Supply-side Crowding-out and Crowding-in Effects of Malawi's Farm Input Subsidy Program on Private-Sector Input Marketing: A quasi-experimental field study

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Abstract:

The present article estimates the extent to which participation in Farm Inputs Subsidy Program (FISP) crowds-out/in fertilizer sales among private sector retailers in Malawi. Malawi implemented FISP reforms during 2015/16 season that allowed certain larger-scale fertilizer distributors to sell FISP fertilizer at their retail outlets in select districts on a pilot basis while smaller-scale agro-dealers were excluded. We use a unique panel dataset of fertilizer retailers collected before and after the policy change to measure supply-side crowding-in/out impacts of the FISP. Using a difference-in-differences estimator we are able to obtain a causal measurement of how the policy change affects fertilizer sales for retailers who participated in the program and those who did not. Results indicate that distributors who sold the FISP fertilizer experienced a 299 Mt increase in the volume of total fertilizer sales, on average. Conversely, agro-dealers who were excluded from participating in the pilot program experienced a 28 Mt decline in their fertilizer sales, on average. This suggests that the reforms have mainly benefited distributors who sell 90% of the fertilizer in Malawi, but caused some harm to the many agro-dealers who sell 10% of Malawi's fertilizer, but also conduct their businesses in more remote areas.

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Key words: Input subsidies, crowding-out, crowding-in, input supply-chain, Malawi

1. Introduction

Establishing and maintaining an effective and vibrant private input supply sector across Sub-Saharan Africa (SSA) is vital for enhancing smallholder farmers' access to productivity enhancing technologies such as inorganic fertilizer and hybrid seeds. Adoption of the World Bank and International Monetary Funds' structural adjustment programs led to a substantial increase in private sector participation in the input markets in most countries of SSA in the 1980s (Kelly *et* *al*., 2003; Gregory and Bumb, 2006; Government of Malawi, 2010). During that time period, private sector input traders were allowed to import, distribute, and sell fertilizers, which had previously been under almost exclusive control by government run parastatal institutions in many countries. This paradigm change was expected to facilitate the development of well-functioning markets and enhance farmers' access to fertilizers thereby enhancing agricultural production (Gregory and Bumb, 2006).

Despite the greater involvement of the private sector in the fertilizer market over the past 30 years, input markets in most countries of SSA remain underdeveloped. Poor dealer networks, inadequate infrastructure, unpredictable policy environments, credit constraints, limited market information and access to inputs are some of the challenges facing smallholder farmers in rural areas (Gregory and Bumb, 2006; Seini *et al*., 2011; Hernandez and Torero, 2013). As a result, in many SSA countries including Ethiopia, Nigeria, Kenya, Tanzania, Ghana, Zambia and Malawi, the government has intervened in the market in the last ten years to provide free or subsidized inputs such as fertilizer and hybrid seed to smallholder farmers in an attempt to enhance access to these inputs.

The objective of the present study is to provide new insights on how inputs subsidy programs affect the private sector by estimating the extent to which the reforms to Malawi's FISP enacted during the 2015/16 season increase (crowd-in) or decrease (crowd-out) commercial sales by private input suppliers. Malawi's reforms allowed some larger-scale, private-sector input distributors to sell FISP fertilizer at their retail outlets in selected districts on a pilot basis. At the same time, smaller-scale independent agro-dealers were excluded from participating in the pilot.[1] Prior to the reforms, the government was responsible for distribution and sale of FISP fertilizer to smallholders through its parastatal operations.[2]

According to Morris *et al*. (2007), farm input subsidies should be temporary and used as a vehicle to develop a robust input supply chain. In this paper, we contend that, if the FISP helps crowd-in commercial input sales by encouraging participating retailers to move into new and underserved areas, and creates competition among retailers, then private sector involvement in the FISP could be viewed as a positive step for the program. Conversely, if the FISP crowds-out or displaces commercial input sales, this would suggest that the program is undermining the long-term viability of the input supply chain, and raises questions about whether or not the private sector would be able to meet farmers' input needs if the FISP was to end.

To estimate the crowding-out/in impacts of this policy change, we use three waves of nationally representative panel data from private input retailers in Malawi collected in three consecutive agricultural seasons of 2013/14, 2014/15, and 2015/16. In combination with our dataset, the fact that the pilot program was decided upon and initiated during the 2015/16 season provides us with a natural experimental setting to conduct our analysis. We use our data from before and after the policy change to apply a quasi-experimental, difference-in-difference (DD) estimator to test how the FISP fertilizer pilot during 2015/16 affected i) the volume of commercial fertilizer sales for larger-scale distributors who were allowed to participate, ii) the

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[1] By definition, an independent agro-dealer is as a local entrepreneur who sells seeds, fertilizer and agro-chemicals to smaller-scale farmers in rural areas (Alliance for a Green Revolution in Africa, 2007; Chinsinga, 2011).

[2] An earlier program that allowed certain larger-scale distributors to sell subsidized fertilizer during the 2006/07 and 2007/08 seasons. After 2007/08 the program was discontinued, and all subsidized fertilizer went through government shops from 2008/09 onward.

volume of commercial fertilizer sales for other larger-scale distributors who were not allowed to participate and iii) the volume of commercial fertilizer sales for smaller-scale independent agro-dealers who were also excluded from participating in the program.

