FOOD SECURITY RESEARCH PROJECT

The Effects of the Food Reserve Agency on Maize Market Prices in Zambia

by

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Mason is assistant professor, International Development, in the Department of Agricultural, Food, and Resource Economics at Michigan State University (AFRE/MSU) and is currently on long-term assignment with the Food Security Research Project (FSRP) in Lusaka, Zambia. Myers is university distinguished professor, Commodity Market Analysis and Policy, in AFRE/MSU.

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Any views expressed or remaining errors are solely the responsibility of the authors. Comments and questions should be directed to the Project Director, Food Security Research Project, 26A Middleway, Kabulonga, Lusaka; Tel +260 (21)1261194; email: *kabaghec@msu.edu*.

FOOD SECURITY RESEARCH PROJECT TEAM MEMBERS

The Zambia Food Security Research Project field research team is comprised of Chance Kabaghe, Antony Chapoto, T. S. Jayne, William Burke, Nicole Mason, Munguzwe Hichaambwa, Solomon Tembo, Stephen Kabwe, Auckland Kuteya, Nicholas Sitko, Mary Lubungu, and Arthur Shipekesa. MSU-based researchers in the Food Security Research Project are Steve Haggblade, James Shaffer, Margaret Beaver, David Tschirley, and Chewe Nkonde.

EXECUTIVE SUMMARY

Over the last decade, governments in eastern and southern Africa have become increasingly involved in grain marketing via strategic reserves and marketing boards. Kenya, Malawi, Zimbabwe, Ethiopia, Tanzania, and Zambia all have one or both of these entities, and their level of involvement in grain marketing has generally increased in recent years. Yet, to date, relatively little is known about how the resurgent activities of strategic grain reserves and marketing boards are affecting market prices. This paper estimates the effects of the Zambia Food Reserve Agency's (FRA) activities on maize market prices in the country.

The FRA, a parastatal strategic food reserve/maize marketing board, buys maize at a pan-territorial price that typically exceeds wholesale market prices in major maize-producing areas. It then exports the maize or sells it domestically at prices determined by tender, at auction, or administratively. In deficit production years, the Agency often imports maize and sells it to select large-scale millers at below-market prices. The FRA is a major player in the Zambian maize market and substantial public sector resources are devoted to the Agency. For example, the FRA purchased 30% to 86% of the maize marketed by smallholders in six of seven years between 2004/05 and 2010/11, and government spending on the FRA exceeded 25% of total agricultural sector expenditures in several years during this period.

We use a vector autoregression (VAR) approach to estimate the effects of the FRA's pricing policies and net maize purchases on maize market prices in Zambia between July 1996 and December 2008. The Zambia maize market prices in the model are wholesale prices in Lusaka (representing a major maize consumption area) and in Choma (representing a major maize production area). The FRA's pricing policies are modeled as a buy price premium (the FRA buy price minus the market price in Choma) and a sell price premium (the FRA sell price minus the market price in Lusaka). VAR estimation results are used to simulate the path of market prices that would have occurred in the absence of the FRA. The simulated market prices are then compared to historical price levels (in terms of means, standard deviations, and coefficients of variation) to infer the effects of the FRA on maize market prices.

Two key findings emerge from the analysis. First, consistent with the general perception in Zambia, results suggest that the FRA's activities have raised average market prices, particularly since mid-2003. The Agency's activities are estimated to have increased mean maize market prices between July 2003 and December 2008 by 17% in Lusaka and 19% in Choma.

Second, in line with the FRA's strategic goal to stabilize market prices, wholesale maize prices were less variable between October 1996 and December 2008 than they would have been in the absence of the FRA. Results suggest that the Agency's activities reduced the coefficient of variation of maize market prices by 14% between October 1996 and June 2003, and by 34-36% between July 2003 and December 2008.

Who is likely to have gained and lost from the higher average maize market prices brought about by the FRA's activities? Higher average maize market prices are beneficial for net sellers of maize and detrimental for net buyers of maize. Nationally-representative household survey data collected by the Zambia Central Statistical Office and Ministry of Agriculture and Cooperatives indicate that only approximately 28% of smallholder farm households sell more maize than they buy; the remaining 72% either buy more maize than they sell (49%) or neither buy nor sell maize (23%). Thus higher maize prices hurt urban consumers and the nearly 50% of smallholders that are net buyers of maize. Large-scale farmers and the 28% of smallholders that are net sellers benefit from higher average maize prices.

