DOI: 10.1111/rode.12374

REGULAR ARTICLE

WILEY

The effect of the National Food Reserve Agency on maize market prices in Tanzania

Guillaume Pierre[1] | **Karl Pauw**[2] | **Emiliano Magrini**[1]

[1]Food and Agriculture Organization (FAO)

[2]International Food Policy Research Institute (IFPRI)

Correspondence
Karl Pauw, International Food Policy Research Institute (IFPRI)
Email: k.pauw@cgiar.org.

Abstract

Tanzania's National Food Reserve Agency has a mandate to ensure food security through procuring, reserving and recycling grain (primarily maize) in a cost-effective manner. This mandate excludes a price stabilization role. Procurement prices, based on production costs, are often set above market prices to encourage production. Several disbursements channels exist: grain provided free or at a discount to targeted vulnerable households; subsidized sales to millers; and sales to prisons or nongovernmental aid programs, typically at market-related prices. Given the perception that these activities are distortive, we use time-series econometrics to model maize price dynamics in select wholesale markets to capture the Agency's market impact. We find that its pricing strategy had an insignificant impact on prices during 2010/11–2014/15 despite a fairly significant presence in at least some regional markets. We recommend that the Agency reconsiders offering a price premium on procured maize or selling maize at discount to millers, as limited market spill-over effects imply the benefits are captured by only a few, even though its practice of providing subsidized or free maize to vulnerable people is not in question. Furthermore, current storage capacity expansion plans are not required and inconsistent with its food security mandate.

1 | INTRODUCTION

Government interventions in staple grain markets are an important, albeit closely scrutinized element of food security policies in eastern and southern African countries (Jayne, 2012). Tanzania is no exception, with government engaging regularly in the maize market through trade policy measures, input policies, and direct procurement and disbursement through its grain reserve agency. Since maize is a key food security crop produced by most smallholders (USAID, 2010) it is understandable that government feels mandated to intervene so as to ensure sufficient availability of maize at affordable prices.

As such, most prominent maize market interventions have been justified or designed with explicit food security objectives in mind. These include: the National Agricultural Input Voucher Scheme (NAIVS), first implemented in 2007/08 to boost maize production, which at its height reached 2 million farmers and supplied 57 percent of fertilizer in the Tanzania (Msolla, 2016); frequent maize exports bans, particularly during 2006–2012, typically introduced when domestic maize prices were high and removed again when prices were low (Baffes, Kshirsagar, & Mitchell, 2015); and the procurement and disbursement of primarily maize through its National Food Reserve Agency (NFRA), established in 2008 to replace the Strategic Grain Reserve (SGR), and with a mandate to guarantee food security in Tanzania (NFRA, 2016b). With the abolition of NAIVS (see Cameron, Derlagen, & Pauw, 2016) and the Prime Minister's commitment to discontinue the distortive practice of maize export bans (Diao & Kennedy, 2016), the NFRA has come to the fore as the government's primary vehicle for addressing food insecurity.

The NFRA's mission statement as articulated in the Strategic Plan 2016/17–2020/21 is "to ensure availability of food in times of shortage by procuring, reserving and recycling strategic stock in an efficient manner" (NFRA, 2016b, p. 28). A fixed procurement price is calculated each year prior to the harvest in June on the basis of production cost estimates. Procurement typically takes place between July and December, and grain is stored in NFRA warehouses, from where it is distributed by the Ministry of Agriculture, Livestock and Fisheries (MALF) to those facing food shortages or food emergencies, typically between November and April, or sold to the private sector, parastatals or nongovernmental food aid programs. Although the NFRA's predecessor, the SGR, had a mandate to stabilize prices, it was considered ineffectual in this regard, ostensibly due to budget constraints. Therefore, in line with the government's food market liberalization objectives, the NFRA's mandate explicitly excluded a price stabilization role (Stryker, 2015).

The NFRA has not escaped close scrutiny of its activities or even blame for distorting markets, creating disincentives to produce maize, or contributing to market uncertainty and price instability (Barreiro-Hurle, 2012; Stryker, 2015). Of course, government grain reserves are by nature distortionary—they are designed to intervene in markets where the private sector chooses not to participate or fails to achieve equitable outcomes (Murphy, 2009)—but since market distortions are associated with efficiency losses, the consensus is that government grain reserve activities should ideally be kept to a minimum. Nevertheless, the NFRA has gone against advice and has set ambitious targets for expanding its presence in the maize market through rapid storage capacity expansion (NFRA, 2014) to levels considered by some to be in excess of what is required to fulfill its food security mandate (Stryker, 2015). The NFRA price setting mechanism also frequently sets procurement prices above the prevailing market price (NFRA, 2016b), which is considered to be distortionary.

As claims of distortionary effects of NFRA activities in Tanzania have been largely anecdotal, this study sets out to empirically examine the impact of the NFRA on wholesale market prices. Methodologically our approach is similar to that adopted by Jayne, Myers, and Nyoro (2008) in

Kenya and Mason and Myers (2013) in Zambia and involves time-series econometrics in which the relationship between wholesale market prices and NFRA buying or selling prices in surplus or deficit maize production zones is modeled. This ultimately permits us to simulate a counterfactual wholesale market price under a hypothetical situation where the NFRA transacts at the prevailing market price. However, unlike the previous studies cited, our analysis explicitly includes procurement and sales quantities as a means to control for market presence. Furthermore, we account for cointegration between Tanzanian and Kenyan maize markets and seasonal price patterns. To our knowledge this is the first study of its kind in Tanzania, utilizing NFRA procurement and disbursement data that until now has not been analyzed. It also timely, with NFRA having recently launched its Strategic Plan 2016/17–2020/21 (NFRA 2016b). As such this study could inform future planning and implementation of its strategy.

The remainder of the paper is structured as follows. Section 2 provides the economic and policy context, focusing on the features of the maize market, current NFRA mandate and activities, and future NFRA storage capacity expansion plans. Section 3 presents the methods and data, while Section 4 presents the results and analysis. Finally, Section 5 draws brief conclusions and highlights several policy recommendations.

2 | ECONOMIC AND POLICY CONTEXT

2.1 | The Tanzanian maize market

Maize is a dominant staple food crop in Tanzania. Grown by around two-thirds of smallholder farmers, maize covers 45 percent of arable land and generates around half of cash income in rural areas (USAID, 2010). As a food crop it contributes 42 percent of calories available to the average household, and this share rises to 47 percent among poor households (Pauw & Thurlow, 2011). Within this context the prioritization of maize under the Tanzania Agriculture and Food Security Investment Plan 2010–2020 (TAFSIP) is understandable (United Republic of Tanzania, 2011). TAFSIP sets ambitious expansion targets for priority crops. Even prior to the implementation of TAFSIP, maize was already a strong performer, with production expanding by 50 percent during 2005–2010. Since then production has increased further from around 4.7 to 6.7 tonnes in 2014 (FAOSTAT, 2016). However, with virtually no yield improvement over this period—yields remained at or below 1.6 tonnes per hectare, well below what the International Fertilizer Development Center (2012) considers to be the potential maize yield of 5.1 tonnes per hectare—output growth was driven largely by land expansion.