By measuring supply-side crowding-out/in of input subsidies on commercial fertilizer sales, this article adds an important dimension to the growing literature on input subsidies in SSA. A number of empirical studies using nationally representative data from the region have estimated crowding-out/in out of commercial input by subsidized inputs by farmers using observational panel data via econometric estimation (*e.g*. the demand side of the market). Most of these studies find that when farmers receive subsidized fertilizer and seed, they significantly crowd-out their demand for commercial fertilizers in the open market (Xu *et al*., 2008; Ricker-Gilbert *et al*., 2011; Takeshima *et al*., 2012; Mason and Ricker-Gilbert 2013; Jayne *et al.,* 2013; Mason and Jayne, 2013).[3] In contrast, the few studies that have evaluated the impacts of input subsidies from the supply side are descriptive in nature (Dorward *et al*., 2008; Kelly *et al*., 2010; Fitzpatrick, 2012; Chirwa and Dorward, 2012; Mather *et al*., 2016). The closest article to ours is by Mather *et al.* (2016) that investigate the impact of Tanzania's input subsidy program on the private-sector input supply chain. Our study builds on Mather *et al*. (2016) and other previous studies, as it is the first study from SSA to empirically estimate the supply-side impact of input subsidy programs on commercial input sales using nationally representative panel data.

[3] To our knowledge, Liverpool-Tasie (2014) is the only study to find significant evidence of commercial fertilizer crowding-in from a pilot fertilizer subsidy program in Kano State, Nigeria.

2. Agricultural Input Supply in Malawi

2.1. Structure of the Input Supply Chain

The main actors in the agricultural input supply chain in Malawi are the government and private-sector input suppliers. The government retails inputs through their two parastatal enterprises; the Smallholder Farmers' Fertilizer Revolving Fund of Malawi (SFFRFM) and Agricultural Development and Marketing Corporation (ADMARC). Although ADMARC market depots are supposed to operate in remote areas that are not adequately served by the private sector, they also operate in areas that are well served by the private sector (Dorward *et al*., 2007; Kelly *et al*., 2010). Thus, there is competition between ADMARC and private-sector retailers in areas of high input demand, leading to possible crowding-out of private sector sales by parastatal activities. Most ADMARC and SFFRFM retail outlets sell inputs on a seasonal basis, opening their doors for sales before and during the planting season from October-February.

The private input suppliers in Malawi are categorized into two main groups: i) major distributors and ii) independent agro-dealers. Major distributors such as Farmers' World, Export Trading, Nyiombo Investment, Transglobe, AGORA and Kulima Gold are larger-scale commercial operators. They import and supply different fertilizers to their individual network of retail outlets across Malawi. Conversely, Independent agro-dealers play a critical role in shortening farmers' distance to input markets by operating in remote rural areas which are not served by major distributors. They enhance farmers' access to agricultural inputs for both rainy season and winter cropping under irrigation schemes. Many independent agro-dealers often purchase their fertilizer from the larger-scale distributors and sell it in the smaller quantities needed by smaller-scale farmers at a higher per unit price.

2.2. Private Sector Involvement in Fertilizer Subsidy

As already indicated, prior to the 2015/16 pilot the retail sale of subsidized fertilizer under FISP had been done solely by government through its network of SFFRFM and ADMARC market depots, except for a brief interlude during the 2006/07 and 2007/08 seasons. During these two seasons, the major distributors were allowed to sell subsidized fertilizer to smallholder farmers while independent agro-dealers were excluded (Chirwa and Dorward, 2012; Kelly *et al*., 2010; Fitzpatrick, 2012; Government of Malawi, 2010). In the 2006/07 season, a total of 174,688 Mt of subsidized fertilizer was sold to smallholder farmers with private retailers accounting for 28 percent, and the remainder by ADMARC and SFFRFM (Dorward *et al.*, 2008; Chirwa and Dorward, 2013).

In 2007/08, the government stimulated the expansion of the private sector to remote rural areas where their presence was limited in the 2006/07 season. The government offered an incentive bonus of about MK 100 (US$0.71) or MK 200 (US$1.42) on top of the district value of the subsidy voucher depending on the distance to remote rural areas (Kelly *et al*., 2010; Chirwa and Dorward, 2013).[4] This encouraged some private sector actors to deliver to more remote rural areas than in the previous 2006/07 season. According to Kelly *et al*. (2010), the private sector delivered the subsidized fertilizer either through direct deliveries to temporary distribution points or through independent agro-dealers who acted as agents for the distributors. A total of

[4] US$ 1.00 = MK140.5 as of 2007.

50,719 Mt were distributed by private retailers, representing 24 percent of the subsidized fertilizer sales (Logistics Unit, 2008).

During the 2015/16 season, the Government of Malawi allowed some larger-scale private-sector input distributors to sell FISP fertilizer in 9 out of 28 districts at their retail outlets on a pilot basis, while smaller-scale independent agro-dealers were excluded from participating in the pilot. According to Government of Malawi (2016), selection of pilot districts was based on their determination of whether the district was adequately served by the private sector or not. Balaka, Chikwawa, Chiradzulo, Mwanza, Neno, Nkhotakota, and Salima districts represented districts that the government believed were not adequately served by the private sector whereas Dedza and Mchinji districts were considered to be adequately served by the private sector.

Capacity to open selling points in the rural areas or to sub-contract other suppliers in the pilot district were among the criteria used to select participating firms (Government of Malawi, 2016). This means that bidders who had physical infrastructure in the pilot districts were given the contract to distribute fertilizer there. Two distributors were awarded contracts to sell the allocated subsidized fertilizer to farmers in each of the pilot districts. In addition, the participating distributors that were awarded the FISP contracts were required to compete with each other to sell the volume of FISP fertilizer that was allocated to the pilot districts at a fixed farmers' contribution of MK3500 (US$6.36) per 50 kg bag of either UREA or NPK.[5] A total of 33,910 Mt were distributed by private retailers, representing 23 percent of the subsidized fertilizer sales in 2015/16 season (Logistics Unit, 2016).