Among smallholder net sellers, gains from higher maize market prices would be highly concentrated in the hands of the 3-5% of maize-growing smallholders that account for 50% of all smallholder marketed maize. This group tends to have more land and non-land assets than other smallholders do. Therefore, to the extent that they raise average maize market prices in Zambia, the FRA's policies are regressive: higher maize prices harm urban consumers and a large proportion of rural households, and help large-scale farmers and a small number of relatively better off smallholders.

Who is likely to have benefited from the more stable maize market prices brought about by the FRA's activities? Results of previous studies suggest that relatively better off producers are likely to be the principal beneficiaries of more stable maize prices, while many poor rural may actually be hurt by more stable food prices. However, the welfare effects of FRA-induced increases in the average *level* of maize market prices are likely to dwarf any welfare effects that result from price *stabilization.*

If similar results hold in Zambia, it would indicate that both the mean maize price raising and the price stabilizing effects of FRA policies are regressive: they disproportionately benefit relatively better off households and have negative net effects on relatively poor households.

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ACRONYMS

ADF	Augmented Dickey-Fuller
AMIC	Agricultural Market Information Center
BPP	Buy Price Premium
CFS	Crop Forecast Survey
CSO	Central Statistical Office
CV	Coefficient of Variation
ESA	Eastern and Southern Africa
FEWSNET	Famine Early Warning Systems Network
FAOSTAT	Food and Agriculture Organization Statistical Database
FRA	Food Reserve Agency
FSRP	Food Security Research Project
GRZ	Government of the Republic of Zambia
kg	kilogramme
KPSS	Kwiatkowski, Phillips, Schmidt, and Shin
MACO	Ministry of Agriculture and Cooperatives
MT	Metric Ton
NAMBOARD	National Agricultural Marketing Board
NCPB	National Cereals and Produce Board
OLS	Ordinary Least Squares
PHS	Post-Harvest Survey
PP	Phillips-Perron
SAFEX	South African Futures Exchange
SD	Standard Deviation
SGR	Strategic Grain Reserve
SPP	Sell Price Premium
SS	Supplemental Survey
VAR	Vector Autoregression
ZMK	Zambian Kwacha

1. INTRODUCTION

After being scaled back to varying degrees during structural adjustment in the 1980s and 1990s, direct government involvement in grain markets through marketing boards and/or strategic reserves is once again *en vogue* in eastern and southern Africa (ESA).[1] A key example is the Government of the Republic of Zambia (GRZ), which through the Food Reserve Agency (FRA) has become a major player in the domestic maize market in recent years (Govereh, Jayne, and Chapoto 2008; Tembo et al. 2009).

Established by GRZ in 1996 as a national food reserve, the FRA's mandate was expanded in 2005 to include crop marketing. The Agency's stated objective is to "contribute to the stabilization of national food security and market prices of designated crops," although its focus has been almost exclusively on maize (FRA n.d.). The FRA purchased nearly 400,000 metric tons (MT) of maize, or more than 50% of the total maize marketed by smallholder farmers, in both the 2006/07 and 2007/08 maize marketing years.[2] The FRA's largest maize purchase campaign to date was in 2010/11 when it bought 878,570 MT of maize or 83% of expected maize sales by smallholders. Substantial GRZ budgetary resources have been devoted to the FRA: in 2006 and 2007, spending on the FRA accounted for approximately 26% of total government agriculture-related expenditures (Govereh et al. 2009). (This figure is based on estimates of actual government expenditures, not budget allocations.)

The FRA sets a pan-territorial indicative price at which it buys maize from individual farmers and cooperatives but private sector traders are allowed to operate and purchase maize at prices above or below the FRA price. Maize purchased by the FRA is exported or sold on the domestic market (mainly to millers and traders) at prices determined by a tender process, at auction, or in consultation with local stakeholders. In deficit production years, GRZ through FRA often imports large quantities of maize and sells it to select large-scale millers, typically at prices below the cost of commercial importation (Govereh, Jayne, and Chapoto 2008).