Unpredictable markets are often blamed for the dominance of subsistence-oriented farming in sub-Saharan Africa (Fafchamps, 1992). Market thinness, lack of information, and poor infrastructure can all contribute to such market unpredictability; however, it is also frequently linked to discretionary government interventions in the form of trade policies (e.g., trade restrictions or tariffs) that are not easily anticipated, or extensive engagement through marketing boards or strategic grain reserves. In this regard, Chapoto and Jayne (2009) show that those southern and eastern African countries that have adopted less interventionist staple grain market policies experienced higher agricultural growth and lower price volatility compared to those countries (such as Tanzania) that have highly discretionary or unpredictable market policies. Thus, even though government market interventions are well intentioned and designed to address food security concerns, they may ultimately be self-defeating if they are not implemented in a predictable and transparent manner.

The maize export ban in Tanzania, implemented for food security reasons, is a case in point. Following a highly unstable period (2006–2012) during which bans were introduced and lifted no

less than ten times (Stryker, 2015), the Prime Minister agreed to discontinue the practice in 2012, given evidence of highly distortive impacts on market prices (Baffes et al., 2015) and adverse welfare effects (Diao & Kennedy, 2016). The effect of this policy shift was immediately evident: whereas the average maize trade deficit was 30,000 tonnes during 2006–2011, Tanzania became a net exporter of maize thereafter, exporting on average 90,000 tonnes of maize per annum during 2012–2015 (UN Comtrade, 2016).

The impact of NFRA activities is less understood, and claims of distortionary impacts are not necessarily causally verified or are even anecdotal. Barreiro-Hurle (2012) argues that during years in which Tanzania was a net maize importer (e.g., 2006, 2008, and 2010), farmers were unable to benefit from the protection afforded by import tariffs on private imports because these years frequently coincided with significant imports and/or stock releases at discounted prices by the NFRA. Excessive trade and transport costs further prevented farmers and rural traders from effectively competing with imported maize. The NFRA has also drawn critique from elsewhere; for example, Stryker (2015) argues that the NFRA has been under pressure to offer above-market procurement prices and to sell below market price, which has disrupted the market and created uncertainty.

2.2 | NFRA mandate and activities

The NFRA was established as an executive agency of MALF, which is also responsible for determining a policy framework within which NFRA operates and the financial resources required to fulfill its obligations. The NFRA manages 33 warehouses with a combined storage capacity of 241,000 tonnes. Geographically it operates across seven zones of the country: the Arusha zone in the northern region; the Shinyanga zone in the north-eastern lake region; the Dodoma zone in the central region; the Kipawa zone in the coastal region (also often referred to as the Dar es Salaam zone); and the Makambako, Sumbawanga, and Songea zones, all located in the southern highlands of the country.

Although the NFRA's mandate does not include a price stabilization role, it has the potential to reduce seasonal price variations through its pricing, procurement, and disbursement activities. With respect to procurement, as noted, the NFRA sets an annual procurement price prior to the harvest based on estimated costs of producing maize. When buying from farmers, NFRA withholds a 2 percent *ad valorem* tax, while payment is not necessarily made on delivery. However, at the time of the transaction, the net price received by farmers still tends to exceed the prevailing market price (NFRA, 2016b). Figure 1 shows that during most the procurement phases from July to December each year (shaded sections) the procurement price was above the national average market price. The exceptions were the 2012 and 2013 procurement seasons when market prices rose to historically high levels. In several other seasons the market price rose above the procurement price, but typically only after December. The implication, however, is that if there are significant delays in paying farmers or traders, they may at times be better off supplying the commercial market directly.

Closer inspection reveals that the buy premiums (i.e., buy price minus the prevailing market price) are significantly positive in the Songea and Sumbawanga zones (30–40 percent) for most of the period under study. These are two important surplus-producing maize areas where the NFRA is particularly active as a buyer. Market prices in surplus areas tend to be somewhat lower than the national average, especially during the harvest season, which explains the positive premium. In contrast, premiums in Arusha and Dodoma are negative (–10 percent) over the period as a whole, even if quite volatile over time. These are deficit maize-producing areas where prices tend to be higher than the national average and therefore generally above the NFRA procurement price. This highlights the importance of distinguishing between NFRA impacts in surplus and deficit zones.

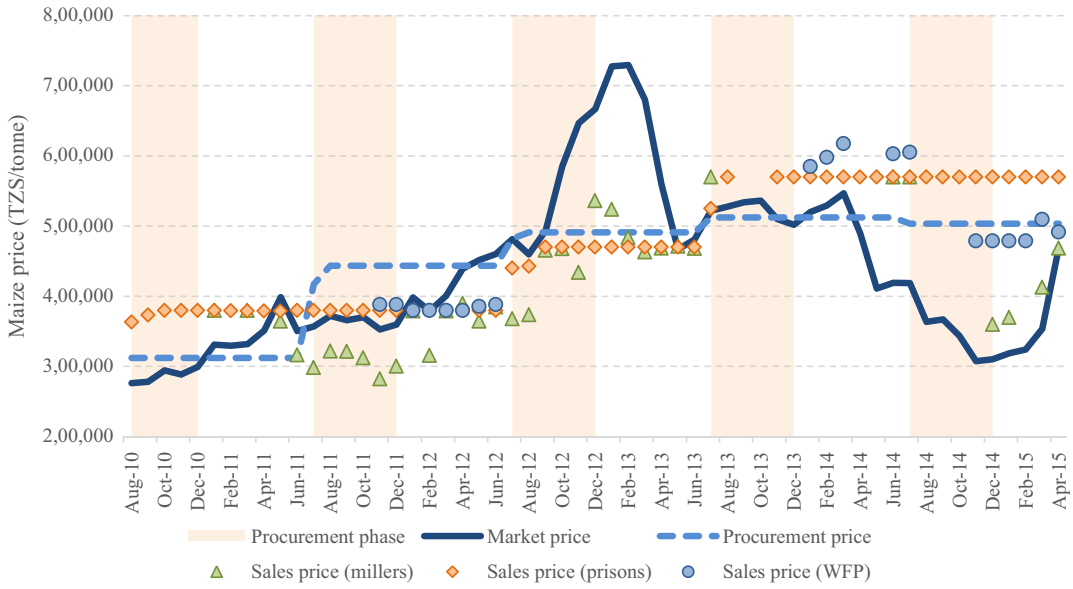

FIGURE 1 NFRA Procurement and Sales Prices and Prevailing Wholesale Market Prices, 2010/11–2014/15
[Colour figure can be viewed at wileyonlinelibrary.com]
Sources: NFRA (2016a) and MALF (2016).

The implication of the NFRA's price setting mechanism is that the agency should, in theory, be able to exert upward pressure on post-harvest farm gate prices, at least in surplus-producing areas. This impact is strengthened by the fact that around 80 percent of the NFRA's annual procurement is typically concluded in the months of August, September, and October each year, that is, relatively early in the marketing season when the bulk of the harvest is marketed and prices are suppressed. However, the NFRA's impact on the market also depends on its market presence (or market shares). NFRA's market shares displayed in Table 1 are expressed as a percentage of marketed production within each region. We assume that around two-fifths of the maize crop is marketed and the balance is retained for home consumption.

The three largest maize-producing regions over the period 2010/11–2014/15 are Makambako, Sumbawanga, and Songea, and these are also the regions where NFRA procurement levels are highest in absolute terms. In relative terms, however, the NFRA's market presence varies from a 15.8 percent market share in Makambako to 31.8 percent in Songea. Even though Shinyanga is a relatively large producing area, the NFRA's presence in that market is minimal. Absolute procurement levels are also relatively small in Arusha, Dodoma, and Dar es Salaam, owing to the fact these are deficit maize-producing areas. However, market shares in Arusha (35.3 percent) and Dodoma (42.9 percent) are the largest of all zones. We are unable to calculate the market share in Dar es Salaam since procurement levels far exceed production in that district, mainly because traders procure maize elsewhere and deliver it to Dar es Salaam, a major consumer center. This highlights a challenge, more generally, of analyzing NFRA impacts at a regional level when maize is freely traded across regional borders. At national level, NFRA procured on average around 10 percent of the annual maize crop, which corresponds to 22.5 percent of the marketed produce.