[5] 1US$= MK550 as of November, 2015.

3. Conceptual Framework

We adopt a profit maximization framework to understand how the 2015/16 FISP pilot program in Malawi may affect commercial and total fertilizer sales, both for retailers who participate in the pilot and retailers who are excluded from it.[6, 7] Consider a fertilizer retailer who maximizes profits, π, as follows:

1) $\pi = pF - cV - T$

where the quantity of fertilizer sold by the firm is denoted by F, and p represents its per unit price. A vector of inputs associated with acquiring and marketing fertilizer (*e.g.*, labour, transport, wholesale price) is denoted by V, and c represents their per unit cost, while T represents the transactions costs that play a substantial role in determining the amount of F to stock and also the ultimate profitability of selling fertilizer. According to Morris *et al.* (2007), major risks for input suppliers in SSA include; i) inventory risk caused by year to year variability in effective demand for fertilizer by farmers which forces retailers to carry excess inventory that they cannot offload; ii) financing risk created by the inability for many retailers to secure commercial credit to buy inventory at the start of the season; iii) price risk, caused by high volatility in fertilizer prices making it difficult to liquidate inventory when excess stocks are not sold; iv) policy risk caused by government's inconsistent involvement in fertilizer markets providing fertilizer to farmers at highly subsidized prices. All of these risks increase the

[6] For simplicity, our framework focuses on fertilizer, but it can be applied to other inputs like seed as well.
[7] See Xu et al. (2008) for a conceptual model of demand side crowding-out/in.

transactions costs of stocking and selling fertilizer and make it difficult for fertilizer retailers to accurately predict the profit maximizing level of F to choose.

In the absence of a fertilizer subsidy program or if the firm does not participate in an existing subsidy program, then total fertilizer sales, F, are equal to commercial fertilizer sales, C. Conversely, if the firm is able to participate in a fertilizer subsidy program, such as the one piloted in Malawi in 2015/16, then F is a function of subsidized fertilizer sales, S, in addition to C, such that

2) $F = S + C$,

Participation in the subsidy means that $S > 0$, and the question becomes: how does participation in the subsidy program ($P = 1$ if $S > 0$) affect both total fertilizer sales and commercial fertilizer sales by the firm?

If we relate this issue back to the risk associated with stocking fertilizer in Africa according to Morris *et al*. (2007), participating in the subsidy could help reduce the firm's price risk and policy risk by enabling them to coordinate with the government's policy and ensuring that they have a supply of fertilizer to sell to customers at a below market price. However, given fixed human and physical capacity in the short term, the private retailer who participates in the subsidy program may focus its resources on selling S at the expense of selling C, causing commercial fertilizer sales to be crowded-out by subsidized sales. Conversely, if participation in the subsidy drives new customers to the firm who want to purchase subsidized fertilizer, and those customers top up their subsidized purchases with additional commercial purchases, then participating in the subsidy program could crowd-in C.

At the same time, firms that are unable to participate in the fertilizer subsidy program likely experience an increase in price and policy risk. As mentioned above, if recipients of subsidized fertilizer choose to go to firms that sell both subsidized and commercial fertilizer, and take advantage of "one-stop shopping", then not participating in the subsidy would cause commercial fertilizer sales to decline for the non-participating firms. Conversely, if firms that participate in the subsidy chose to focus on selling S rather than C, there could be more opportunities for firms who do not participate in the program to capture some of these commercial sales.

Ultimately, the extent to which crowding-out/in of commercial fertilizer sales happens to firms who participate in the pilot and those that do not is an empirical question that we describe and estimate in the following sections.

4. Estimation Strategy

The implementation of the FISP pilot program in 2015/16 where selected distributors could retail FISP fertilizer in certain districts provides us with a natural experiment to measure the impact of the pilot on the volume of fertilizer sold by both commercial distributors and independent agro-dealers in the pilot districts. In this article, the districts in which the private-sector was allowed to sell FISP fertilizer are considered as treatment districts and the districts in which the government distributed the subsidized fertilizer through SFFRFM and ADMARC are considered as control districts. Some of the larger-scale distributors were allowed to sell FISP fertilizer in 2015/16 if they were located in the pilot districts, and others were not. For the distributors in pilot districts treatment occurs at the individual retail outlet level.

Since we have observations on the same retail outlets over the two seasons immediately preceding the pilot program and one season after the pilot program started, we use a quasi-experimental difference-in-difference (DD) estimator to measure the effect of the FISP program on commercial fertilizer sales for retail outlet i of a larger-scale distributor at time t as follows:

3) $C_{it} = \beta_0 + \beta_1 P_i + \beta_2 D_i + \beta_3 t + \beta_4 (P_i * t) + \beta_5 (D_i * t) + \beta_6 X_{it} + \varepsilon_{it}$

where C represents the volume of commercial fertilizer sales for each retail outlet, just as in equation 2. We also estimate equation 3 with F, total fertilizer sales, as the dependent variable. The constant is represented by β_0, and $\beta_1 - \beta_6$ are all unknown parameters to estimate while ε_{it} is the error term. Participation in the FISP pilot by the retail outlet i is represented by P, and it accounts for the average difference before the pilot, between retailers that participated in the 2015/16 FISP pilot and those that did not. Note that P takes on a value of 1 for participating retailers in all waves of the panel and zero otherwise. In addition, distributors that operated in the FISP pilot district but did not participate in the 2015/16 pilot are denoted by D. Note that D takes on a value of 1 for non-participating retailers in all waves of the panel and other firms (*i.e*. participating retailers) get a zero. The year dummy t varies by year but is the same for the treated and control firms. It takes on a value of 1 for the pilot year of 2015/16 and zero for the earlier years (2013/14, and 2014/15).