Despite the resurgence over the last decade of marketing boards and strategic reserves as key players in grain markets in Zambia and elsewhere in ESA, there has been relatively little empirical analysis of how these entities' renewed activities are affecting market prices for grain. Two important exceptions are Jayne, Myers, and Nyoro (2008) and Chapoto and Jayne (2009). Jayne, Myers, and Nyoro use a vector autoregression (VAR) model to estimate the effects of National Cereals and Produce Board (NCPB) activities on wholesale maize prices in Kenya. They find that NCPB activities had a stabilizing effect on market prices and that these activities reduced market price levels during the early 1990s but raised them by approximately 20% between 1995 and 2004.

Chapoto and Jayne (2009) estimate a single equation reduced form model of wholesale maize prices in Zambia as a function of lagged maize prices and variables representing supply and demand shifters, including lagged FRA maize purchases and sales and other GRZ maize market policies. They find no significant effect of lagged FRA purchases on maize prices but

[1] A marketing board is a state-controlled or state-sanctioned entity established to direct the market and marketing of specific commodities within a given country or other geographic area (Staatz 2006; Barrett and Mutambatsere 2008). A strategic grain reserve (SGR) is a "public stock of grain used to meet emergency food requirements, to stabilize food prices, and [or] to relieve temporary shortages while commercial imports or food aid are being arranged" (Minot 2010). Some entities that refer to themselves as SGRs, e.g., the Zambian Food Reserve Agency, have functions, such as grain marketing and market facilitation, that are more characteristic of grain marketing boards.

[2] The maize marketing year in Zambia, henceforth referred to as *marketing year*, is from May to April.

significant negative effects of lagged FRA sales on maize prices. Chapoto and Jayne do not investigate the impacts of the FRA's pricing decisions on market prices.

In this paper, we use a VAR approach similar to Jayne, Myers, and Nyoro (2008) and monthly data from July 1996 through December 2008 to estimate the impacts of the FRA's pricing decisions and net maize purchases on the level and variability of wholesale maize prices in Zambia. The VAR results are used to simulate the path of market prices that would have occurred in the absence of the FRA. The level and variability of these simulated prices are compared to those of the realized historical prices to determine the effects of the FRA on maize market prices.

The general perception in Zambia is that the FRA's activities have raised the level of maize prices and one of the FRA's goals is to stabilize market prices (Govereh, Jayne, and Chapoto 2008; FRA n.d.). This paper provides empirical evidence on the impacts of FRA policies, and therefore adds to knowledge of the effects of parastatal grain marketing boards in ESA. Given the importance of maize in domestic production and consumption in Zambia and the high level of government resources devoted to the FRA, a better understanding of the effects of the Agency's activities is needed (Govereh et al. 2009). This paper will contribute to such an enhanced understanding, which could, in turn, aid in improving the effectiveness of GRZ expenditures in the agricultural sector.

The remainder of the paper is organized as follows. In section 2, we discuss GRZ maize marketing and trade policies from liberalization in the early 1990s to present, with an emphasis on how the role and level of involvement of the FRA in the maize market have evolved over time. We present the methodology in section 3 and describe the data used in the analysis in section 4. The results are presented in section 5, and conclusions and policy implications are discussed in section 6.

2. GRZ MAIZE MARKETING AND TRADE POLICIES AND FOOD RESERVE AGENCY ACTIVITIES

Maize is the dominant food crop in Zambia. Approximately 80% of smallholders grow maize and it accounts for 60% of the calories consumed in the country (Zulu, Jayne, and Beaver 2007; Dorosh, Dradri, and Haggblade 2009). Prior to liberalization in the 1990s, maize marketing was controlled by the government agricultural marketing parastatal, the National Agricultural Marketing Board (NAMBOARD), which set pan-territorial/pan-seasonal producer prices for maize and also handled GRZ maize imports and distribution. Private inter-district trade of maize was prohibited (Govereh, Jayne, and Chapoto 2008). NAMBOARD was abolished in 1989, its marketing functions transferred to cooperatives, and an Economic Structural Adjustment Programme was initiated in 1991 (Jayne and Jones 1997; Govereh, Jayne, and Chapoto 2008). Private maize trade was legalized and pan-territorial/pan-seasonal pricing of maize was eliminated.