The primary mandate of the NFRA is to provide food to vulnerable populations. Each year vulnerability assessments are conducted and people from all districts in the country are classified as either food secure or acutely or moderately food insecure. The acutely insecure receive free food,

TABLE 1 Annual NFRA Buying and Selling Activities, 2010/11–2014/15

		2010/11	2011/12	2012/13	2013/14	2014/15	Five-year average
Arusha (–)	NFRA procurement (t)	16,767	1,252	316	34,882	37,952	18,234
	Production (t)	109,310	86,800	88,250	165,891	195,532	129,157
	% marketed production	*38.3*	*3.6*	*0.9*	*52.6*	*48.5*	*35.3*
	NFRA sales (t)	6,665	3,344	5,579	5,380	39,328	12,059
Dodoma (–)	NFRA procurement (t)	15,222	1,401	3,714	24,350	36,546	16,247
	Production (t)	62,570	70,930	84,920	138,469	116,943	94,766
	% marketed production	*60.8*	*4.9*	*10.9*	*44.0*	*78.1*	*42.9*
	NFRA sales (t)	6,934	4,314	2,419	9,837	26,429	9,987
Dar es Salaam (–)	NFRA procurement (t)	–	–	12,099	5,405	17,139	11,548
	Production (t)	970	3060	660	2,369	1,642	1,740
	% marketed production	–	–	–	–	–	–
	NFRA sales (t)	20,772	20,298	5,588	1,518	18,981	13,431
Makambako (+)	NFRA procurement (t)	39,070	18,573	13,243	40,817	65,024	35,345
	Production (t)	359,150	639,440	368,330	666,303	765,079	559,660
	% marketed production	*27.2*	*7.3*	*9.0*	*15.3*	*21.2*	*15.8*
	NFRA sales (t)	140	26,315	8,289	3,453	43,519	16,343
Shinyanga (+)	NFRA procurement (t)	5,104	1,307	–	6,262	7,651	5,081
	Production (t)	267,738	334,030	330,960	539,204	329,275	360,241
	% marketed production	*4.8*	*1.0*	–	*2.9*	*5.8*	*3.5*
	NFRA sales (t)	4,811	14,348	4,467	2,233	5,816	6,335
Songea (+)	NFRA procurement (t)	48,264	52,269	26,863	57,552	76,453	52,280
	Production (t)	225,470	423,090	527,310	452,457	427,827	411,231
	% marketed production	*53.5*	*30.9*	*12.7*	*31.8*	*44.7*	*31.8*
	NFRA sales (t)	65	62,510	10,889	20	4,602	15,617
Sumbawanga (+)	NFRA procurement (t)	56,725	51,044	7,346	50,117	64,745	45,995
	Production (t)	330,830	523,800	345,490	538,868	425,681	432,934
	% marketed production	*42.9*	*24.4*	*5.3*	*23.3*	*38.0*	*26.6*
	NFRA sales (t)	1,170	1,724	8,650	–	8,740	5,071
National	NFRA procurement (t)	181,152	125,846	63,581	219,385	305,510	179,095
	Production (t)	1,356,038	2,081,150	1,745,920	2,503,561	2,261,979	1,989,730
	% marketed production	*33.4*	*15.1*	*9.1*	*21.9*	*33.8*	*22.5*
	NFRA sales (t)	40,557	132,853	45,881	22,441	147,415	77,829

Notes: Procurement, production, and sales volumes are shown in tonnes (t). Distributions of food are not accounted for in sales figures. The NFRA share of the market is expressed as a percentage of the marketed production, assumed to be two-fifths of the production volume, an accurate estimate nationally, but a simplification regionally. The signs below region names indicate surplus (+) or deficit (–) maize-producing areas.

Source: NFRA (2016a) and MALF (2016).

while the moderately insecure can access maize at a heavily subsidized price of TZS 50 per kilogram. This is only a fraction of the market price, which in 2014/15, for example, averaged TZS 360 per kilogram. Although disbursement volumes vary somewhat over time, the NFRA, under instruction from the Prime Minister's Office, has allocated, on average, 6,200 tonnes to acutely insecure people and 41,000 tonnes to moderately insecure people over the period 2010/11–2014/15 (NFRA, 2016a).

As shown in Table 1, although sales volumes vary substantially from one year to the next, average annual sales have amounted to around 78,000 tonnes during 2010/11–2014/15 (NFRA, 2016a). Figure 1 shows the timing and price at which these sales take place. About 8 percent of sales (on average 5,900 tonnes per annum) have been to prisons. With the exception of the 2012/13 season, the price paid by prisons has been at or above the prevailing market price, with an average premium of around 7 percent. A further 34 percent of sales (around 26,800 tonnes) have been to the World Food Programme (WFP) at an average premium of 8 percent. Although the WFP procures infrequently, its procurement volumes are relatively high when they do enter the market.

The remaining 58 percent of sales (around 45,000 tonnes) have been to millers. The NFRA regards this disbursement activity as an important avenue for providing food at affordable prices. Formally, the sale process involves identifying regions and districts where prices are high and then selecting private millers to procure, mill and distribute maize. Contracts between NFRA and millers specify procurement quantities and regulate their flour retail prices (NFRA, 2016b). As shown in Figure 1, with the exception of 2014/15, the selling price for millers was generally below the national average market price, equating to a discount of around 6 percent over 2010/11–2014/15, and reaching 14 and 19 percent during 2011/12 and 2012/13, respectively (NFRA, 2016a).

In summary, the NFRA can potentially influence the market through two channels. The first is through its price setting and procurement activities. Four-fifths of annual procurement is concluded in August, September, and October when prices tend to be suppressed, and procurement prices tend to be above market prices, at least in surplus zones. The NFRA's presence in the market, estimated at around 22.5 percent of marketed production nationally and up to 40 percent in some regions (Table 1), is also not insignificant. Ultimately its impact and ability to raise post-harvest farm gate prices depends on the interplay between the procurement price, the prevailing local market price at the time of the transaction, and the procurement level relative to maize supply and demand dynamics in a particular market.

The second channel is its food aid disbursement and sales activities. Figure 2 provides a summary of these disbursement activities during 2010/11–2014/15. Taking into account the volume and price discount of transactions, we conclude that the main channels of impact for lowering prices are likely to be sales to millers and the distribution of free or highly subsidized food to food insecure people. These disbursement avenues jointly account for around 86,000 of the 125,000 tonnes (69 percent) distributed annually, on average, during 2010/11–2014/15. Sales to WFP are at a premium, but the maize procured by the WFP is also likely to be released free of charge as part of its own food aid initiatives. Thus, although the NFRA does not explicitly have a price stabilization mandate, it could potentially reduce peak season prices through these disbursement activities.