The parameter β_4 represents our average treatment effect on the treated (ATT). It is the average change in quantity of fertilizers sold by retailers who participated in the pilot in the DD estimation framework. It is the interaction of P and t, making the corresponding coefficient estimate of $\hat{\beta}_4$ of principal interest in this paper because it captures the impact of participating in the FISP pilot on fertilizer sales. A positive coefficient estimate on $\hat{\beta}_4$ indicates that participation in the FISP pilot in 2015/16 crowds-in commercial fertilizer sales (total fertilizer sales in another specification), while a negative coefficient indicates that commercial sales (total fertilizer sales in another specification) are crowded-out by the pilot. The effect of the pilot on larger-scale distributors who are located in pilot districts but do not retail FISP fertilizer in 201/16 is captured by the coefficient $\hat{\beta}_5$. The sign and statistical significance of the coefficient $\hat{\beta}_5$, provides an indication of whether or not there is an indirect or spill-over effect, either positive or negative on non-participating distributors located in pilot districts. A range of control variables is denoted by X. A full list of variables used in the models for this study are presented in table A.1 in the appendix.

Next we considered the effect of the FISP pilot on independent agro-dealer firm i at time t as follows:

$$4)\ C_{it} = \alpha_0 + \alpha_1 T_i + \alpha_2 t + \alpha_3 (T_i * \ t) + \alpha_4 X_{it} + \mu_{it}$$

where C represents commercial fertilizer sales and total maize seed sales in another specification. The variable T is equal to 1 if the agro-dealer is located in a district that was part of the pilot. Note, that the agro-dealers in pilot districts take on a value of 1 for all waves of the survey and zero, otherwise. The other variables in equation 4 are the same as in equation 3, while α_0 is a constant and $\alpha_1 - \alpha_4$ are parameters that were estimated, and μ_{it} represents the error term. In this equation the coefficient $\hat{\alpha}_3$ is the ATT of interest and is simply the DD estimate of being located in a FISP pilot district in 2015/16, since independent agro-dealers were not allowed to participate in the pilot. However, they may have been affected indirectly by participating larger-scale distributors in their district.[8] As such, a positive coefficient on $\hat{\alpha}_3$ suggests crowding-in of commercial sales for agro-dealers by the pilot, while a negative coefficient indicates crowding-out.

Identification Strategy, DD estimator

It is important to note that selection of FISP pilot districts by the government of Malawi was non-random, and was likely based on maize growing districts, while considering both easy and hard to reach areas. Therefore, a potential source of endogeneity bias in this context comes from conditions that we cannot observe, which likely determine selection of pilot districts and influence commercial fertilizer sales (Jalan and Ravallion, 1998; Khandker *et al*., 2010). In this regard, the DD estimator allows us to control for possible endogeneity of districts that were selected for the pilot. This form of endogeneity caused by time-constant unobserved heterogeneity (*i.e*. the unobserved difference in mean counterfactual outcomes between the pilot and control districts) cancels out through differencing, and the growth in commercial fertilizer sales for the retailers (*i.e*. distributor and independent dealer) in control districts serves as the counterfactual indicator (Khandker *et al*., 2010).[9]

Parallel-Trend Assumption Test

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[8] The models are estimated separately for distributors and independent agro-dealers because distributors sell large volumes of fertilizer whereas independent agro-dealers sell a relatively small volume, making direct comparison between the two groups intractable.

[9] The DD estimator is a form of FE when the treatment variable of interest varies at a higher level than the individual or store in our case (Angrist and Pischke, 2009).

While the DD estimator controls for time-constant unobserved heterogeneity, the coefficient estimates must be consistent with the parallel trend assumption. It stipulates that the average change in fertilizer sales for retailers in pilot districts if they were untreated would be equal to the observable average change among comparable retailers in control districts (Mora and Reggio, 2012). Thus, the outcomes for the treatment and control firms must follow the same time trend in the absence of the treatment. However, if the results are not consistent with the parallel trend assumption, it means that time-varying unobservable factors are correlated with firms who are in the FISP pilot districts and their fertilizer sales. Thus causing the estimate of the ATT to be biased.

To deal with this problem and provide evidence in support of the parallel trend assumption in our context, we run a series of falsification tests using pre-treatment period data, 2013/14 and 2014/15 along with baseline controls. In the falsification tests, we assume that the FISP pilot program occurred in the 2014/15 season (recall that in reality it started the next season in 2015/16). If the coefficients measuring the impact of participating in the FISP pilot (direct impact) and the impact of the FISP pilot (indirect impact) on fertilizer sales are insignificant in the falsified models for distributors and independent agro-dealers, then the estimates are consistent with the parallel trend assumption.

Results of our parallel trend assumption test are presented in the appendix in tables A.2 and A.3 for distributors and tables A.4 for independent agro-dealers in fertilizer markets. None of the ATT estimates in tables A.2 – A.4 are statistically significant at the 10% level, suggesting that the coefficient estimates in both distributor and independent agro-dealer models are consistent with the parallel trend assumption.