The FRA was established by GRZ in 1996 after the enactment of the Food Reserve Act of 1995. The FRA's original mandate was to establish and administer a national food reserve (GRZ 1995). Private maize trade remained legal but buffer stocks held by the FRA were intended to reduce maize price variability and to provide liquidity in the maize market as the private sector established itself in the early years of market liberalization (Govereh, Jayne, and Chapoto 2008).

Table 1 summarizes the tonnage of maize purchased on the domestic market by the FRA each year from 1996/97 through 2010/11 as well as the number of districts from which maize was purchased, the price at which it was purchased, and the estimated tonnage of maize produced and sold by smallholders each year. FRA's purchases on the domestic market can be divided into roughly three periods: 1996/97-1997/98, when it bought small quantities of maize from smallholders via private traders; 1998/99-2001/02, when it made no domestic purchases due to lack of funding; and 2002/03 to present, when it has purchased substantial quantities of maize directly from smallholders.

During the first period (1996/97-1997/98), the FRA contracted small-scale traders to buy maize from smallholder on its behalf. The quantities of maize procured were small and came from only four or five of Zambia's 72 districts (Table 1). FRA buy prices were uniform within districts but differed across districts to better reflect market conditions.[3]

Then, after four years of no purchases on the domestic market, the FRA began to participate more actively in maize marketing in 2002/03. That year, the Agency purchased 23,535 MT of maize directly from smallholders in 10 surplus districts following a drought-related poor harvest in large swathes of the country. At the beginning of the 2003/04 marketing year, the FRA announced plans to purchase 205,700 MT of maize directly from smallholders in 37 districts at a pan-territorial price of K30,000 per 50-kilogramme (kg) bag. This was the first time in more than a decade that GRZ set a pan-territorial price for maize (FEWSNET 2003a; FEWSNET 2003b). The Agency only managed to buy approximately 55,000 MT due to funding shortfalls but its plans sent a clear signal: the FRA intended to be a major player in the Zambian maize market. The FRA's expanded role was codified when the Food Reserve Act was amended in October 2005, adding crop marketing and price setting as major functions of the Agency (GRZ 2005).

[3] Chance Kabaghe, personal conversation, 5 March 2010.

Table 1. FRA Maize Prices and Purchases, and Estimated Smallholder Maize Production and Sales, 1996/97-2010/11 Marketing Years

Market-ing year	FRA pan-territorial price (ZMK/ 50 kg)	# of districts in which FRA purchased maize	FRA domestic maize purchases (MT)	Estimated smallholder maize:[d] Production (MT)	Sales (MT)	FRA purchases as % of small-holder maize sales	Prod-uction and sales data source
1996/1997	11,800[a]	5	10,500	1,117,955	280,955	3.7	PHS
1997/1998	7,880[a]	4	4,989	804,626	206,557	2.4	PHS
1998/1999	N/A	0	0	724,024	175,515	0	PHS
1999/2000	N/A	0	0	929,304	242,753	0	PHS
2000/2001	N/A	0	0	1,253,722	303,738	0	PHS
				1,282,352	323,387	0	SS
2001/2002	N/A	0	0	957,437	209,326	0	CFS
				938,539	197,915	0	PHS
2002/2003	40,000[b]	10	23,535	673,673	143,453	16.4	CFS
				947,825	195,407	12.0	PHS
2003/2004	30,000	36	54,847	970,317	260,885	21.0	CFS
				1,126,316	291,462	18.8	PHS
				1,365,538	370,332	14.8	SS
2004/2005	36,000	46	105,279	1,364,841	331,006	31.8	CFS
				1,216,943	356,750	29.5	PHS
2005/2006	36,000	50	78,667	652,414	151,514	51.9	CFS
				800,574	206,092	38.2	PHS
2006/2007	38,000	53	389,510	1,339,479	454,676	85.7	CFS
				1,388,311	674,020	57.8	PHS
2007/2008	38,000	58	396,450	1,419,545	533,632	74.3	CFS
				1,960,692	762,093	52.0	SS
2008/2009	45,000[c]	58	73,876	1,392,180	522,033	14.2	CFS
2009/2010	65,000	59	198,630	1,657,117	613,356	32.4	CFS
2010/2011	65,000	62	878,570	2,463,523	1,062,010	82.7	CFS

