.5-2 ha), implementing the subsidies through an e-voucher in order to crowd in private sector participation and create jobs, and making the e-voucher flexible so that farmers can purchase the crop, livestock, and fish-farming inputs best suited to their needs, could help to achieve the three-pronged objectives of doing something visible for the rural populace (i.e., subsidizing inputs), improving economic conditions, and ultimately winning more votes.

Finally, the fact that Zambian voters respond much more strongly to changes in economic conditions than to fertilizer subsidies and FRA maize purchases suggests that it would be good politics to shift some funds away from the two programs (which currently consume over 80% of total public spending on agriculture) and toward investments and programs known to reduce poverty and inequality and/or create jobs (MFNP various years). These would include public investments in road and electricity networks, irrigation, and agricultural research, development, and extension, as well as investments in the health and education sectors (Fan, Gulati, and Thorat 2008; Economist Intelligence Unit 2008).

Notes

[1] "Subsidizing the Rich". Available at: http://www.postzambia.com/Joomla/post-read_article.php?articleId=18951, accessed March 2013.
[2] The agricultural year in Zambia is from October through September.
[3] In Part II, voting patterns are analyzed at the district level rather than at the constituency level because data on most of the explanatory variables in the model are only available at the district level or higher levels of aggregation. During the study period, there were nine provinces, 72 districts, and 150 constituencies in Zambia. Estimating the effects of subsidized fertilizer receipt on individual voting decisions is not possible due to lack of data.
[4] Although proportion dependent variables are not uncommon in agricultural economics, fractional response models are rarely used in the discipline, and even less so when combined with CRE and CF approaches. For example, a March 2013 search for "fractional response" in the archives of the *American Journal of Agricultural Economics* yielded only one article that used a fractional response model: Gramig and Wolf (2007).
[5] Clientelism is defined as the exchange of state resources for political support.
[6] Elections in Zambia are based on a plurality voting system. The winner is the candidate receiving the most votes, even if s/he does not win an absolute majority.
[7] Mwanawasa won 43.0% of the votes compared to 29.4% and 25.3% for Sata and Hichilema, respectively (ECZ 2006a).
[8] Initiated in 2000/01 and continuing to date, the Food Security Pack program defines 'vulnerable but viable' households as those not in gainful employment and headed by women, children, or terminally-ill individuals, supporting disabled persons or orphans, or "affected by calamities" (Tembo 2007, p. 40; PAM 2005).
[9] Smallholder households are defined as those cultivating less than 20 ha.
[10] Throughout the article, unless otherwise specified, we use the 10% level as our cutoff for statistical significance.
[11] Data on membership in a cooperative/farmer group are not available. Regardless, this variable is likely to be endogenous because many households join cooperatives for the sole purpose of gaining access to subsidized inputs. Household asset wealth (farm equipment and livestock) is used instead of income because income data are only available for the year *after* subsidized fertilizer is received.
[12] An SEA is the most disaggregated geographic unit in the dataset used in this part of the article. An SEA includes 150-200 households, or roughly two to four villages.
[13] Expected growing season rainfall and expected moisture stress are defined, respectively, as the averages over the last nine agricultural years of total rainfall in millimeters (mm) between November and March and of the number of 20-day periods (Nov.-Mar.) with less than 40 mm of rainfall.
[14] This is not surprising given the high correlation between presidential and parliamentary election outcomes (ρ= 0.80, see also table A2 in the Appendix) and the high correlation between the two definitions of subsidized fertilizer (ρ=0.98). Furthermore, the scale of the Food Security Pack Program is minute compared to FSP. For example, in 2006/07, 1.1% of smallholder households received Food Security Pack Program fertilizer, while 11.2% received FSP fertilizer (Mason and Jayne forthcoming).
[15] This calculation is based on the average difference in the estimated partial effects of MMD victories by margins of 59.1 and 18.9 percentage points, holding other covariates constant at observed levels.
[16] In recent years, the FRA has purchased 80% or more of the total maize marketed by Zambian farmers. See Mason and Myers (2013) for details.
[17] We also estimated models including both $subfert_{dt-1}$ and $subfert_{dt-2}$ but the variables were neither individually nor jointly significant (p>0.10). As additional robustness checks, we estimated models including district-level allocations of subsidized fertilizer in the election year itself (instead of lagged). Our rationale for doing so was that some fertilizer may have been distributed by election time in 2006 and 2011 (even though most was distributed after the election) and/or promises may have been made during presidential campaigns about subsidized fertilizer allocations to different areas, and thus may have influenced voters. However, contemporaneous subsidized fertilizer allocations have no statistically significant effect on the incumbent's vote share (p>0.10).

[18] The maize marketing year in Zambia is from May through April. FRA typically purchases maize from June through October. Data are only available on *total* (not monthly) FRA purchases in the 2011/12 marketing year. However, this total includes FRA purchases made *after* the September 2011 election. It is for this reason that we use FRA purchases in the previous marketing year. However, as robustness checks, we also estimated models with FRA purchases in the current (rather than previous) marketing year but these have no statistically significant effect on the incumbent's vote share ($p>0.10$).

[19] We also experimented with adding to the model provincial-level variables capturing the percentage of the population belonging to each of the seven broad ethnic groups in Zambia (Bemba, Tonga, Northwestern, Barotse, Nyanja, Mambwe, and Tumbuka). However, these variables were neither individually nor jointly significant ($p>0.10$). District-level data on ethnicity are not available.

[20] District-level data on these variables are not available. We also experimented with using mean per capita income, per capita expenditure, or the share of food expenditures in total expenditure as alternative ways of capturing the income/wealth levels of the population. The key findings of the article are robust to these alternative model specifications.

[21] As a robustness check, we also estimated linear models via fixed effects in which the dependent variable is the number (as opposed to the share) of votes won by the MMD. The key results are similar to the CRE fractional response results reported here. For the share dependent variable, CRE fractional response is more appropriate than the (linear) fixed effects estimator used by Cerda and Vergara (2008). See Papke and Wooldridge (1996, 2008) for a thorough discussion of the benefits of fractional response models for proportion dependent variables.

[22] We would have preferred to use total landholding (cultivated area plus fallow land, virgin land, orchards, gardens, and borrowed/rented out fields) or area of readily cultivable land (i.e., total landholding excluding orchards and virgin land) instead of cultivated area for the IVs but these data are not available for 2004/05 and 2005/06, which are used for the IVs for the 2006 election year. The data are available, however, for 2009/10 and 2010/11, which are used for the 2011 election year. These data reveal that the percentage of smallholder households cultivating 2+ ha of land is highly correlated with the percentage with 2+ ha of readily cultivable land (ρ=0.99) or total landholdings of 2+ ha ($\rho\geq$0.80). We therefore expect that the results using IVs based on area of readily cultivable land or total landholding would be very similar to the results reported here.