5. Data

The panel dataset used in our analysis was collected by Lilongwe University of Agriculture and Natural Resources (LUANAR) on fertilizer distributor retail outlets and independent agro-dealers across Malawi. Each distributor outlet and agro-dealer selling point was surveyed in three consecutive seasons (2013/14, 2014/15 and 2015/16) across 20 districts[10]. A total of 431 independent agro-dealers and 178 retail outlets of fertilizer distributors were interviewed across Malawi in the first survey wave, which occurred during the months of May and June, 2014. Two follow-up surveys were conducted in the months of June 2015 and March 2016, respectively. Three hundred fifty-six private sector retailers were located and re-interviewed each year. The analysis uses a dataset with 468 observations from 156 retail outlets of input distributors and 600 observations from 200 independent agro-dealers who were interviewed across the country in all three survey waves.

5.2. Nonrandom Attrition over the years

Input retailers leaving the sample for non-random reasons could be an issue in our context, and could potentially bias our results if not dealt with. Table 1 shows the extent of attrition among agro-dealers that were surveyed between 2013/14 and 2015/16. Overall, attrition is high among

[10] Rumphi, Mzimba, Nkhatabay, Dowa, Kasungu, Lilongwe, Nkhotakota, Ntchisi, Salima, Dedza, Mchinji, Ntcheu, Thyolo, Zomba, Blantyre, Machinga, Chikwawa, Balaka, Chiradzulu, and Mulanje. Of these sampled districts, seven districts were under FISP pilot in 2015/16 season.

independent agro-dealers and lower among larger-scale distributors. Attrition between 2013/14 and 2015/16 among distributors (3 to 10 percent) is attributed to shut down of some selling points in some market centers due to poor sales over time and security threats.[11]

Attrition among independent agro-dealers increased from 15 to 26 percent between 2013/14 and 2015/16 seasons. Most of the independent agro-dealers that were not re-sampled stopped selling farm inputs, few moved to other market centers (which were not part of the sampled market centers), while others started new businesses such as selling hardware and groceries.

[Table 1 Here]

Attrition seems to be an issue with independent agro-dealers, since they have relatively high attrition rates across survey waves. Since we have three waves of data, we run a form test of attrition bias proposed in Wooldridge (2010, p. 837-838). Results of the test are presented in table A.5 and A.6 in appendix. The findings in table A.5 and A.6 suggest that attrition is not an issue because coefficient estimates on the selection variable are not statistically significant (p-value>0.10) in both distributor and independent agro-dealer models. Furthermore, it is important to note that any remaining bias caused by non-random attrition likely causes our crowding-out/in results to be under-estimated. This attenuation bias would occur because retailers who were driven out of business by the FISP or other reason have zero sales in the following year, so including them will likely increase the crowding-out estimate.

[11] For example, security threats were mentioned in Nsaru market center in Lilongwe District

6. Results

6.1. Descriptive Results

Table 2 presents distribution of fertilizer sales by distributors and agro-dealers (see table A.7 in appendix for descriptive statistics for variables used in the empirical models). Table 2 shows that distributors have a major share of commercial fertilizer sales compared to independent agro-dealers in the input market at the retail level. This might suggests that major distributors may have some monopoly power in the distribution and sale of commercial fertilizers. However, table 2 also indicates that the market share of commercial fertilizer sales for independent agro-dealers has increased by more than 100 percent (from 4.53 to 9.34 percent of total sales) across the country between 2013/14 and 2015/16. This suggests that the independent agro-dealers' role in supplying inputs to farmers increase in both its relative and absolute importance during this period. In addition, the decline in fertilizer sales by distributors from 85,300 Mt in 2013/14 to 32,600 Mt in 2014/15 could be attributed to devastating floods that affected the country in January 2015 which was followed by a dry spell (*El Niño*) in 2015/16 season. Collectively, these natural disasters could have reduced the demand for commercial fertilizer.

[Table 2 Here]

6.2. Empirical Results

Table 3 presents DD results of estimating the extent to which the FISP pilot affected the volume of commercial fertilizer sales for larger-scale fertilizer distributors. Recall that some of the distributors were allowed to participate in the FISP pilot and some were not. Table 3 shows that the ATT coefficient for measuring the impact of involving the distributors in the sale of commercial fertilizer is negative but not statistically significant. This finding suggests that participating in the FISP pilot did not crowd-out or crowd-in commercial fertilizer sales for larger-scale distributors who participated in the program. The absence of crowding-out or crowding-in of commercial fertilizer from the FISP pilot could be explained by the fact that most farmers purchase commercial fertilizer from larger-scale distributors soon after selling their maize harvest from April to September when they have cash on hand, while FISP distribution occurs from October to January. In addition, many of the participating distributors in pilot districts stopped selling commercial fertilizer between October and January to concentrate on selling FISP fertilizer in order to meet the district allocated volumes in time.

The coefficient for measuring the impact of the pilot program on distributors that were not allowed to sell FISP fertilizers to farmers but were located in the pilot district (*i.e.*: indirect impact or *spillover effect*) is negative but not statistically significant. The treatment variable =1 if the distributor operated in one of the pilot districts. This finding suggests that excluding other distributors in the FISP pilot did not affect fertilizer sales for larger-scale distributors who were not involved in the program in 2015/16, on average.

[Table 3 Here]

Table 4 presents DD results of estimating the extent to which the FISP pilot affected the volume of total fertilizer sales for larger-scale fertilizer distributors (*i.e*. commercial fertilizer plus FISP fertilizer sales). The coefficient for measuring the program's direct impact is positive and significant at 1 percent level in table 4. It indicates that distributors who participated in the FISP pilot during 2015/16 increased total fertilizer sales by 298,894 kg on average. Participation in the FISP pilot enabled these distributors to add FISP sales during planting season, in addition to continuing their commercial sales during other times of the year. In addition, the results in table 4 show that the indirect impact of FISP on distributors who were not allowed to sell FISP fertilizers to farmers but were located in the pilot district is also negative but not statistically significant. This is consistent with the findings in table 3, which suggests that there is no indirect benefits or loss to the distributors who did not participate in the FISP pilot.