Notes: [a]Not a pan-territorial price but the average price paid by FRA to private traders. [b]Not a pan-territorial price but the price paid by FRA directly to smallholder farmers in the districts where it was purchasing; initial FRA price of K30,000 was raised to K40,000 in August 2002. [c]FRA price increased to 55,000 in September 2008. [d]Smallholder maize production and sales based on CFS data are expected, not realized, levels.
Sources: FRA; CSO/MACO Crop Forecast Surveys (CFS); CSO/MACO Post-Harvest Surveys (PHS); CSO/MACO/FSRP Supplemental Surveys (SS).

Each year from 2003/04 to the present, the FRA has purchased maize directly from smallholders at a pan-territorial price. The FRA typically announces its maize buy price and target purchase quantities in May, and then starts buying in June or July once the maize is sufficiently dry. In most years, it stops buying maize at the end of September or October. Farmers selling to the FRA are not paid on the spot; the Agency aims to pay them within ten days of delivery but long delays are common. Private traders are free to buy from farmers at prices above or below the FRA price.

From 2004/05 to 2010/11, FRA local purchases ranged from a low of approximately 74,000 MT in 2008/09, to nearly 400,000 MT in 2006/07 and 2007/08, to a high of 878,570 MT in 2010/11. Over this period, FRA's share of the smallholder maize market was at its lowest in 2008/09 (14%), exceeded 50% in both 2006/07 and 2008/09, and was 83% of expected

smallholder maize sales in 2010/11. The spatial coverage of FRA's purchases increased steadily over time from 36 districts in 2003/04 to 62 districts in 2010/11 (Table 1).

Table 2 compares the prices at which the FRA bought and sold maize, and average wholesale market prices in six provincial trading centers. Since 2002/03, the FRA buy price has consistently exceeded average wholesale prices, particularly in major maize-producing areas such as Choma, Kabwe, Chipata, and Kasama (Table 2). The above-market buy prices make it difficult for the FRA to export maize unless treasury funds are available to subsidize exports. FRA exports in 2007/08 and 2010/11 generated a trading loss (Govereh, Jayne, and Chapoto 2008; Nkonde et al. 2011).

Much of the maize purchased by the FRA is channeled to large industrial millers and trading firms but the GRZ Disaster Management and Mitigation Unit, the World Food Programme, cooperative unions, and consumers also occasionally buy maize from the Agency. Most FRA maize sales occur during the hungry season months of December through March and are done via a tender process. The FRA periodically sells maize at a pan-territorial price that is determined in consultation with stakeholders such as the Zambia National Farmers Union, the Grain Traders Association of Zambia, and the Millers Association of Zambia. Beginning in October 2010, the FRA sold small quantities of maize (20,000 MT) through an auction-like mechanism on the Zambia Agricultural Commodity Exchange. Because of these different pricing institutions, the FRA sell price often varies from transaction to transaction. While the Agency typically purchases maize at above-market prices, it sometimes sells maize on the domestic market at below-market prices. In most years, however, the weighted average FRA sell price exceeded average wholesale prices throughout Zambia (Table 2). See Mason (2011, Appendix F) for additional background information on the FRA.

Table 2. FRA Buy Price and Weighted Average Sell Price, and Average Market Wholesale Prices, 1996/97-2009/10 Marketing Years (ZMK/50-Kg)