[23] In addition to the aforementioned robustness checks, we estimated models excluding FRA purchases and also tested for interaction effects between subsidized fertilizer and a number of variables, namely: the provincial dummies (which also capture ethnic differences across provinces), the percentage of the population that is rural, FRA purchases, poverty levels, and the year dummy. However, none of these is statistically significant at the 10% level or lower, suggesting that there are no differential (district-level) responses to fertilizer subsidies by these different groups.

[24] This result is based on the average difference in the incumbent's predicted vote share with FRA purchases set at 6,678 MT and 6,745 MT, and holding other covariates constant at observed levels.

[25] Compare these effects to the effect of a 1% increase in FRA purchases. Furthermore, the models suggest that halving the unemployment rate, poverty rate, and Gini coefficient of income would raise the incumbent's vote share by 33, 36, and 49 percentage points, respectively. The impacts of these 50% decreases swamp that of a 50% increase in FRA purchases.

[26] Moreover, despite a decade of massive public spending on FRA activities and fertilizer subsidies, rural poverty rates have not budged from 78% (CSO 2011; Jayne et al. 2011). While this does not mean that the programs had no effect on rural poverty, it does provide *prima facie* evidence that the effects, if there were any, were not very large.

References

Banful, A.B. 2011. "Old Problems in the New Solutions? Politically Motivated Allocation of Program Benefits and the 'New' Fertilizer Subsidies." *World Development* 39:1166–1176.

Bratton, M., R. Bhavnani, and T. Chen. 2011. "Voting Intentions in Africa: Ethnic, Economic, or Partisan?" Working Paper No. 127, Afrobarometer, accessed May 21, 2013, http://www.afrobarometer.org/component/content/article/68-english/working-papers/177-wp-127.

Briggs, R.C. 2012. "Electrifying the Base? Aid and Incumbent Advantage in Ghana." *Journal of Modern African Studies* 50:603–624

Burke, W.J., T.S. Jayne, and N.J. Sitko. 2012. "Can the FISP More Effectively Achieve Food Production and Poverty Reduction Goals?" Policy Synthesis No. 51, Food Security Research Project, accessed May 21, 2013, http://fsg.afre.msu.edu/zambia/ps_51.pdf.

Burke, W.J., T.S. Jayne, and R. Black. 2012. "Getting More 'Bang for the Buck': Diversifying Subsidies Beyond Fertilizer and Policy Beyond Subsidies." Policy Synthesis No. 52, Food Security Research Project, accessed May 21, 2013, http://fsg.afre.msu.edu/zambia/ps_52.pdf.

Central Statistical Office (CSO). 2003. *Population Projections Report*. Lusaka: CSO.

——. 2011. *Living Conditions Monitoring Survey Report: 2006 and 2010*. Lusaka: CSO.

Cerda, R., and R. Vergara. 2008. "Government Subsidies and Presidential Election Outcomes: Evidence for a Developing Country." *World Development* 36:2470–2488.

Chamberlain, G. 1984. "Panel Data." In Z. Grilliches and M. D. Intrilligator, eds. *Handbook of Econometrics*. Amsterdam: North-Holland, pp. 1247–1318.

Chapoto, A. 2012. "The Political Economy of Food Price Policy: The Case of Zambia." Working Paper No. 2012/100, United Nations University-World Institute for Development Economics Research, accessed May 21, 2013, http://www.wider.unu.edu/publications/working-papers/2012/en_GB/wp2012-100/.

Chibwana, C., M. Fisher, and G. Shively. 2012. "Cropland Allocation Effects of Agricultural Input Subsidies in Malawi." *World Development* 40:124–133.

Chinsinga, B. 2010. "Seeds and Subsidies: The Political Economy of Input Programmes in Malawi." Working Paper No. 013, Future Agricultures, accessed May 21, 2013, http://www.future-agricultures.org/publications/research-and-analysis/working-papers/doc_download/1041-seeds-and-subsidies-the-political-economy-of-input-programmes-in-malawi.

Chinsinga, B. 2012. "The Political Economy of Agricultural Policy Processes in Malawi: A Case Study of the Fertilizer Subsidy Programme." Working Paper No. 039, Future Agricultures, accessed May 21, 2013, http://www.future-agricultures.org/publications/research-and-analysis/working-papers/doc_download/1567-the-political-economy-of-agricultural-policy-processes-in-malawi-a-case-study.

Chirwa, E.W., M. Matita, and A. Dorward. 2010. "Targeting Agricultural Input Subsidy Coupons in Malawi." Paper prepared for the Evaluation of the Farm Input Subsidy Programme in Malawi 2010/11, accessed May 21, 2013, http://www.wadonda.com/Chirwa_Matita_Dorward_2010_Targeting.pdf.

Cox, G.W., and M.D. McCubbins. 1986. "Electoral Politics as a Redistributive Game."