[Table 4 Here]

Table 5 shows DD results of the extent to which the FISP pilot affected the volume of commercial fertilizer sales for independent agro-dealers. Recall that none of the agro-dealers were allowed to sell FISP fertilizer under the pilot program in 2015/16, so the treatment variable =1 if the agro-dealer operates in one of the pilot districts where the larger-scale distributors retailed FISP fertilizer. Although overall commercial fertilizer sales among the independent agro-dealers were significantly higher in 2015/16 than in 2014/15 season according to the descriptive evidence in table 2, the DD results in table 5 indicate that excluding the independent agro-dealers from the retailing of FISP fertilizer to farmers in 2015/16 reduced their commercial fertilizer sales volume by 27,864 kg in the pilot district on average. This is a significant drop in commercial sales, and key informant interviews suggest that it may be due to the improved timely delivery of the FISP fertilizer by the participating larger-scale fertilizer distributors in the pilot districts. This enabled FISP beneficiaries to access the inputs on time, compared to ADMARC and SFFRFM late delivery of FISP fertilizer in past years in all districts and in the current year in non-pilot districts.

As a result, FISP beneficiary farmers in the pilot districts had their input needs met by the participating distributors who sold FISP fertilizer during the 2015/16 season. In contrast, in districts that were not part of the pilot, farmers had to go to independent agro-dealers to buy commercial fertilizer when their FISP fertilizer was not available at government-run ADMARC or SFFRFM market depots. As a result, independent agro-dealers in pilot districts experienced a reduction in fertilizer sales from being excluded by the pilot.

[Table 5 Here]

Finally, we consider crowding-out and crowding-in of commercial fertilizer at a national level in order to get an estimate of the incremental impact of the 2015/16 pilot on total fertilizer use in Malawi. As already indicated, larger-scale distributors sold 33,910 Mt of FISP fertilizer in 2015/16, and their commercial fertilizer sales were not crowded-out or crowded-in by the pilot. At the same time, the average smaller-scale independent agro-dealer in pilot districts had 28 Mt of commercial fertilizer crowded-out by not being able to participate. Furthermore, on average there are 19 independent agro-dealers operating in pilot districts on average and the pilot covered nine districts. Therefore, the pilot program crowded out 4,788 Mt of commercial fertilizer [28 x 19 x 9 = 4,788]. As a result, the subsidy pilot added 29,122 additional Mt of total fertilizer in Malawi [33,910 – 4,788 = 29,122], with the benefits going to the larger-scale distributors who participated in the pilot. The overall crowding-out rate of commercial fertilizer sales by the pilot is 14.12% [(4,788/33,910) x 100].

6. Conclusions and Policy Implications

Using a unique panel dataset of larger-scale fertilizer distributors and smaller-scale independent agro-dealers, this article analysed how Malawi's FISP crowds-out or crowds-in commercial fertilizer sales following a pilot program that occurred in 2015/16 that allowed certain distributors to retail FISP fertilizer to smallholder farmers. The empirical results reveal that involving the distributors in the retailing of subsidized fertilizer to farmers does not negatively affect their commercial fertilizer sales. Instead, it increases their volume of total fertilizer sales across the year, as they benefit from the added FISP sales during the planting season, while maintaining commercial fertilizer sales during the rest of the year. Furthermore, excluding other larger-scale distributors from FISP retailing does not affect their commercial fertilizer sales. Conversely, excluding the smaller-scale independent agro-dealers from retailing FISP fertilizer crowds out some of their commercial fertilizer sales. This seems to be due to improved timely delivery of the FISP fertilizer by the participating larger-scale distributors in the pilot districts. This enabled FISP farmer beneficiaries to access the inputs on time compared to the other districts where government parastatals ADMARC and SFFRFM handled FISP fertilizer and delivered it to sale points late in the season.

Based on the results from our study, we make the following policy recommendations. First, since the study finds that distributors who participated in the pilot benefited by increasing their sales, the government of Malawi should continue to increase the quota volume of FISP fertilizer that is allocated to the private sector for sale to smallholders. Doing so is an important strategy for developing the private sector capacity in the input market. This will relieve the government of the logistical burden that has been of drain on their scarce resources. As such, parastatal involvement can be scaled down as the private sector takes an increasingly larger share of the responsibility for providing inputs to smallholders.

Second, independent agro-dealers play an important role in linking farmers to input markets by selling fertilizer in smaller quantities than distributors who sell fertilizer in 50-kg packages, and operating in remote rural areas. As such, there is a need to provide independent agro-dealers with support to increase their capacity so that they remain viable and are not further crowded-out if larger-scale distributors are allowed to retail more FISP fertilizer in the future. Such support for agro-dealers includes, linking them to warehouses to increase their storage capacity, improving the rural road networks to allow agro-dealers to expand their operation to more remote areas, linking them to financial institutions and guaranteeing credit for them.

Third, results from our study suggest that the market share of fertilizer sold by independent agro-dealers has grown in the past few years. Therefore, after the government of Malawi has invested in building agro-dealers' capacity, they should consider allowing agro-dealers to retail FISP fertilizer. This can be done through direct involvement of established agro-dealers in the fertilizer subsidy and/or promoting distributor – independent agro-dealer partnership when awarding FISP contracts, where distributors would essentially sub-contract with agro-dealers to have them sell FISP fertilizer to smallholders in more remote areas. Doing so, will maintain the viability of these local entrepreneurs and provide smallholder farmers with more locations where they can acquire subsidized fertilizer and seed.