		Weighted	Wholesale price					
Marketing year	FRA buy price	average FRA sell price[a]	Lusaka	Ndola	Choma	Kabwe	Chipata	Kasama
1996/1997	11,800	No sales	6,815	7,672	4,601	5,944	5,504	6,718
1997/1998	7,880	16,876	10,718	11,262	8,506	11,339	11,634	10,782
1998/1999	N/A	22,357	16,014	18,902	14,617	14,974	16,028	17,161
1999/2000	N/A	N/A	14,768	16,175	12,583	12,166	11,392	11,116
2000/2001	N/A	15,811	15,973	17,304	14,518	13,001	11,922	13,786
2001/2002	N/A	13,392	31,900	26,667	30,344	32,520	24,933	27,975
2002/2003	40,000[b]	49,000	48,290	36,575	40,017	39,193	32,903	34,276
2003/2004	30,000	44,471	31,525	27,757	23,096	26,455	20,543	28,716
2004/2005	36,000	35,332	30,480	26,642	25,859	25,400	25,121	26,863
2005/2006	36,000	36,202	39,113	40,749	39,363	36,801	36,544	37,339
2006/2007	38,000	43,184	29,877	31,062	23,839	26,746	22,737	30,167
2007/2008	38,000	39,821	34,962	37,655	30,673	31,699	26,576	37,474
2008/2009	55,000[c]	63,000	58,877	57,266	51,554	49,175	45,681	48,958
2009/2010	65,000	No data	60,879	58,722	55,518	48,160	48,801	54,599

Sources: FRA, AMIC.

Notes: [a]Weighted average sell price based on share of total sales in Zambia in the marketing year sold at a given price. [b]Initial FRA price of K30,000 was raised to K40,000 in August 2002. [c]Initial FRA price of K45,000 was increased to K55,000 in September 2008.

In addition to the maize marketing activities of the FRA, the GRZ uses a number of other policy tools to influence maize markets and prices. These are: (i) explicit export bans and implicit export bans through limited issuance of export licenses; (ii) adjusting import tariff rates; (iii) government-arranged maize imports and sales of subsidized maize to large industrial millers; (iv) levies on the inter-district movement of maize; and (v) targeted fertilizer subsidies (Govereh, Jayne, and Chapoto 2008).[4]

[4] See Govereh, Jayne, and Chapoto (2008) for a detailed timeline of maize marketing and trade policy changes in Zambia from 1990 to 2007 and Nkonde et al. (2011) for a timeline of key maize market policies and events in 2010.

3. METHODOLOGY

3.1. Vector Autoregression Model

In this paper, we use a vector autoregression (VAR) approach to estimate the effects of FRA activities on maize market prices in Zambia. A VAR is a system of equations in which all variables are treated as endogenous and each variable is regressed on past values of itself as well as current and past values of the other variables in the system.[5] In the current application, we define two groups of endogenous variables: a vector of maize market prices ($\boldsymbol{y_t}$), and a vector of FRA policy variables ($\boldsymbol{p_t}$). A VAR of $\boldsymbol{y_t}$ and $\boldsymbol{p_t}$ can be written as

$$\begin{aligned} \boldsymbol{B y_t} &= \sum_{i=1}^{k} \boldsymbol{B_i y_{t-i}} + \sum_{i=0}^{k} \boldsymbol{C_i p_{t-i}} + \boldsymbol{A^y v_t^y} \\ \boldsymbol{G p_t} &= \sum_{i=0}^{k} \boldsymbol{D_i y_{t-i}} + \sum_{i=1}^{k} \boldsymbol{G_i p_{t-i}} + \boldsymbol{A^p v_t^p} \end{aligned} \tag{1}$$

where $\boldsymbol{B}, \boldsymbol{B_i}, \boldsymbol{C_i}, \boldsymbol{A^y}, \boldsymbol{G}, \boldsymbol{D_i}, \boldsymbol{G_i}$, and $\boldsymbol{A^p}$ are matrices of unknown parameters that capture the dynamic relationships between maize market prices and FRA policies, *k* is the maximum lag length for variables in the system, and vectors $\boldsymbol{v_t^y}$ and $\boldsymbol{v_t^p}$ are error terms (Jayne, Myers, and Nyoro 2008; Bernanke and Mihov 1998).

The reduced form of (1) can be estimated with ordinary least squares (OLS).[6] Given the estimated VAR, one can simulate what the historical paths of the maize market prices would have been in the absence of the FRA. This is achieved by setting the market price error terms to their estimated historical values, setting the FRA policy variables to zero, and then constructing dynamic forecasts for the market prices (Jayne, Myers, and Nyoro 2008). The simulated paths of the market variables can then be compared to their historical (factual) paths in order to evaluate the effects of alternative policies on the market variables.