Journal of Politics 48:370–389.
Denning, G., P. Kabambe, P. Sanchez, A. Malik, R. Flor, R. Harawa, P. Nkhoma, C. Zamba, C. Banda, C. Magombo, M. Keating, J. Wangila, and J. Sachs. 2009. "Input Subsidies to Improve Smallholder Maize Productivity in Malawi: Toward an African Green Revolution." *PLoS Biology* 7(1): e1000023. doi:10.1371/journal.pbio.1000023
Dixit, A., and J. Londregan. 1996. "The Determinants of Success of Special Interests in Redistributive Politics." *The Journal of Politics* 58:1132–1155.
——. 1998. "Ideology, Tactics, and Efficiency in Redistributive Politics." *Quarterly Journal of Economics* 113:497–529.
Dunning, T., and S. Stokes. 2010. "How Does the Internal Structure of Political Parties Shape their Distributive Strategies?" Paper presented at the American Political Science Association annual meeting, Washington DC, 2–5 September.
Economist Intelligence Unit (EIU). 2008. *Lifting African and Asian farmers out of poverty: Assessing the investment needs*. Research report for the Bill and Melinda Gates Foundation. New York: EIU.
Electoral Commission of Zambia (ECZ). 1996. *Presidential Results by Province*. Lusaka: ECZ. Accessed March 1, 2013, http://www.elections.org.zm/media/presidential_elections_1996pdf.pdf.
ECZ. 2002. *Presidential Election 2001 – Provisional Results*. Lusaka: ECZ. Accessed March 1, 2013, http://www.elections.org.zm/media/presidential_results_2001.pdf.
ECZ. 2006a. *Presidential Elections Results*. Lusaka: ECZ. Accessed March 1, 2013, http://www.elections.org.zm/media/2006_presidential_results.pdf.
ECZ. 2006b. *Registered Voters Per Polling District, 2006*. Lusaka: ECZ.
ECZ. 2008. *2008 Presidential Election Results*. Lusaka: ECZ. Accessed March 1, 2013, http://www.elections.org.zm/media/2008_presidential_election_results_press_release1.doc.
ECZ. 2011a. *2011 Presidential Election Results*. Lusaka: ECZ. Accessed March 1, 2013, http://www.elections.org.zm/media/28092011_public_notice_-_2011_presidential_election_results.pdf.
ECZ. 2011b. *2011 Register of Voters: Registered Voters per Constituency*. Lusaka: ECZ. Accessed March 1, 2013, http://www.elections.org.zm/media/31072011_registered_voters_per_constituency.pdf.
Fan, S., A. Gulati, and S. Thorat. 2008. "Government Spending, Growth and Poverty in Rural India." *American Journal of Agricultural Economics* 82:1038–1051.
Food Reserve Agency (FRA) Agro Support Department. 1999. *Implementation Manual on Modalities for the Distribution of the 1999/2000 Agricultural Season Inputs*. Lusaka: FRA.
Gramig, B.M., and C.A. Wolf. 2007. "Estimating Within-Herd Preventive Spillovers in Livestock Disease Management." *American Journal of Agricultural Economics* 89:1219–1225.
Hicken, A. 2011. "Clientelism." *Annual Review of Political Science* 14:289–310.
Holden, S., and R. Lunduka. 2012a. "Do Fertilizer Subsidies Crowd Out Organic Manures? The Case of Malawi." *Agricultural Economics* 43:303–314.
Holden, S., and R. Lunduka. 2012b. "Who Benefit from Malawi's Targeted Farm Input Subsidy Program?" *Forum for Development Studies* 40:1–25.
Jayne, T.S., A. Chapoto, and J. Govereh. 2010. "Grain Marketing Policy at the

Crossroads: Challenges for Eastern and Southern Africa." In A. Sarris and J. Morrison, eds. *Food Security in Africa: Market and Trade Policy for Staple Foods in Eastern and Southern Africa*. Rome: FAO, pp. 115–157.

Jayne, T.S., N.M. Mason, W.J. Burke, A. Shipekesa, A. Chapoto, and C. Kabaghe. 2011. "Mountains of Maize, Persistent Poverty." Policy Synthesis No. 48, Food Security Research Project, accessed March 1, 2013, http://fsg.afre.msu.edu/zambia/ps_48.pdf.

Lindbeck, A., and J. Weibull. 1993. "A Model of Political Equilibrium in a Representative Democracy." *Journal of Public Economics* 51:195–209.

Magaloni, B. 2006. *Voting for Autocracy: Hegemonic Party Survival and its Demise in Mexico*. Cambridge: Cambridge University Press.

Mason, N.M., and T.S. Jayne. Forthcoming. "Fertilizer Subsidies and Smallholder Commercial Fertilizer Purchases: Crowding Out, Leakage, and Policy Implications for Zambia." *Journal of Agricultural Economics*, in press.

Mason, N.M., and R.J. Myers. 2013. "The Effects of the Food Reserve Agency on Maize Market Prices in Zambia." *Agricultural Economics* 44:203–216.

Mason, N.M., and J. Ricker-Gilbert. 2013. "Disrupting Demand for Commercial Seed: Input Subsidies in Malawi and Zambia." *World Development* 45:75–91.

Mason, N.M., T.S. Jayne, and R.J. Myers. 2012. "Smallholder Behavioral Responses to Marketing Board Activities in a Dual Channel Marketing System: The Case of Maize in Zambia." Paper presented at IAAE triennial conference, Foz do Iguaçu, Brazil, 18–24 August, accessed March 1, 2013, http://ageconsearch.umn.edu/bitstream/126927/2/MasonEtAl.pdf.

Mason, N.M., T.S. Jayne, and R. Mofya-Mukuka. Forthcoming. "Zambia's Input Subsidy Programs." Working Paper, Indaba Agricultural Policy Research Institute, in press.

Megill, D. J. 2005. "Recommendations for Adjusting Weights for Zambia Post-Harvest Survey Data and Improving Estimation Methodology for Future Surveys." Working Paper No. 13, Food Security Research Project, accessed March 1, 2013, http://www.aec.msu.edu/fs2/zambia/wp13_zambia.pdf.

Ministry of Agriculture and Cooperatives (MACO). Various years. *Fertilizer Support Program Implementation Manual*. Lusaka: MACO.

MACO. 2009. *Farmer Input Support Program Implementation Manual for the 2009/2010 Agricultural Season*. Lusaka: MACO.

MACO, Agricultural Consultative Forum (ACF), and Food Security Research Project (FSRP). 2002. "Developments in Fertilizer Marketing in Zambia: Commercial Trading, Government Programs, and the Smallholder Farmer." Working Paper No. 4, Food Security Research Project, accessed March 1, 2013, http://fsg.afre.msu.edu/zambia/wp4zambia.pdf.

Ministry of Agriculture and Livestock (MAL). 2012. *Farmer Input Support Program Implementation Manual: 2012/2013 Agricultural Season*. Lusaka: MAL.

Ministry of Finance and National Planning (MFNP). Various years. *Estimates of Revenue and Expenditure: Activity Based Budget.* Lusaka: Government Printer.

Mofya-Mukuka, R., S. Kabwe, A. Kuteya, and N.M. Mason. 2013. "How Can the Zambian Government Improve the Targeting of the Farmer Input Support Programme?" Policy Brief No. 59, Indaba Agricultural Policy Research Institute, accessed March 1, 2013, http://fsg.afre.msu.edu/zambia/ps_59.pdf.

Mpesi, A.M., R.L. Muriaas. 2012. "Food Security as a Political Issue: the 2009 Elections in Malawi." *Journal of Contemporary African Studies* 30:377–383.

Mundlak, Y. 1978. "On the Pooling of Time Series and Cross Section Data." *Econometrica* 46:69–85.

Nadeau, R., and M.S. Lewis-Beck. 2001. "National Economic Voting in US Presidential Elections." *Journal of Politics* 63:159–181.