2.3 | NFRA storage capacity

The NFRA's current storage capacity of 241,000 tonnes is spread across 33 warehouses located in the seven operational zones, with zonal capacities ranging from 14,500 tonnes in Shinyanga to 52,000 tonnes in Dar es Salaam. In addition to noting the need for rehabilitating around half the

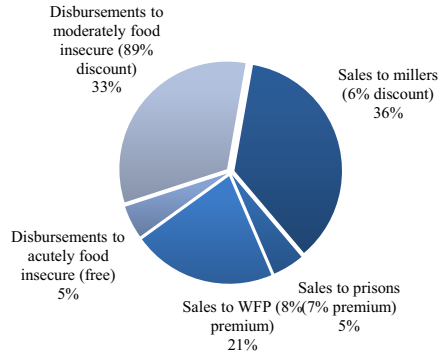

FIGURE 2 NFRA Sales Premiums/Discounts and Disbursement Shares, 2010/11–2014/15 [Colour figure can be viewed at wileyonlinelibrary.com]
Source: NFRA (2016a).

existing storage facilities, the NFRA Investment Plan 2014/15–2023/24 sets out an ambitious target of expanding storage capacity to 700,000 tonnes by 2020, a target that has also been adopted in the Strategic Plan 2016/17–2020/21 (NFRA 2016b). While the principle of maintaining strategic food reserves is seldom in question in developing countries, there is less consensus about what optimal stock levels should be, partly due to political sensitivities and conflicting interests or objectives (Rashid and Lemma 2011). Storage requirements also vary depending on the mandates of strategic grain reserves, with those agencies that fulfill both a food security and price stabilization role typically requiring larger stock levels to effectively fulfill the latter role.

At about 5 percent of the domestic maize harvest, NFRA storage capacity is comparable to that in Ethiopia (4.2 percent) (see Rashid & Lemma, 2011) and Pakistan (4.7 percent), with the latter considered by Dorosh, Minten, and Stifel (2015) to be a good guideline for grain reserve agencies with both food security and price stabilization mandates. India's capacity of over 20 percent is considered excessive, whereas Bangladesh maintains stock levels of only 2.9 percent of the grain crop, partly because it relies substantially on trade policy to stabilize prices (Dorosh et al., 2015; see also Dorosh 2008). In placing its expansion plans in context, the NFRA (2014) cites the examples of neighbors Malawi, which has capacity to store over 10 percent of its national crop, and Kenya, which in the past (2007/08) maintained carry-over stock equivalent to one-third of its annual harvest. However, Malawi's grain reserve agency only utilizes around half its installed capacity (Thangata & Lemma, 2010), while in Kenya the reserve target has been revised downwards to 9 percent of the national crop (Business Daily, 2016). Kenya also produces only about half the maize Tanzania produces in per capita terms and relies heavily on imports, and therefore maize market dynamics and storage requirements are very different from those in Tanzania.

As further justification for its expansion plans the NFRA (2014) calculates the standard deviation of maize production (1991–2011) and the average annual import bill, both of which are close to 700,000 tonnes. In arguing that these numbers should determine the NFRA storage capacity, the impression is created that the NFRA sees no role for the private sector in cushioning the effect of domestic production deviations or shortfalls. Stryker (2015) argues that the storage capacity plans should not consider the extent to which production deviates from the trend, but should focus on consumption instead. Households are resilient and resourceful: they do not rely solely on maize as a source of food; they do not necessarily only rely on the current production season; and the onus should not entirely be on government to support the food insecure. Stryker (2015) shows that the standard deviation from the consumption trend is 108,000 tonnes, which in a statistical sense

means national maize availability will drop below the trend (requirement) by more than 108,000 tonnes only once every 5 years, and by more than 216,000 tonnes (2 standard deviations) only once every 40 years.

NFRA data confirm that since its establishment in 2008/09 NFRA food disbursements only exceeded 108,000 tonnes once, in 2009/10, when it reached 111,950 tonnes (NFRA 2016a). Average disbursements were 47,200 tonnes targeted at approximately 1.2 million food insecure people every year. Incidentally, the WFP and the Overseas Development Administration (ODA) of the United Kingdom propose that governments should plan for average distribution of 400 grams of food per day to 95 percent of food insecure people for a period of 4 months (Rashid & Lemma, 2011). Applying this formula to the Tanzanian context equates to 55,000 tonnes, which is remarkably similar to actual food aid disbursements.

On this basis, Stryker (2015) argues that procurement should be 100,000 tonnes per annum, which will be sufficient for food aid distributions over a typical 5-year period. The balance of stocks not disbursed as food aid can be sold, as is current practice. The cost of doubling procurement and rolling stock levels to 200,000 tonnes or more (i.e., similar to annual procurement levels seen in 2013/14 and 2014/15) will ensure Tanzania can deal with food insecurity internally over a 40-year period, but the cost of maintaining large stock levels over such a long period of time far outweighs the cost of relying on international markets, as Stryker (2015) illustrates in detail, and Dorosh (2008) discusses in the context of South Asia. The implications are twofold: firstly, procurement beyond 100,000 tonnes per year is not required under the NFRA's current food security mandate; and secondly, current storage capacity is indeed sufficient, and expenditure should be directed to maintenance of existing facilities rather than capacity expansion. Of course, procurement targets and storage capacity requirements can be reviewed over time to account for population growth and/or the share of the population likely to be classified as food insecure.

3 | METHODS AND DATA

Following Jayne et al. (2008) and Mason and Myers (2013), we use a time-series econometric model to evaluate the impact of NFRA activities on wholesale market prices. Specifically, we assess the extent to which NFRA buy or sell premiums (defined as the difference between the procurement or sale price and the price in the nearest wholesale market) affect maize price dynamics in wholesale markets. This essentially involves modeling price dynamics at wholesale market level, and thereafter simulating counterfactual price paths free of the impact of the NFRA buy or sell premiums. A comparison of the simulated and historical price paths reveals the likely impact that the NFRA pricing, procurement, and disbursement strategies had on maize market price dynamics.

Our analysis is based on monthly observations on maize procurement and disbursements and the associated quantities and prices from 2010/11–2014/15 (NFRA, 2016a). As discussed, procurement prices are set annually by the NFRA, based on a representative cost of maize production, whereas selling prices tend to be set in a more *ad hoc* manner and may vary depending on who the maize is sold to. Among the seven NFRA operational zones, data for Sumbawanga and Songea, two important surplus maize-producing areas, as well as Arusha, Dodoma and Dar es Salaam (Kipawa), which are all deficit maize-producing areas, were included in the analysis. The other two regions, Makambako and Shinyanga, were excluded due to missing price data and low transactions volumes. Data on wholesale maize market prices are from MALF (2016).

Although we follow a similar approach to Jayne et al. (2008) and Mason and Myers (2013), our implementation differs in certain respects. Both earlier studies deployed an autoregression

model after rejecting the possibility of cointegration within their price system. First, given evidence that local maize market prices in Tanzania and those in Kenya, an important trading partner, are cointegrated (Baffes et al., 2015), we use a vector error correction model (VECM) to estimate the long-run equilibrium between domestic prices and those in Nairobi, Kenya. Second, we control for seasonality in short-run dynamics of maize prices with a trigonometric function. Third, in addition to including NFRA buy and sell premiums as exogenous variables, we also control for relative quantities procured or sold in each market. The earlier analyses only considered pricing strategies. Other features include dummy variables for periods during which a maize export ban was in place, as well as a dummy for the 2012/13 maize price crisis in Tanzania (see Figure 1). This modeling approach assumes that the NFRA pricing strategy, the seasonal movements, and the export ban only push prices off their long-term equilibrium for brief periods of time since prices tend to revert back to their longer-run spatial equilibrium setting.