To apply this framework to analyze the effects of FRA activities on maize market prices in Zambia, we need to specify the market prices ($\boldsymbol{y_t}$) and FRA policy variables ($\boldsymbol{p_t}$). We discuss each of these elements in turn.

3.2. Maize Market Prices ($\boldsymbol{y_t}$)

Since 2003, the FRA has purchased maize directly from smallholders at a pan-territorial price. Private traders also buy maize from smallholders and the FRA buy price might affect the prices paid by private traders to farmers. Thus, a logical variable to include in $\boldsymbol{y_t}$ is farmgate maize market prices in Zambia. Unfortunately, reliable, high frequency time series data on farmgate maize prices are not available. However, monthly data on into-mill

[5] See Sims (1980), Fackler (1988), and Hamilton (1994) for details on VARs in general, and Mason (2011) for technical details on the VAR estimated in this paper.

[6] The VAR in this paper is estimated under the assumption of stationarity. Unit root test results support this assumption for four of the six endogenous variables in the Zambia/FRA VAR (see Table A.1 in the Appendix). If there are indeed unit roots (and potentially cointegration), OLS estimates of the VAR parameters are consistent but not efficient (Hamilton 1994). As long as these estimates are consistent, the simulated no FRA price paths and related estimates of the effects of the FRA on market prices should be consistent.

wholesale maize prices are available for several urban centers in Zambia. In this study, we include in $\boldsymbol{y}_t$ wholesale maize market prices in Lusaka and Choma.

Lusaka is the national capital and largest city in the country, and represents a major maize consumption area in the model. Choma in Southern Province represents a major maize production area. Over the 1993/94 to 2009/10 agricultural seasons, Southern Province accounted for 21% of national smallholder maize production and 18% of smallholder maize sales. Among Zambia's nine provinces, only Eastern Province had a larger share of smallholder maize production (26%) and only Central Province had a larger share of smallholder maize sales (25%).

In addition to wholesale maize prices in Lusaka and Choma, also included in $\boldsymbol{y}_t$ are wholesale maize prices on the South African Futures Exchange (SAFEX) near Johannesburg and retail maize prices in Mchinji, Malawi, near the border with Zambia's Eastern Province. (Wholesale price data are not available for Malawi.) South Africa is the major source of formal maize imports for Zambia, accounting for 72% of such imports between 1999 and 2006 (FAOSTAT 2010). Malawi is a major source of informal maize trade with Zambia, with much of this maize crossing the Eastern Province border near Mchinji (FEWSNET 2010).

3.3. FRA Policy Variables ($\boldsymbol{p}_t$)

The variables in the $\boldsymbol{p}_t$ vector are intended to capture FRA policies that affect maize prices in Zambia. We follow Jayne, Myers, and Nyoro (2008) and define three candidate policy variables: (i) the FRA buy price premium (BPP, the FRA buy price minus the wholesale price in the major maize production area, Choma); (ii) the FRA sell price premium (SPP, the weighted average FRA sell price minus the wholesale price in the major maize consumption area, Lusaka); and (iii) net FRA maize purchases (FRA domestic purchases minus domestic sales).[7]

A positive shock to the BPP is expected to put upward pressure on maize market prices because it means that the FRA buy price has increased relative to the market price in the major production area. This is expected to attract more maize sales to the FRA marketing channel and shift the private sector supply curve to the left. A positive shock to the SPP is also expected to put upward pressure on maize market prices because it means that the FRA sell price has increased relative to the market price in the major consumption area. This would likely attract more maize purchases to the private sector channel and shift its demand curve to the right.

[7] The FRA net purchases variable was ultimately dropped from the model because sensitivity analysis shows that its inclusion has no substantive impact on the estimated effects of FRA policies on maize market prices in Zambia; the FRA buy and sell price premiums capture most of the FRA effects. Jayne, Myers, and Nyoro (2008) find the same in their Kenya/NCPB VAR analysis.

4. DATA

This paper uses monthly data from July 1996 through December 2008. The FRA first became active in the Zambian maize market in July 1996 and the most recently available data on FRA maize sales are for December 2008. (The FRA has not released sales data for January 2009 to present.) Data on FRA purchase and sales quantities and prices are from the FRA. The original sales quantity and price data, which are at the transaction level, are aggregated to the monthly level. As sale prices differ across transactions, a weighted average sell price is computed for each month, where the weights are the share of total monthly maize sales at that price.