Nichter, S. 2008. "Vote Buying or Turnout Buying? Machine Politics and the Secret Ballot." *American Political Science Review* 102:19–31.

Pan, L., and L. Christiaensen. 2012. "Who is Vouching for the Input Voucher? Decentralized Targeting and Elite Capture in Tanzania." *World Development* 40:1619–1633.

Papke, L.E., and J.M. Wooldridge. 1996. "Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates." *Journal of Applied Econometrics* 11:619–632.

Papke, L.E., and J.M. Wooldridge. 2008. "Panel Data Methods for Fractional Response Variables with an Application to Test Pass Rates." *Journal of Econometrics* 145:121–133.

Posner, D.N. and D.J. Simon. 2002. "Economic Conditions and Incumbent Support in Africa's New Democracies: Evidence from Zambia." *Comparative Political Studies* 35:313–336.

Programme Against Malnutrition (PAM). 2005. *The Targeted Food Security Pack for Vulnerable but Viable Farmers: Programme Implementation Guidelines for the 2005/06 Agricultural Season*. Lusaka: PAM.

Ricker-Gilbert, J., T.S. Jayne, and E. Chirwa. 2011. "Subsidies and Crowding Out: A Double-Hurdle Model of Fertilizer Demand in Malawi." *American Journal of Agricultural Economics* 93:26–42.

Ricker-Gilbert, J., T.S. Jayne, and G. Shively. 2013. "Addressing the 'Wicked Problem' of Input Subsidy Programs in Africa." *Applied Economic Perspectives and Policy* 35:322–340.

Rivers, D., and Q.H. Vuong. 1988. "Limited Information Estimators and Exogeneity Tests for Simultaneous Probit Models." *Journal of Econometrics* 39:347–366.

Smiddy, K., and D.J. Young. 2009. "Presidential and Parliamentary Elections in Malawi, May 2009." *Electoral Studies* 28:642–673.

Stokes, S.C. 2007. "Political clientelism." In C. Boix and S. Stokes, eds. *The Oxford Handbook of Comparative Politics*. New York: Oxford University Press, pp. 604–627.

Tembo, S. 2007. *Case study: Food Security Packs by Programme Against Malnutrition – Final Draft report.* Lusaka: RuralNet Associates.

Wooldridge, J.M. 2010. *Econometric Analysis of Cross Section and Panel Data,* 2nd ed. Cambridge, MA: MIT Press.

Xu, Z., W.J. Burke, T.S. Jayne, and J. Govereh. 2009. "Do Input Subsidy Programs "Crowd In" or "Crowd Out" Commercial Market Development? Modeling Fertilizer Demand in a Two-Channel Marketing System." *Agricultural Economics* 40:79–94.

TABLES

Table 1. GRZ Fertilizer Subsidy Programs, Rates, Tonnage, and Number of Intended Beneficiaries, and Timing of Presidential Elections, 1997/98-2012/13

Agricultural year (Oct.-Sep.)	Main fertilizer subsidy program	Fertilizer subsidy rate	MT of fertilizer	Intended beneficiaries
Nov. 1996 – Chiluba (MMD) re-elected				
1997/1998	Fertilizer Credit Program	Loan	15,495	--
1998/1999	Fertilizer Credit Program	Loan	50,001	--
1999/2000	Fertilizer Credit Program	Loan	34,999	--
2000/2001	Fertilizer Credit Program	Loan	23,227	--
2001/2002	Fertilizer Credit Program	Loan	28,985	--
Dec. 2001 – Mwanawasa (MMD) elected				
2002/2003	Fertilizer Support Program	50%	48,000	120,000
2003/2004	Fertilizer Support Program	50%	60,000	150,000
2004/2005	Fertilizer Support Program	50%	46,000	115,000
2005/2006	Fertilizer Support Program	50%	50,000	125,000
Sep. 2006 – Mwanawasa (MMD) re-elected				
2006/2007	Fertilizer Support Program	60%	84,000	210,000
2007/2008	Fertilizer Support Program	60%	50,000	125,000
Oct. 2008 – Banda (MMD) elected following Mwanawasa's death				
2008/2009	Fertilizer Support Program	75%	80,000	200,000
2009/2010	Farmer Input Support Program	75%	100,000	500,000
2010/2011	Farmer Input Support Program	76%	178,000	891,500
Sep. 2011 – Sata (PF) elected				
2011/2012	Farmer Input Support Program	79%	182,454	914,670
2012/2013	Farmer Input Support Program	--	183,634	900,000

Source: MAL (2012); ECZ (various years).
Note: -- Information not available.

Table 2. 2006 and 2011 Presidential Election Results and Subsidized Fertilizer Received in the Previous Agricultural Season, by Province

Panel A: 2006 election		% of votes won by:				Subsidized fertilizer (2005/06 agricultural year):		
Province	Dominant ethnic group	MMD (Mwanawasa)	PF (Sata)	UDA (Hichilema)	Other parties	Total FSP allocation (MT) (% of total in paren.)	% of smallholder HHs receiving FSP fertilizer	Mean kg of FSP fertilizer per smallholder HH
Central	Bemba	**60.0**	14.4	24.1	1.5	9,000 (18.0%)	6.7%	30.3
Copperbelt	Bemba	38.3	**52.7**	7.4	1.6	6,520 (13.0%)	8.7%	34.3
Eastern	Nyanja	**44.3**	11.0	39.0	5.7	10,020 (20.0%)	6.9%	19.0
Luapula	Bemba	33.3	**60.9**	4.2	1.6	2,070 (4.1%)	3.7%	5.9
Lusaka	Nyanja	27.7	**49.2**	21.5	1.6	3,408 (6.8%)	11.2%	42.8
Northern	Bemba	**49.9**	42.7	5.6	1.9	8,258 (16.5%)	13.2%	31.5
Northwestern	Northwestern	**69.9**	2.0	26.1	2.0	2,740 (5.5%)	4.0%	10.2
Southern	Tonga	20.1	3.6	**74.4**	2.0	6,936 (13.9%)	5.9%	22.0
Western	Barotse	**77.3**	7.2	12.4	3.2	1,048 (2.1%)	1.1%	2.4
Nationwide	Bemba	**43.0**	29.4	25.3	2.3	50,000 (100%)	6.9%	20.3