The final representation of the VECM is as follows

$$\Delta\begin{bmatrix} P_t^{\text{Local}} \\ P_t^{\text{Nairobi}} \end{bmatrix} = \alpha\beta'\begin{bmatrix} P_{t-1}^{\text{Local}} \\ P_{t-1}^{\text{Nairobi}} \end{bmatrix} + \Gamma\Delta\begin{bmatrix} P_{t-1}^{\text{Local}} \\ P_{t-1}^{\text{Nairobi}} \end{bmatrix} + \Phi\left[\Delta BP_{t-1}^{\text{Local}}\Delta SP_{t-1}^{\text{Local}}Q_{t-1}\cos\left(\frac{t\pi}{6}\right)\sin\left(\frac{t\pi}{6}\right)D^{\text{Ban}}D^{\text{Crisis}}\right] + \varepsilon_t,$$

where P_t^{Local} and SP_t^{Nairobi} represent the prices in local Tanzanian markets (zones) and prices in Nairobi; BP_t^{Local} and SP_t^{Local} represent the NFRA buy and sell premium, respectively; $Q_{t\text{-}1}$ represents the net volumes of operations, that is, sales and distributions subtracted from procurements, as a share of production; cos ($t\pi/6$) and sin ($t\pi/6$) are the cosine and sine functions, included to capture seasonality (Gilbert, Christiaensen, & Kaminski, 2017); D^{Ban} and D^{Crisis} are dummy variables for the export bans and the 2012/13 food price crisis, respectively; and ε_t is a vector of random uncorrelated innovations.

The left-hand side of the equation is the vector of market price changes. The first term on the right-hand side models the long-term relationship that represents the equilibrium between the Kenyan and Tanzanian prices and captures, through α, the rate of adjustment of prices towards the long-term spatial equilibrium following a shock. The second term accounts for short-term price shocks in both Tanzanian and Kenyan markets. The vector Φ captures the impact of several exogenous variables on the short-run dynamics of maize prices. The underlying assumption is that NFRA activities can influence short-run dynamics of maize prices, but not the longer-run spatial equilibrium with Kenya. Hence, a positive buy premium shock is expected to generate short-term upward pressure on market prices. Similarly, a positive sell premium shock should create short-term downward pressure on market prices.

Once the VECM is estimated for each local market, we recover its vector autoregressive form through matrix algebra (see Pfaff, 2008) for forecasting purposes. We impose typical identification restrictions on the system by setting the contemporaneous impact of policy variables to zero. Then, following the same procedure as Jayne et al. (2008) and Mason and Myers (2013), we simulate hypothetical maize market price paths under the assumption that the NFRA had transacted at market prices rather than at administratively fixed procurement prices or *ad hoc* selling prices that may or may not be different from prevailing market prices. This is achieved by setting the error terms to their estimated historical values, fixing the NFRA policy variables (i.e., the buy and sell premiums are set to zero), and constructing dynamic one-step-ahead forecasts for market prices. The simulated paths of the market variables can then be compared to their historical paths in order to evaluate the effects of alternative buy and sell prices on market variables.

4 | RESULTS AND ANALYSIS

Unit root tests support the hypothesis of integration of the first order for all market price series (Table 2). The Johansen (1988) procedure tests reported in Table 3 reveal cointegration within our dataset and therefore provide justification for including the long-term relationships between local markets and the Nairobi market in our econometric model. Estimated coefficients for each regional market equation are reported in Table 4.

The error correction term reported in Table 4 is negative and significant for all markets, except for Arusha, confirming that the domestic prices and the Nairobi market tend, over time, to converge on a long-run equilibrium. The export ban coefficient is always negative and significant in two zones, signaling a price-reducing effect of this particular trade policy. The price crisis in 2012/13 is captured and controlled for by the related dummy. The coefficients for the price premium variables do not have a consistent sign across markets. The buy premium has a statistically significant price-reducing effect only in Dar es Salaam, while the sell premium is statistically significant and negative only in Arusha. The coefficients associated with the net volume of operations are not signification except in Songea, suggesting that an increase in NFRA procurement operations could have a price-reducing effect in that market.

We next consider the simulated counterfactual price paths obtained under the hypothesis of competitive pricing of NFRA operations. Results are displayed separately for surplus maize-producing areas (i.e., Sumbawanga and Songea) in Figure 3 and deficit maize-producing areas (i.e., Arusha, Dodoma, and Dar es Salaam) in Figure 4. For each market, the left-hand figure shows the historical price path (solid line) against the simulated counterfactual (dashed line), while the right-hand figure shows the deviation of the counterfactual price from the historical price in percentage difference terms. Thus, a positive sign suggests that maize prices would have been higher in the absence of NFRA distortive behavior, and vice versa.

In general, and consistent with the expectations given the size and significance of NFRA policy variable coefficients reported in Table 4, the simulated counterfactuals deviate very little from their historical counterparts. The general conclusion is that the pricing, procurement, and selling strategies of the NFRA have neither a substantial nor a sustained impact on maize market prices. Higher prices offered to farmers and traders during procurement only tend to benefit those directly engaged in the transactions; spill-over effects to the rest of the market are largely absent. Likewise, subsidized sales to millers or vulnerable households also do not have any significant price-reducing effect in the market in general, and once again only benefits those buyers with direct access to NFRA maize or the targeted beneficiaries.

TABLE 2 Market Price Series Unit Root Tests

	Level		Level and trend		Difference	
	ADF	PP	ADF	PP	ADF	PP
Dodoma	0.48	−1.97	−2.11	−1.69	−5.39***	−6.78***
Nairobi	0.76	−3.19**	−2.70	−2.74	−5.63***	−4.89***
Songea	0.28	−2.64*	−2.11	−2.64	−5.44***	−7.59***
Sumbawanga	0.25	−2.53	−2.70	−2.37	−5.77***	−8.88***
Arusha	0.38	−1.38	−1.90	−2.29	−3.76***	−6.39***
Dar es Salaam	0.34	−1.54	−2.33	−2.76	−3.71***	−8.97***

Notes: Significant at ***1%, **5%, *10%. ADF = Augmented Dickey–Fuller; PP = Philips and Peron.
Source: authors' estimates.

TABLE 3 Cointegration Test with Nairobi

	Sumbawanga	Songea	Arusha	Dodoma	Dar es Salaam
$r \leq 1$	11.52**	4.74	6.27	9.83**	4.59
$r = 0$	21.31***	18.90**	21.36***	18.83**	33.72***

Notes: Significant at ***1%, **5%, *10%. Critical values of test for 10%/5%/1%: $r \leq 1$: 7.52/9.24/12.97; $r = 0$: 13.75/15.67/20.20. The no-cointegration hypothesis is rejected for all markets. The test results are straightforward for Dar es Salaam, Songea and Arusha, for which one cointegration vector is indicated. For Sumbawanga and Dodoma, the no-cointegration hypothesis is rejected together with the one-or-fewer-relationship hypothesis, implying two vectors. As the ADF and PP unit root tests confirmed, due to the presence of unit roots and for the sake of parsimony and comparability across our markets we retain the one-cointegration vector option as only one cointegration relationship can exist between these markets.
Source: authors' estimates.