While detailed empirical research is still needed to understand how farmers in the pilot districts were served by the private input suppliers' participation in the FISP, our results seem to indicate that the private sector retailers were able to make the fertilizer available to smallholders much earlier in the season compared to the government's ADMARC and SFFRFM fertilizer depots. Since, timely application of fertilizer is crucial for maize yields, the evidence of private sector distribution efficiency may be a positive strategy for boosting agricultural production in Malawi. Therefore, continuing and/or increasing participation by the private sector in input subsidy programs is essential for maintaining a viable, and sustainable input supply system in Malawi that benefits rural smallholder farmers.

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Table 1: Attrition among Retailers in 2013/14 and 2015/16 Seasons

Agricultural Season	Distributors	Attrition (%)	Independent Agro-dealers	Attrition (%)
2013/14	180	_____	430	_____
2014/15	175	3	354	15
2015/16	156	10	200	26

Table 2: Quantity of fertilizer sold by private agro-dealers over time

Growing Season	Source of fertilizer	Commercial fertilizer (Mt)	Subsidy fertilizer (Mt)	Market share (%)
2013/2014	Distributor	85,300	0	95.47
	Independent	4,046	0	4.53
2014/2015	Distributor	32,600	0	94.00
	Independent	2,081	0	6.00
2015/2016	Distributor	42,200	6,053	90.66
	Independent	4,347	0	9.34

Table 3: Impact of FISP pilot on volume of commercial fertilizer sales for distributors

Dependent variable: commercial fertilizer sales (kg)	**DD estimator**	
	Coefficients	**Std. Errors**
Covariates:		
=1 if participated in FISP pilot	-79,523**	(36,946)
=1 if season is 2013/14	25,856	(50,725)
=1 if season is 2015/16	34,154	(51,925)
Program direct impact (ATT):		
*=1 if participated in FISP pilot * =1 if season is 2015/16*	-19,651	(61,462)
Program indirect impact (ATT):		
*=1 if in FISP pilot district * =1 if season is 2015/16*	-85,429	(57,008)
Distance to ADMARC/SFFRFM (KM)	-14,751	(24,663)
Number of years of operation	1,858	(3,044)
Number of farm families in the extension planning area	6,447**	(2,496)
Store size (m^2)	10**	(5)
Number of full time employees	-1,529	(8,788)
Located on tarmac road=1	-47,269	(82,860)
Region:		
=1 if Northern region	152,350***	(57,957)
=1 if Central region	146,800***	(46,746)
Constant	-106,639	(88,670)

Note: N=465; ***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Table 4: Impact of FISP pilot on volume of total fertilizer sales for larger-scale distributors

Dependent variable: total fertilizer sales (subsidized + commercial) in kg	**DD estimator**	
	Coefficients	**Std. Errors**
Covariates:		
=1 if participated in FISP pilot	-78,395**	(37,633)
=1 if season is 2013/14	25,017	(50,760)
=1 if season is 2015/16	34,716	(51,914)
Program direct impact (ATT):		
*=1 if participated in FISP pilot * =1 if season is 2015/16*	298,894***	(71,374)
Program indirect impact (ATT):		
*=1 if in FISP pilot district * =1 if season is 2015/16*	-86,518	(56,949)
Distance to ADMARC/SFFRFM (KM)	-18,763	(24,382)
Number of years of operation	1,484	(3,068)
Number of farm families in the extension planning area	6,576***	(2,506)
Store size (m^2)	10**	(5)
Number of full time employees	-1,405	(8,794)
Located on tarmac road=1	-46,829	(82,546)
Region:		
=1 if Northern region	149,794**	(58,584)
=1 if Central region	144,068***	(47,833)
Constant	-101,386	(89,859)

Note: N=465;***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Table 5: Impact of FISP pilot on commercial fertilizer sales by independent agro-dealers

Dependent variable: commercial fertilizer sales in kg	DD estimator	
	Coefficients	**Std. Errors**
Covariates		
=1 if season is 2013/14	13,157***	(4,473)
=1 if season is 2015/16	19,072**	(9,255)
Program indirect impact (ATT):		
*=1 if in FISP pilot district * =1 if season is 2015/16*	-27,864**	(11,872)
Distance to ADMARC/SFFRFM (KM)	-432	(603)
Number of years of operation	3**	(1)
Number of farm families in the extension planning area	330	(445)
Store size (m^2)	2,320	(2,277)
Number of full time employees	1,102	(771)
Located on tarmac road=1	7,337	(10,215)
Region:		
=1 if Northern region	17,830	(16,676)
=1 if Central region	25,097	(15,205)
Constant	-38,679	(31,167)

Note: N=461; ***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Appendix

Appendix, Table A.1: Measurements of variables used in DD estimator

Variable	Type	Measurements
Dependent Variables		
Commercial fertilizer Sales (kg)	Continuous	Annual commercial fertilizer sales in 2013/14 to 2015/16 seasons (*i.e.* April this year to March the following year).
Independent Variables		
Number of farm families in the EPA	Continuous	Number of farm families at an EPA level. It is measured in `000.
Distance to ADMARC/SFFRFM (km)	Continuous	Distance between agro-dealer and ADMARC/SFFRFM depots.
Located on tarmac road=1	Binary	Location of the agro-dealer: 1= if an agro-dealer is located on tarmac road; 0 otherwise
Store size (m^2)	Continuous	The size of the store
Number of years of operation (years)	Continuous	Number of years the store has been operating in the market center selling fertilizer.
Full time employees	Continuous	Number of people employed by an agro-dealer
Location of the agro-dealer	Binary	Region the agro-dealer is operating either in Northern, Southern or Central region