Panel B: 2011 election		% of votes won by:				Subsidized fertilizer (2010/11 agricultural year):		
Province	Dominant ethnic group	MMD (Banda)	PF (Sata)	UPND (Hichilema)	Other parties	Total FISP allocation (MT) (% of total in paren.)	% of smallholder HHs receiving FISP fertilizer	Mean kg of FISP fertilizer per smallholder HH
Central	Bemba	**49.0**	28.7	21.1	1.2	30,160 (17.1%)	34.2%	102.1
Copperbelt	Bemba	26.6	**68.8**	3.6	1.1	17,121 (9.7%)	27.3%	70.4
Eastern	Nyanja	**74.3**	18.9	3.4	3.4	34,701 (19.7%)	33.2%	86.7
Luapula	Bemba	23.3	**74.7**	0.9	1.2	10,352 (5.9%)	19.6%	48.5
Lusaka	Nyanja	31.0	**56.3**	11.4	1.3	11,423 (6.5%)	43.7%	117.3
Northern	Bemba	32.6	**65.1**	0.8	1.5	26,537 (15.1%)	37.4%	95.8
Northwestern	Northwestern	**51.3**	11.1	36.0	1.6	11,024 (6.3%)	32.3%	87.4
Southern	Tonga	19.4	6.7	**72.3**	1.6	30,290 (17.2%)	28.9%	82.1
Western	Barotse	**33.8**	23.5	28.7	14.1	4,492 (2.6%)	5.9%	16.1
Nationwide	Bemba	36.2	**42.9**	18.5	2.5	176,100[a] (100%)	29.2%	78.4

Source: ECZ (various years); MACO (various years); 2005/06 and 2010/11 CSO/MACO Crop Forecast Surveys.
Note: Dominant party in province in **bold**. MMD = Movement for Multiparty Democracy. PF=Patriotic Front. UDA=United Democratic Alliance (a coalition of United Party for National Development (UPND), Forum for Democracy and Development (FDD), and United National Independence Party (UNIP)). Other parties are All People's Congress and Heritage Party in 2006, and UNIP, National Restoration Party, National Movement for Progress, Heritage Party, Alliance for Democracy and Development, Forum for Democracy and Development, and Zambians for Empowerment and Development in 2011. [a]Total fertilizer under FISP in 2010/11 was 178,000 MT but 1,900 MT was for backup and not allocated to a particular province.

Table 3. Factors Affecting the Kilograms of Subsidized Fertilizer Allocated to a Smallholder Household, 1999/2000, 2002/2003, & 2006/2007 Agricultural years (CRE Tobit)

GRZ fertilizer subsidy programs included:	All[a]						Fertilizer Credit Program & FSP only					
Election outcomes:	(A) Presidential			(B) Parliamentary			(C) Presidential			(D) Parliamentary		
Explanatory variables:	APE	Sig.	p-val.	APE	Sig.	p-val.	APE	Sig.	p-val.	APE	Sig.	p-val.
MMD won the HH's constituency in the last election (=1)	23.212	***	0.000	18.720	***	0.000	19.142	***	0.000	16.195	***	0.000
Pct. point spread b/w MMD & lead opposition in constituency	-0.087		0.297	-0.116		0.156	-0.100		0.227	-0.147	*	0.066
Interaction effect: MMD won constituency (=1) × pct. point spread	0.535	***	0.000	0.601	***	0.000	0.559	***	0.000	0.553	***	0.000
Maize producer price (ZMK/kg, t-1)	0.006		0.720	0.013		0.443	0.019		0.310	0.028		0.130
Commercial fertilizer price (ZMK/kg)	0.014	**	0.041	0.007		0.323	0.015	**	0.024	0.010		0.114
Landholding size (cultivated+fallow, ha)	2.314	***	0.000	2.280	***	0.000	2.220	***	0.000	2.196	***	0.000
Value of farm equipment ('00,000 ZMK)	0.186		0.380	0.192		0.361	0.149		0.444	0.158		0.414
Value of livestock ('00,000 ZMK)	0.075	**	0.037	0.076	**	0.036	0.088	***	0.009	0.090	***	0.008
Number of children age 4 and under	-1.667		0.233	-1.768		0.209	-1.263		0.359	-1.383		0.318
Number of children age 5 to 14	-0.504		0.610	-0.431		0.662	-0.410		0.657	-0.384		0.678
Number of prime age (PA) adults (age 15 to 59)	0.962		0.393	0.968		0.396	0.595		0.576	0.619		0.567
Number of adults age 60 and above	0.708		0.863	0.568		0.889	0.587		0.883	0.547		0.890
Age of the HH head	0.345		0.158	0.331		0.173	0.278		0.251	0.259		0.283
Highest level of education completed by the HH head (none is base):												
Lower primary (grades 1-4) (=1)	-0.780		0.870	-0.871		0.856	-0.736		0.883	-0.707		0.888
Upper primary (grades 5-7) (=1)	5.198		0.308	5.295		0.305	5.251		0.345	5.401		0.337
Secondary (grades 8-12) (=1)	13.308	*	0.072	13.032	*	0.077	11.496		0.141	11.111		0.155
Post-secondary education (=1)	1.598		0.887	1.046		0.925	0.700		0.947	0.097		0.993
Sex and residence status of HH head (resident male head is base):												
Female-headed with non-resident husband (=1)	12.940		0.494	11.956		0.526	17.314		0.377	17.262		0.384
Female-headed with no husband (=1)	-3.338		0.513	-3.326		0.513	-3.664		0.485	-3.908		0.452
Head/spouse disease-related PA death in last 3-4 years (=1)	13.795		0.171	13.964		0.169	17.048		0.107	17.253		0.106
Other HH member disease-related PA death in last 3-4 years (=1)	7.753		0.157	7.603		0.162	5.638		0.262	5.771		0.253
Expected growing season rainfall (100 mm)	-11.533	***	0.006	-11.679	***	0.008	-11.212	***	0.007	-10.010	**	0.019
Expected moisture stress (# of 20-day periods with <40mm rain)	-5.907		0.428	-5.633		0.437	-8.906		0.200	-7.515		0.264
SEA is suitable for low input management maize production (=1)	1.009		0.755	1.758		0.587	2.425		0.429	2.672		0.385
Km from center of SEA to nearest district town (as of 2000)	-0.186	**	0.030	-0.187	**	0.029	-0.156	*	0.071	-0.158	*	0.067
Km from center of SEA to nearest tarred/main road (as of 2000)	-0.139	***	0.002	-0.103	**	0.030	-0.139	***	0.002	-0.119	**	0.011
Km from center of SEA to nearest feeder road (as of 2000)	-2.092	***	0.000	-2.208	***	0.000	-1.920	***	0.001	-2.057	***	0.001
Agricultural year (2006/07 is base):												
1999/2000 (=1)	-14.194		0.216	-17.505		0.124	-1.911		0.884	-0.918		0.944
2002/2003 (=1)	14.587	**	0.041	9.279		0.160	3.614		0.560	1.052		0.858