TABLE 4 Johansen Procedure VECM Estimation Results

			Sumbawanga	Songea	Arusha	Dodoma	Dar es Salaam
Endogenous variables	Error correction term		−0.428***	−0.350***	−0.010	−0.323***	−0.243 *
	Local price (ΔP_{t-1})		−0.528***	−0.176	−0.605***	−0.165	−0.321
	Nairobi price ($\Delta P_{t-1}^{\text{Nairobi}}$)		0.186	−0.101	0.284*	0.398***	0.272
Exogenous variables	Export ban		−0.125**	−0.065	−0.057	−0.076*	−0.152
	Seasonality	$\cos(t\pi/6)$	0.000	0.003	0.015	0.040*	0.056
		$\sin(t\pi/6)$	−0.040	−0.080	0.041*	0.002	0.026
	Price crisis		0.319***	0.264***	0.053	0.127**	0.038
	Buy premium (ΔBP_{t-1})		−0.001	0.132	−0.044	0.047	−0.669***
	Sell premium (ΔSP_{t-1})				−0.348**	0.109	0.076
	Quantity (Q_{t-1}, net)		−0.516	−2.840***	−0.746	−0.137	−0.007
	R^2		0.392	0.422	0.339	0.397	0.273
	N		57	57	54	57	45

Notes: Significant at ***1%, **5%, *10%.
Source: Authors' estimates based on NFRA (2016a) and MALF (2016).

Next we consider surplus maize-producing zones more specifically (Figure 3), where the NFRA procures relatively large quantities of maize (see Table 1). Overall, the NFRA's impact in Sumbawanga is relatively weak, with prices having been pushed up by only around 0.5 percent on average over the period. Even in Songea, where the NFRA has a slightly larger market presence, the price effect, although more variable over time, is centered around a zero mean.

In Arusha, a deficit market close to the Kenyan border, prices tend to be higher than in the rest of Tanzania. Buy and sell premiums, even though slightly negative on average, generated some upward pressure on market prices, particularly during 2012/13, a surprising result considering attempts at the time to lower prices through active disbursement of subsidized maize to millers (Figure 4). Also in Dodoma the average buy premium was negative, but periods of a positive buy premium combined with a positive average sell premium pushed prices upwards by around 3 percent on average. In Dar es Salaam, the NFRA price premium impact was largely insignificant, although it seems the NFRA pricing strategy contributed significantly to already low market prices during 2014/15.

There are several notes of caution in the analysis of these results. First, inter-regional maize trade flows may cancel out or displace NFRA effects. This is particularly true in a region such as Dar es

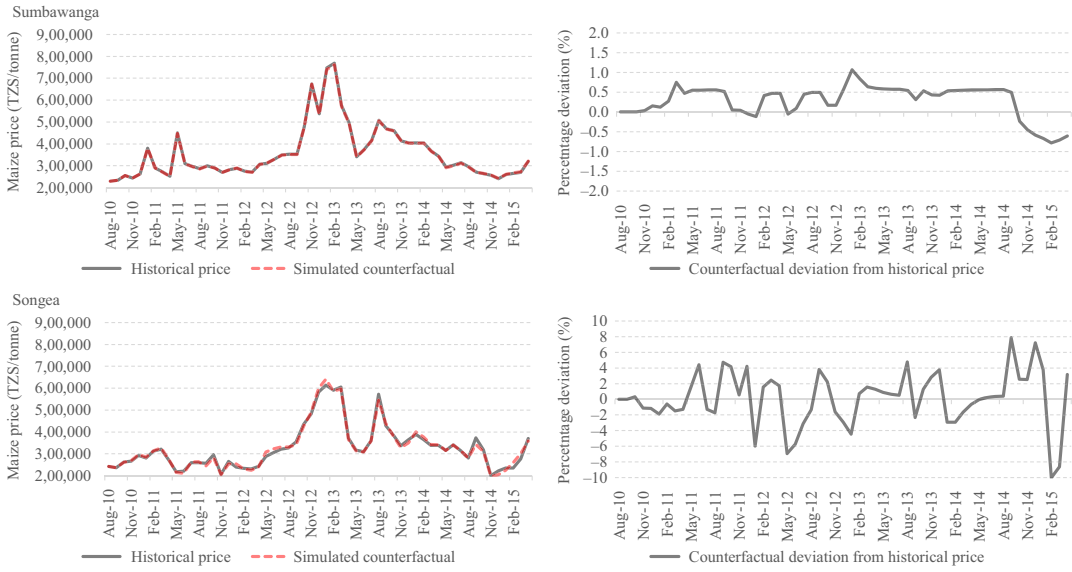

FIGURE 3 Simulated NFRA Wholesale Maize Market Price Impact in Surplus Zones, 2010/11–2014/15
[Colour figure can be viewed at wileyonlinelibrary.com]
Source: authors' estimates based on NFRA (2016a) and MALF (2016).

Salaam, a major consumer center, which relies on substantial imports from the rest of the country. Second, although periods of procurement and sales of maize stocks tend to follow sequentially, these activities may at times overlap, thus potentially having opposing effects in the market which are difficult to disentangle. Third, as shown in Figure 1, selling prices may differ depending on the nature of the transaction (i.e., motivated by food security or stock releases of a more commercial nature), and hence what we observe here at wholesale market level may be an average and possibly insignificant effect compared to prevailing market prices. Lastly, and related to the previous point, the NFRA's impact is most likely more pronounced at a very localized level, whether through procurement from specific farmers or traders, or food disbursements to select districts. While potentially significant for those affected, this may not necessarily be observed at the wholesale level.

We next turn to a brief analysis of operational costs. The NFRA does not explicitly have a price stabilization mandate, but in its role of ensuring food security it does tend to offer a premium on maize purchases and it also releases stock at discount prices. Considering the indication from our results that the NFRA activities ultimately have no significant spill-over effects in regional markets and tend to benefit only a select few, its strategy may be at odds with its commitment to operate in a cost-efficient manner. Focusing on the procurement side, it is evident that not buying at market prices has budgetary implications. In fact, over the 2010/11–2014/15 period, the accumulated cost of buying maize at official procurement prices rather than at prevailing market prices was TZS 68.3 billion. Figure 5 shows the actual cost differentials as well as the premium paid in percentage terms. It is evident that the bulk of additional costs were incurred in the surplus maize-producing zones of Songea, Sumbawanga, and Makambako where both procurement levels and price premiums were highest.

Although the NFRA already controls relatively large shares of marketed production in key areas, evidence suggests that net procurement volumes do not significantly affect the market price. Model limitations prevent us from simulating the impact of an increase in procurement or sales volumes in the same way we examine changes in the pricing strategy; however, it is certainly