Appendix, Table A.2: Parallel trend assumption test in distributor commercial fertilizer sale model

Dependent variable: commercial fertilizer sales in kg	**DD estimator**	
	Coefficients	**Std. Errors**
Covariates:		
=1 if participated in FISP pilot	-125,248***	(39,647)
=1 if season is 2014/15	-23,737	(50,616)
Program direct impact (ATT):		
*=1 if participated in FISP pilot * =1 if season is 2014/15*	-34,948	(58,121)
Program indirect impact (ATT):		
*=1 if in FISP pilot district * =1 if season is 2014/15*	-33,131	(60,143)
Distance to ADMARC/SFFRFM (KM)	-5,357	(35,261)
Number of years of operation	-1,512	(3,658)
Number of farm families in the extension planning area	3,883	(2,906)
Store size (m^2)	16**	(7)
Number of full time employees	4,362	(7,443)
Located on tarmac road=1	49,606	(125,336)
Region:		
=1 if Northern region	161,007***	(62,150)
=1 if Central region	167,121***	(41,143)
Constant	-64,644	(101,694)

Note: N=310; ***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Appendix, Table A.3: Parallel trend assumption test in total fertilizer sale distributor model

Dependent variable: total fertilizer sales (subsidized + commercial) in kg	**DD estimator**	
	Coefficients	**Std. Errors**
Covariates:		
=1 if participated in FISP pilot	-125,248***	(39,647)
=1 if season is 2014/15	-23,737	(50,616)
Program direct impact (ATT):		
*=1 if participated in FISP pilot * =1 if season is 2014/15*	-34,948	(58,121)
Program indirect impact (ATT):		
*=1 if in FISP pilot district * =1 if season is 2014/15*	-33,131	(60,143)
Distance to ADMARC/SFFRFM (KM)	-5,357	(35,261)
Number of years of operation	-1,512	(3,658)
Number of farm families in the extension planning area	3,883	(2,906)
Store size (m^2)	16**	(7)
Number of full time employees	4,362	(7,443)
Located on tarmac road=1	49,606	(125,336)
Region:		
=1 if Northern region	161,007***	(62,150)
=1 if Central region	167,1201***	(41,143)
Constant	-64,644	(101,694)

Note: N=310; ***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Appendix, Table A.4: Parallel trend assumption test in agro-dealer fertilizer sale model

Dependent variable: commercial fertilizer sales in kg	**DD estimator**	
	Coefficients	**Std. Errors**
Covariates:		
=1 if season is 2014/15	-7,511*	(4,226)
Program indirect impact (ATT):		
*=1 if in FISP pilot district * =1 if season is 2014/15*	-11,497	(7,388)
Distance to ADMARC/SFFRFM (KM)	94	(756)
Number of years of operation	4*	(2)
Number of farm families in the extension planning area	-13	(320)
Store size (m^2)	2,283	(1,631)
Number of full time employees	16,878	(11,580)
Located on tarmac road=1	122	(270)
Region:		
=1 if Northern region	509	(7,034)
=1 if Central region	10,879**	(4,751)
Constant	5,064	(10,482)

Note: N=303; ***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Appendix, A.5: Attrition test for distributor model

Dependent variable: commercial fertilizer sales in kg	**DD estimator**	
	Coefficients	**Std. Errors**
Covariates:		
Distance to ADMARC/SFFRFM (KM)	-90,345***	(25,592)
Number of years of operation	47,103	(55,073)
Number of farm families in the extension planning area	-7,310	(28,614)
Number of full time employees	102,788	(86,586)
Selection	139,430	(117,975)
Constant	46,459	(43,417)

Note: N=332; ***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Appendix, A.6: Attrition test for independent agro-dealer model

Dependent variable: commercial fertilizer sales in kg	DD estimator	
	Coefficients	**Std. Errors**
Covariates:		
Distance to ADMARC/SFFRFM (KM)	-12	(2,867)
Number of years of operation	-2,911	(2,904)
Number of farm families in the extension planning area	-1,376	(1,372)
Number of full time employees	6,428**	(3,058)
Selection	-5,426	(6,446)
Constant	1,778	(4,506)

Note: N=437; ***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.

Appendix, A.7: Descriptive Statistics for variables used in both distributor and independent agro-dealer models

Variable	Distributor		Independent agro-dealer		t-/chi2 test (P-Value)
	Mean/proportion	Std. Dev.	Mean/proportion	Std. Dev.	
Dependent Variables					
Commercial fertilizer Sales (kg)	342242.7	1960336	22717.71	60238.65	-3.499***
Independent Variables					
Number of farm families in the EPA	23963.36	10165.20	22228.06	8914.71	-2.765***
Distance to ADMARC/SFFRFM (km)	7.29	5.08	7.93	4.53	2.02**
Store size (m^2)	3712.49	6181.22	1192.63	2835.77	-7.97***
Number of years of operation (years)	9.53	5.54	7.41	5.66	-5.79***
Full time employees	1.58	2.62	0.97	1.12	-4.63***
Located on tarmac road=1	90.81	_____	85.31	_____	10.42***
Location of the agro-dealer					
Northern region=1	17.95	_____	7.81	_____	
Central region=2	71.15	_____	74.19	_____	26.91***
Southern region=3	10.90	_____	18	_____	

***, **, * indicates that the corresponding coefficient estimates are statistically significant at the 1%, 5%, and 10% level respectively.