Table 3 (cont'd)

GRZ fertilizer subsidy programs included:	All[a]						Fertilizer Credit Program & FSP only					
Election outcomes:	(A) Presidential			(B) Parliamentary			(C) Presidential			(D) Parliamentary		
Explanatory variables:	APE	Sig.	p-val.	APE	Sig.	p-val.	APE	Sig.	p-val.	APE	Sig.	p-val.
Province (Central is base):												
Copperbelt (=1)	6.610		0.652	9.176		0.558	14.526		0.388	15.259		0.375
Eastern (=1)	-8.462		0.240	-3.830		0.571	-11.451		0.102	-7.503		0.254
Luapula (=1)	-4.398		0.664	-1.649		0.884	-2.509		0.824	-1.655		0.890
Lusaka (=1)	34.792	*	0.064	30.813	*	0.081	49.917	**	0.031	47.596	**	0.036
Northern (=1)	3.909		0.700	9.287		0.397	5.082		0.634	9.059		0.428
Northwestern (=1)	5.479		0.676	21.782		0.169	9.793		0.514	21.943		0.201
Southern (=1)	23.907		0.138	40.593	**	0.029	18.232		0.226	36.721	**	0.046
Western (=1)	-15.751		0.464	-19.799		0.279	14.833		0.755	9.548		0.824
Agro-ecological region (region I, <800 mm rainfall) is base:												
IIa (800-1000 mm rainfall, clay soils) (=1)	12.906		0.436	14.360		0.383	20.575		0.238	21.298		0.222
IIb (800-1000 mm rainfall, sandy soils) (=1)	28.780		0.592	39.519		0.511	-9.272		0.712	-6.875		0.802
III (>1000 mm rainfall) (=1)	-0.400		0.984	-3.292		0.870	-1.814		0.931	-4.388		0.832
Uncensored (non-zero) observations	1,531			1,531			1,285			1,285		
F-test: joint significance of all regressors	7.77	***	0.000	7.59	***	0.000	8.80	***	0.000	8.73	***	0.000

Source: Own calculations.

Note: ***p < 0.01, **p < 0.05, *p <0.10. N=12,855. Time averages included in all regressions (CRE). APE = average partial effect. Farm equipment is plows, harrows, and ox-carts. Livestock are cattle, sheep, goats, and pigs. Resident males are defined as those that were at home for at least six of the 12 months. APEs include the effects of squared terms for landholding size, value of livestock, and rainfall. Robust standard errors computed using Huber/White sandwich estimator and clustered at household level. [a]All = Fertilizer Credit Program, FSP, and Food Security Pack Program.

Table 4. Mean Subsidized Fertilizer Receipt and Subsequent District-Level Presidential Election Outcomes, 2006 and 2011 Presidential Elections

	MMD won the district in the next presidential election?		Two groups statistically different?
Mean subsidized fertilizer receipt during the agricultural year prior to the election	Yes (N=67)	No (N=77)	H_0: Yes=No vs. H_1: Yes > No (p-value)
% of smallholder HHs receiving subsidized fertilizer	19.0	15.1	0.075
Kg of subsidized fertilizer/smallholder HH	52.1	40.6	0.070
FSP/FISP allocation (‘000 MT)	1.87	1.31	0.026

Source: Own calculations.
Note: Subsidized fertilizer receipt variables based on 2005/06 and 2010/11 agricultural years.

Table 5. Factors Affecting the Proportion of Votes Won by the Incumbent (the MMD), 2006 and 2011 Presidential Elections (CRE Fractional Response Probit)

	(A)			(B)			(C)		
Explanatory variables	APE	Sig.	p-val.	APE	Sig.	p-val.	APE	Sig.	p-val.
District % of smallholder HHs receiving subsidized fertilizer (t-1)	0.0000143		0.989	--			--		
District mean kg subsidized fertilizer received per smallholder HH (t-1)	--			-0.000101		0.697	--		
District FSP/FISP allocation ('000 MT, t-1)	--			--			0.000274		0.986
FRA purchases (‘000 MT, t-1)	0.00249	*	0.057	0.00255	*	0.062	0.00257		0.117
Demographic variables:									
District total population ('000)	0.00146		0.419	0.00150		0.420	0.00138		0.477
District female % of population	-0.0276		0.610	-0.0261		0.636	-0.0271		0.595
Provincial rural % of population	0.0887	***	0.000	0.0893	***	0.000	0.0888	***	0.000
District % of population age 15-49	-0.000428		0.974	0.000455		0.973	-0.00138		0.921
District % of population age 50-64	0.0438		0.353	0.0428		0.369	0.0430		0.358
District % of population age 65 and up	-0.111		0.138	-0.105		0.156	-0.109		0.128
District registered voters ('000)	-0.000291		0.853	-0.000392		0.808	-0.000247		0.881
District female % of registered voters	0.0201		0.308	0.0219		0.261	0.0193		0.328
Economic variables:									
Provincial labor force ('000)	0.00296	***	0.001	0.00295	***	0.001	0.00295	***	0.002
Provincial unemployment rate (%)	-0.101	***	0.000	-0.103	***	0.000	-0.101	***	0.000
Provincial total poverty rate (%)	-0.0269	***	0.009	-0.0274	***	0.008	-0.0266	**	0.012
Provincial Gini coefficient (0-100 scale)	-0.0246	***	0.004	-0.0246	***	0.005	-0.0246	***	0.004
Province (Central is base, dominant ethic group in paren.):									
Copperbelt (=1) (Bemba)	0.533	***	0.000	0.533	***	0.000	0.533	***	0.000
Eastern (=1) (Nyanja)	-0.422	***	0.000	-0.422	***	0.000	-0.422	***	0.000
Luapula (=1) (Bemba)	-0.409	***	0.000	-0.409	***	0.000	-0.410	***	0.000
Lusaka (=1) (Nyanja)	0.551	***	0.000	0.551	***	0.000	0.551	***	0.000
Northern (=1) (Bemba)	-0.468	***	0.000	-0.468	***	0.000	-0.468	***	0.000
Northwestern (=1) (Northwestern)	0.167		0.356	0.156		0.375	0.179		0.311
Southern (=1) (Tonga)	-0.147		0.294	-0.140		0.313	-0.146		0.307
Western (=1) (Barotse)	-0.238		0.109	-0.244	*	0.090	-0.243		0.113
2011 year dummy (2006 is base)	-0.353	***	0.000	-0.349	***	0.000	-0.352	***	0.000
Province dummies × year dummy	Yes			Yes			Yes		
Log pseudo-likelihood	-60.344			-60.282			-60.404		

Source: Own calculations.