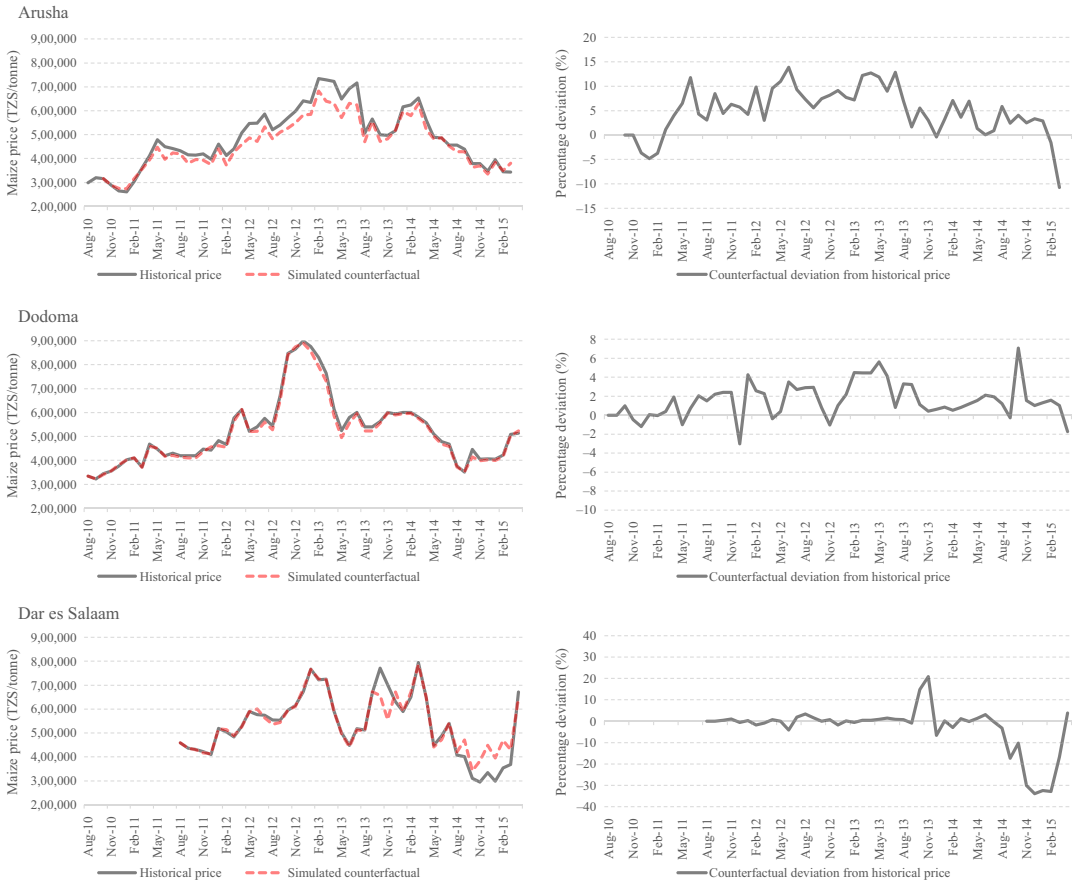

FIGURE 4 Simulated NFRA Wholesale Maize Market Price Impact in Deficit Zones, 2010/11–2014/15
[Colour figure can be viewed at wileyonlinelibrary.com]
Source: Authors' estimates based on NFRA (2016a) and MALF (2016).

plausible to think that if the NFRA follows through with its ambitious capacity expansion targets, and follows that up with larger procurement and sales volumes, it could have a much greater distortionary effect on markets in the future. However, as argued in the preceding section, in the context of the food security mandate of the NFRA, there is little justification for such expansion.

5 | CONCLUSIONS AND POLICY RECOMMENDATIONS

Tanzania's National Food Reserve Agency has a mandate to ensure food security by procuring, reserving, and recycling strategic grain stocks, focusing mainly on maize, one of Tanzania's key staples. As with any strategic grain reserve with a relatively large government-funded budget, its activities are closely scrutinized. In addition to public demands that the NFRA operations be conducted in a cost-efficient manner, many have voiced concerns that NFRA activities distort the maize market and, as such, may prevent the private sector from engaging in trade-related activities, or create disincentives to farmers to produce maize for the market.

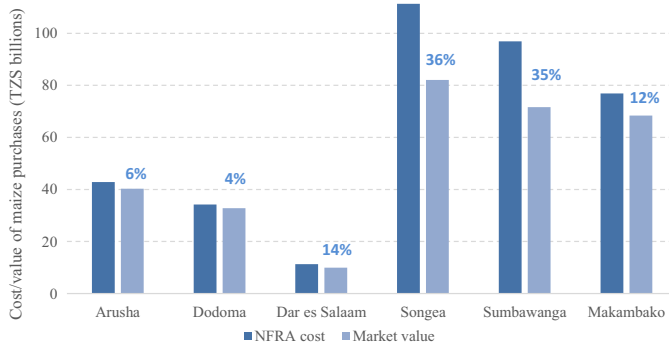

FIGURE 5 Budget Implications of Buy Premiums, 2010/11–2014/15 [Colour figure can be viewed at wileyonlinelibrary.com]

Source: Authors' estimates based on NFRA (2016a) and MALF (2016).

Notes: Mbeya market prices were used as a proxy for prices in Makambako. Shinyanga is excluded here due to insufficient price data and low traded volumes

This study follows an approach similar to that adopted by Jayne et al. (2008) in Kenya and Mason and Myers (2013) in Zambia to examine the NFRA's impact on wholesale market prices. An econometric model was developed to disentangle the relationship between wholesale market prices and NFRA buy or sell premiums in surplus or deficit maize-production zones, controlling for a variety of factors, including relative procurement and sales quantities, cointegration between local Tanzanian markets and the Nairobi market in Kenya, price seasonality, policy shocks such as export bans, and external market shocks such as the price shock in 2012/13. The coefficients recovered from the model were then used to simulate hypothetical maize price paths assuming NFRA procured and sold maize at the prevailing market price rather than at administratively set prices.

The analysis suggests that the impact of the NFRA buy and sell premium is overall weak and difficult to observe. The simulated counterfactual price paths obtained under the hypothesis of competitive pricing of NFRA operations show very little difference with their historical counterparts. Thus there is little to no evidence to suggest that the NFRA pricing strategy distorts wholesale maize markets, with the exception perhaps of isolated periods in some markets, such as the price-increasing effect identified in Arusha during 2012/13, and the price-reducing effect observed in Dar es Salaam during 2014/15. Our results further suggest that the market context of trade partners such as Kenya cannot be ignored when designing domestic price policies; put differently, whereas domestic policy interventions that fall under the mandate of the NFRA may influence prices in the short run, they are unlikely to have sustained market effects due to regional market integration.

The buy and sell premiums are, however, only one avenue through which the NFRA can influence markets. Another is its mere presence in markets as a buyer or seller of maize. Already the NFRA controls relatively large shares of marketed production in key areas and is actively engaged in countercyclical and food security operations. However, also in this regard, evidence suggests that net procurement volumes do not significantly affect the market price. Nevertheless, in the context of plans to significantly expand its storage capacity and market presence (by almost 200 percent) it is certainly plausible to think that this result could change in future. Unfortunately, model limitations prevent us from simulating such an eventuality; yet, as argued in this paper, in the context of the food security mandate of the NFRA, there is no economic justification for such expansion, and current plans deserve reconsideration by policy-makers.

In the context of its food security mandate, which explicitly does not include a price stabilization role, several specific policy recommendations flow from the analysis that could guide future NFRA activities and the broader food security strategy in Tanzania.

First, the NFRA should, in a consistent manner over time, procure an appropriate quantity of maize at market-related prices. NFRA procurement volumes in recent years have been volatile and seemingly unrelated to the quantities of food disbursed under its food security activities. A more reasonable procurement quantity is of the order of 100,000–120,000 tonnes per annum. Procurement prices have also generally exceeded prevailing market prices, yet this practice has had no significant or sustained impact on markets more generally. Since the practice only benefits a few farmers or traders, it cannot be considered a cost-effective food security intervention. Procurement strategy reforms, which should include the use of public tenders or bid-volume-only online auctions, will bring transparency to the market, prevent rent-seeking behavior, and bring about significant savings to the NFRA.