Note: ***p < 0.01, **p < 0.05, *p <0.10. N=144. All regressions include time averages (CRE). APE = average partial effect. Provincial dummy and year dummy APEs include the effects of province dummy × year dummy interactions.

APPENDIX

Table A1. Summary Statistics for CRE Tobit Model of Factors Affecting the Kilograms of Subsidized Fertilizer Allocated to a Smallholder Household

			Percentiles				
	Mean	Std. dev.	10th	25th	50th	75th	90th
Dependent variables:							
Kg of government subsidized fertilizer allocated to the household (all programs)	31.885	150.848	0	0	0	0	50
HH received government subsidized fertilizer (=1)	0.107						
Kg of Fertilizer Credit Program or FSP fertilizer allocated to the household	29.418	148.411	0	0	0	0	0
HH received Fertilizer Credit Program or FSP fertilizer (=1)	0.088						
Explanatory variables:							
MMD won the HH's constituency in the last presidential election (=1)	0.648						
Pct. point spread b/w MMD & lead opposition in constituency - presidential	40.442	23.271	10.037	19.874	39.465	58.629	73.223
MMD won the HH's constituency in the last parliamentary election (=1)	0.629						
Pct. point spread b/w MMD & lead opposition in constituency - parliamentary	29.864	19.294	6.735	14.483	27.046	42.583	57.154
Maize producer price (ZMK/kg, t-1)	475.022	180.835	220.896	268.657	521.739	608.696	660.870
Commercial fertilizer price (ZMK/kg)	1564.236	667.355	741.111	820.000	1660.000	2140.000	2500.000
Landholding size (cultivated+fallow, ha)	2.108	2.374	0.500	0.875	1.500	2.563	4.145
Value of farm equipment ('00,000 ZMK)	1.396	5.065	0	0	0	0	3.500
Value of livestock ('00,000 ZMK)	12.623	60.200	0	0	0	3.500	31.000
Number of children age 4 and under	0.811	0.943	0	0	1	1	2
Number of children age 5 to 14	2.021	1.646	0	1	2	3	4
Number of prime age (PA) adults (age 15 to 59)	2.885	1.709	1	2	2.667	4	5
Number of adults age 60 and above	0.379	0.634	0	0	0	1	1
Age of the HH head	49.195	15.228	31	37	47	61	71
Highest level of education completed by the HH head (none is base):							
Lower primary (grades 1-4) (=1)	0.257						
Upper primary (grades 5-7) (=1)	0.354						
Secondary (grades 8-12) (=1)	0.187						
Post-secondary education (=1)	0.018						
Sex and residence status of HH head (resident male head is base):							
Female-headed with non-resident husband (=1)	0.006						
Female-headed with no husband (=1)	0.213						
Head/spouse disease-related PA death in last 3-4 years (=1)	0.022						
Other HH member disease-related PA death in last 3-4 years (=1)	0.076						
Expected growing season rainfall (100 mm)	9.017	1.846	6.652	7.580	8.792	10.633	11.672
Expected moisture stress (# of 20-day periods with <40mm rain)	1.813	1.012	0.556	0.889	1.889	2.444	2.889
SEA is suitable for low input management maize production (=1)	0.565						
Km from center of SEA to nearest district town (as of 2000)	34.213	22.248	10.1	16.1	28.8	46.0	68.5
Km from center of SEA to nearest tarred/main road (as of 2000)	26.189	36.715	0.8	4.0	12.2	29.6	73.2
Km from center of SEA to nearest feeder road (as of 2000)	3.239	3.141	0.6	1.1	2.3	4.3	7.2

Table A1 (cont'd)

	Mean	Std. dev.	Percentiles				
			10th	25th	50th	75th	90th
Province (Central is base):							
Copperbelt (=1)	0.058						
Eastern (=1)	0.244						
Luapula (=1)	0.092						
Lusaka (=1)	0.024						
Northern (=1)	0.175						
Northwestern (=1)	0.070						
Southern (=1)	0.119						
Western (=1)	0.105						
Agro-ecological region (region I, <800 mm rainfall, is base):							
IIa (800-1000 mm rainfall, clay soils) (=1)	0.441						
IIb (800-1000 mm rainfall, sandy soils) (=1)	0.086						
III (>1000 mm rainfall) (=1)	0.419						

Source: Own calculations.
Note: N=12,855.

Table A2. Number and Percentage of Constituencies Won by the MMD in the 1996, 2001, and 2006 Presidential and Parliamentary Elections

	Number of constituencies won by the MMD (% of constituencies in paren.)			
Election year	Presidential		Parliamentary	
1996	140	(93.3%)	131	(87.3%)
2001	68	(45.3%)	69	(46.0%)
2006	72	(48.0%)	74	(49.3%)
Average	93.3	(62.2%)	91.3	(60.9%)

Source: ECZ (various years)
Note: Out of 150 total constituencies in Zambia.

Table A3. Summary Statistics for CRE Fractional Response Probit Model of Factors Affecting the Proportion of Votes Won by the Incumbent (the MMD)

				Percentiles				
	N	Mean	Std. dev.	10th	25th	50th	75th	90th
Dependent variable:								
District % of votes won by MMD	144	44.328	21.654	17.533	27.280	40.401	62.570	77.346
2006 election	72	49.342	22.000	21.492	32.658	41.635	72.661	78.856
2011 election	72	39.313	20.233	16.455	21.596	34.549	55.366	68.426
MMD won the district (=1)	144	0.465						
2006 election	72	0.486						
2011 election	72	0.444						
Explanatory variables:								
District % of smallholder HHs receiving subsidized fertilizer (t-1)	144	16.928	15.983	0.379	3.485	12.687	28.870	36.004
District mean kg subsidized fertilizer received per smallholder HH (t-1)	144	45.970	46.517	0.405	8.485	30.621	72.289	102.442
District FSP/FISP allocation ('000 MT, t-1)	144	1.570	1.729	0.060	0.300	1.108	2.000	4.480
FRA purchases ('000 MT, t-1)	144	6.678	11.800	0	0.066	1.602	7.050	17.716
District total population ('000)	144	173.513	165.272	64.851	89.390	132.218	206.161	275.353
District female % of population	144	49.977	0.717	49.162	49.553	49.917	50.315	50.731
Provincial rural % of population	144	72.431	26.525	19.647	76.678	84.824	88.767	91.074
District % of population age 15-49	144	46.090	3.095	43	44.1	45.15	47.28	51.4
District % of population age 50-64	144	5.422	0.570	4.76	5.035	5.4	5.8	6.2
District % of population age 65 and up	144	2.755	0.682	1.9	2.2	2.8	3.2	3.6
District registered voters ('000)	144	63.253	65.764	26.378	34.473	47.413	73.032	99.128
District female % of registered voters	144	51.541	3.558	46.526	49.205	51.594	54.180	55.839
Provincial labor force ('000)	144	577.799	156.919	382	419	662	690	753
Provincial unemployment rate (%)	144	11.955	9.312	3.2	5.6	9.2	13	28.3
Provincial total poverty rate (%)	144	66.220	17.489	34.3	67	73	78.5	80.4
Provincial Gini coefficient (0-100 scale)	144	52.458	2.937	50	50	52	53	54
Province (Central is base, dominant ethic group in paren.):								
Copperbelt (=1) (Bemba)	144	0.139						
Eastern (=1) (Nyanja)	144	0.111						
Luapula (=1) (Bemba)	144	0.097						
Lusaka (=1) (Nyanja)	144	0.056						
Northern (=1) (Bemba)	144	0.167						
Northwestern (=1) (Northwestern)	144	0.097						
Southern (=1) (Tonga)	144	0.153						
Western (=1) (Barotse)	144	0.097						
Instrumental variables:								
District % of smallholders cultivating 2+ ha (t-1) – for subsid. fertilizer	144	21.243	12.070	7.146	12.506	19.763	28.618	39.325
District % of smallholders cultivating 2+ ha (t-2) – for FRA purchases	144	20.827	11.465	7.442	11.926	19.130	28.001	36.921

Source: Own calculations.

Table A4. Reduced Form CRE Pooled Ordinary Least Squares Regression Results

Dependent variable:	% of smallholder HHs receiving subsidized fertilizer (t-1)			Mean kg subsidized fertilizer received per smallholder HH (t-1)			FSP/FISP allocation ('000 MT, t-1)			FRA purchases (‘000 MT, t-1)		
Explanatory variables	APE	Sig.	p-val.	APE	Sig.	p-val.	APE	Sig.	p-val.	APE	Sig.	p-val.
IV: District % of smallholder HHs cultivating 2+ ha (t-1)	0.260	**	0.029	1.023	***	0.003	0.034	***	0.008	--		
IV: District % of smallholder HHs cultivating 2+ ha (t-2)	--			--			--			0.334	***	0.000
Demographic variables:												
District total population ('000)	0.341		0.143	0.906		0.311	0.120	***	0.000	1.073	***	0.000
District female % of population	7.619		0.106	17.666		0.196	0.308		0.127	0.667		0.798
Provincial rural % of population	4.846	**	0.034	9.755		0.283	0.704	***	0.000	3.307	**	0.030
District % of population age 15-49	3.072	*	0.084	6.401		0.321	0.505	***	0.001	5.067	***	0.000
District % of population age 50-64	-1.866		0.766	-15.105		0.564	0.207		0.636	6.121		0.201
District % of population age 65 and up	24.666	**	0.022	87.700	*	0.066	0.814		0.221	-6.140		0.439
District registered voters ('000)	-0.479	***	0.009	-1.529	**	0.013	-0.080	***	0.000	-0.610	***	0.001
District female % of registered voters	4.410		0.202	23.199		0.114	0.074		0.693	-1.216		0.601
Economic variables:												
Provincial labor force ('000)	0.088		0.383	0.137		0.674	0.024	***	0.008	0.096		0.318
Provincial unemployment rate (%)	-9.965	***	0.000	-30.251	***	0.003	-0.451	***	0.005	-0.543		0.685
Provincial total poverty rate (%)	-3.502	***	0.003	-9.932	**	0.049	-0.274	***	0.003	-1.430		0.317
Provincial Gini coefficient (0-100 scale)	0.376		0.771	2.059		0.706	-0.056		0.532	-1.535		0.143
Province (Central is base, dominant ethic group in paren.):												
Copperbelt (=1) (Bemba)	360.656	***	0.006	860.827	*	0.062	35.348	***	0.001	131.296	*	0.061
Eastern (=1) (Nyanja)	-141.803	***	0.008	-350.222	**	0.046	-17.763	***	0.000	-68.011		0.105
Luapula (=1) (Bemba)	-79.518	***	0.000	-235.018	***	0.001	-5.222	***	0.002	-13.134		0.194
Lusaka (=1) (Nyanja)	309.606	**	0.025	703.347		0.163	32.574	***	0.002	118.614		0.113
Northern (=1) (Bemba)	-81.096	**	0.038	-189.550		0.186	-12.994	***	0.000	-50.764	*	0.076
Northwestern (=1) (Northwestern)	-5.719		0.822	-6.306		0.946	-1.170		0.475	-8.337		0.610
Southern (=1) (Tonga)	10.706		0.472	35.840		0.449	-1.926		0.129	-3.420		0.795
Western (=1) (Barotse)	-18.492		0.550	-26.717		0.830	-3.613	*	0.053	-12.060		0.537
2011 year dummy (2006 is base)	-2.801		0.750	2.035		0.946	-2.110	***	0.004	-17.214	**	0.010
Copperbelt (=1) × 2011 year dummy	-22.048	***	0.001	-83.247	***	0.010	-0.906	**	0.042	-3.664		0.448
Eastern (=1) × 2011 year dummy	65.179	***	0.000	184.014	***	0.002	5.247	***	0.000	23.558	*	0.086
Luapula (=1) × 2011 year dummy	64.664	***	0.002	189.252	**	0.021	3.971	***	0.008	11.376		0.527
Constant	24.699		0.912	504.249		0.561	-37.104	**	0.031	-123.847		0.390
R-squared	0.702			0.624			0.751			0.750		
Overall model F-statistic	25.28	***	0.000	18.93	***	0.000	40.53	***	0.000	11.24	***	0.000

Source: Own calculations.

Note: ***p < 0.01, **p < 0.05, *p <0.10. N=144. All regressions include time averages (CRE). Interactions with 2011 year dummy for other provinces dropped due to collinearity. The two IVs are highly correlated (ρ=0.82). When both IVs are included in the reduced forms for both sets of suspected endogenous explanatory variables (subsidized fertilizer and FRA purchases), the IVs are highly jointly significant (p<0.02) but only one or neither is individually significant.