Second, annual subsidized sales or handouts to targeted, vulnerable people should remain the NFRA's core business. Excluded from this mandate is a more commercially oriented role for the NFRA, and one which is best played by the National Cereals and Produce Board (NCPB). Additionally, the government should commit to: (i) always maintaining transparency in identifying beneficiaries; (ii) analyzing beneficiary trends over time in order to better understand the dynamics of food insecurity, with a view to develop strategies to enhance communities' resilience to shocks; and (iii) regularly evaluating the option of providing cash rather than food transfers in certain areas, especially surplus-producing regions with vibrant local markets.

Third, sales to millers are also an appropriate means of providing food at affordable prices to regions experiencing high prices, even though current evidence suggests that the NFRA's sales activities have not had a meaningful effect on regional market prices. However, these activities should be based on clear, predefined rules, for example: (i) sales can only be approved when regional or district-specific prices breach a predetermined price level; (ii) the agreed sales price should equal the upper limit of the price band, and flour retail prices should be derived accordingly; and (iii) the exact sales price and quantities available each year should be announced in advance so as to prevent unanticipated shocks to the market.

Fourth, other sales to prisons or international aid agencies are appropriate given the need to recycle unutilized stocks, and these can continue in a transparent manner and at market-related prices as is presently the case. However, there is no need, in principle, for the NFRA to procure more maize than it anticipates distributing under its food security mandate.

Fifth, current plans to expand market presence and storage capacity by 200 percent make no economic sense and should be abandoned. An increased market presence could lead to maize market distortions and displace the private sector, especially when market activities are government-financed, which contradicts economic development goals in Tanzania. Current NFRA storage capacity is sufficient to provide for food insecurity needs over a typical five-year period, while more severe but infrequent disasters can be dealt with through international food imports in a much more cost-effective way than maintaining large stock levels. Future capacity expansion should, however, be anticipated, but the expansion rate should be based on a combination of population growth and food insecurity projections.

ACKNOWLEDGEMENTS

At the time of writing, the authors were all researchers of the Monitoring and Analyzing Food and Agricultural Policies (MAFAP) program of the FAO, funded by the Bill and Melinda Gates

Foundation. Thanks to Alethia Cameron, Ntemi Nkonya, and Jean Balié for support and useful comments, and to the National Food Reserve Agency (NFRA) for making the data available. All interpretations, opinions and analyses are our own and do not necessary reflect those of colleagues or the institutions they represent.

ORCID

Karl Pauw http://orcid.org/0000-0001-6580-0939

REFERENCES

Baffes, J., Kshirsagar, V., & Mitchell, D. (2015). *What drives local food prices? Evidence from the Tanzanian maize market* (Policy Research Working Paper). Washington, DC: World Bank.

Barreiro-Hurle, J. (2012). *Analysis of incentives and disincentives for maize in the United Republic of Tanzania* (Technical Notes Series). Rome: MAFAP.

Business Daily (2016). Maize stocks at strategic reserve to last two weeks. *Business Daily*, 18 October. Available at http://www.businessdailyafrica.com/Maize-stocks-at-strategic-reserve-to-last-two-weeks/539546-3421562-mjeyfrz/

Cameron, A., Derlagen, C., & Pauw, K. (2016). *Options for reducing input costs for smallholder farmers in Tanzania* (Report prepared by MAFAP for MALF). Rome: FAO.

Chapoto, A., & Jayne, T. (2009). *The impact of trade barriers and market interventions on maize price predictability: Evidence from eastern and southern Africa* (International Development Working Paper No. 102). East Lansing: Michigan State University.

Diao, X., & Kennedy, A. (2016). Economywide impact of maize export bans on agricultural growth and household welfare in Tanzania: A dynamic computable general equilibrium model analysis. *Development Policy Review*, *34*(1), 101–134.

Dorosh, P. (2008). Food price stabilization and food security: International experience. *Bulletin of Indonesian Economic Studies*, *44*(1), 93–114.

Dorosh, P., Minten, B., & Stifel, D. (2015). *Cereal price stabilization in East Africa: Implications of international experience*. Presented at the 2nd Economics Association of Malawi (ECAMA) Research Symposium, 4-5 June 2015, Lilongwe, Malawi.

Fafchamps, M. (1992). Cash crop production, food price volatility, and rural market integration in the Third World. *American Journal of Agricultural Economics*, *74*(1), 90–99.

FAOSTAT (2016). *Crop production estimates*. Available at http://www.fao.org/faostat/en/#home

Gilbert, C., Christiaensen, L., & Kaminski, J. (2017). Food price seasonality in Africa: Measurement and extent. *Food Policy*, *67*, 119–132.

International Fertilizer Development Center (2012). *Tanzania fertilizer assessment*. Muscle Shoals, AL: IFDC.

Jayne, T. (2012). Managing food price instability in East and Southern Africa. *Global Food Security*, *1*, 143–149.

Jayne, T., Myers, R., & Nyoro, J. (2008). The effects of NCPB marketing policies on maize market prices in Kenya. *Agricultural Economics*, *38*, 313–325.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2), 231–254.

MALF (Ministry of Agriculture, Livestock0020and Fisheries) (2016). *Maize crop prices, wholesale markets, 2010/11–2014/15*. Dar es Salaam: MALF.

Mason, N., & Myers, R. (2013). The effects of the Food Reserve Agency on maize market prices in Zambia. *Agricultural Economics*, *44*, 203–216.

Msolla, M. (2016). Agricultural input support to Tanzanian farmers: Which way now? Presentation to MALF, Dar es Salaam, 17 May.

Murphy, S. (2009). *Strategic grain reserves in an era of volatility*. Minneapolis, MN: Institute for Agriculture and Trade Policy.

NFRA (National Food Reserve Agency) (2014). *NFRA Investment Plan 2014/15–2023/24*. Dar es Salaam: MALF.

NFRA (National Food Reserve Agency) (2016a). *NFRA maize market transactional data, 2010/11–2014/15*. Dar es Salaam: MALF.

NFRA (National Food Reserve Agency). (2016b). NFRA Strategic Plan 2016/17–2020/21, Ministry of Agriculture, Livestock and Fisheries (MALF), United Republic of Tanzania.

Pauw, K., & Thurlow, J. (2011). Agricultural growth, poverty, and nutrition in Tanzania. *Food Policy*, *36*(6), 795–804.

Pfaff, B. (2008). *Analysis of integrated and cointegrated time series with R*, 2nd edition. New York: Springer.

Rashid, S., & Lemma, S. (2011). *Strategic grain reserves in Ethiopia: Institutional design and operational performance (IFPRI Discussion Paper 01054)*. Washington DC: IFPRI.

Stryker, D. (2015). *Tanzania National Food Reserve Agency's role in assuring food security*. Prepared for the USAID Feed the Future SERA Policy Project, February.

Thangata, P., & Lemma, S. (2010). *Price stabilization and strategic grain reserves: The case of Malawi*. Presented at Risk Management in African Agriculture: Taking Stock of What Has and Hasn't Worked, Lilongwe, Malawi, November.

UN Comtrade (2016). UN Comtrade database. Available at https://comtrade.un.org/

United Republic of Tanzania (2011). *Tanzania Agriculture and Food Security Investment Plan (TAFSIP) 2011-12 to 2020-21*. United Republic of Tanzania.

USAID (2010). *Tanzania National Food Reserve Agency's role in assuring food security*. Feed the Future NAFAKA Staples Value Chain Project.

How to cite this article: Pierre G, Pauw K, Magrini E. The effect of the National Food Reserve Agency on maize market prices in Tanzania. *Rev Dev Econ*. 2018;22:540–557. https://doi.org/10.1111/rode.12374