Lusaka and Choma wholesale maize prices are from the Agriculture Market Information Center (AMIC) of the Zambia Ministry of Agriculture and Cooperatives. The Lusaka (Choma) series is missing price observations for 20.0% (20.7%) of the months during the 150-month study period. Missing values for a given wholesale maize price series were imputed using best-subset regressions on retail maize grain prices in that location as well as wholesale and retail maize prices in the other eight locations for which wholesale price data are collected by AMIC.[8] The retail maize prices used in this procedure are from the Zambia Central Statistical Office.

The SAFEX maize price data are monthly average wholesale spot prices. Monthly South African Rand-US dollar exchange rates are also from SAFEX. The Mchinji, Malawi maize price data are monthly retail prices from the Malawi Ministry of Agriculture and Food Security. Malawian Kwacha-US dollar exchange rates are from the Reserve Bank of Malawi. Zambian Kwacha-US dollar exchange rates are from the Bank of Zambia. Import tariff rates applied to the SAFEX and Mchinji prices are from the Zambia Revenue Authority.

[8] The nine locations are Kabwe, Ndola, Chipata, Mansa, Lusaka, Kasama, Solwezi, Choma, and Mongu.

5. RESULTS

Reduced form VAR estimation results are reported in Table A.2 in the Appendix. These raw results are difficult to interpret directly but are used for the *no FRA* maize market price simulations. Figures 1 and 2 show historical and simulated no FRA maize prices in Choma and Lusaka, respectively. The two sets of results are summarized in Table 3.

With the exception of 1996/97 (the FRA's first marketing year in operation), there is little difference between the levels of historical and simulated prices prior to mid-2003. From October 1996 through June 2003, mean historical prices exceed mean no FRA prices by less than 1% in both Choma and Lusaka (Table 3). The FRA began buying maize directly from smallholders throughout Zambia at a pan-territorial price in July 2003. Since then, simulated no FRA maize market prices are substantially lower than historical prices in all marketing years except 2005/06 (Figures 1 and 2).[9] Between July 2003 and December 2008, the FRA's activities are estimated to have raised mean maize market prices by 19% in Choma and 17% in Lusaka (Table 3).

Although FRA activities had little effect on mean maize market prices prior to July 2003, these activities reduced the standard deviations (SD) of Choma and Lusaka wholesale prices by 13%, resulting in 14% reductions in the coefficients of variation (CV). [10] The market price stabilizing effects of the FRA's involvement in domestic maize marketing are even greater in the July 2003 through December 2008 period; the Agency's activities are estimated to have reduced the CV of maize market prices in Choma and Lusaka by 34% and 36%, respectively. The CV reductions are due to both large increases in mean market prices and large decreases in the SD of market prices (Table 3).

Table 3. Summary of FRA Effects on Choma and Lusaka Wholesale Maize Prices

	Choma price (ZMK/kg)			Lusaka price (ZMK/kg)		
Period, statistic	Historical	Simulated	% difference	Historical	Simulated	% difference
(i) Full sample period (October 1996-December 2008):						
Mean	486	439	10.5%	559	512	9.2%
SD	271	298	-9.1%	296	326	-9.0%
CV	0.559	0.679	-17.7%	0.530	0.636	-16.7%
(ii) October 1996-June 2003:						
Mean	377	374	0.8%	435	433	0.4%
SD	272	312	-12.9%	309	356	-13.1%
CV	0.721	0.835	-13.6%	0.710	0.821	-13.5%
(iii) July 2003-December 2008:						
Mean	618	519	19.1%	711	609	16.8%
SD	204	261	-21.7%	192	256	-24.8%
CV	0.331	0.503	-34.2%	0.270	0.420	-35.6%

Notes: SD=standard deviation. CV=coefficient of variation.

[9] The 2005 smallholder maize harvest was by far the smallest of the 2003 to 2008 period, and FRA maize purchases in 2005/06 were relatively small (Table 1).

[10] CV = SD / |mean|

Figure 1. Historical and Simulated (no FRA) Choma Wholesale Maize Prices

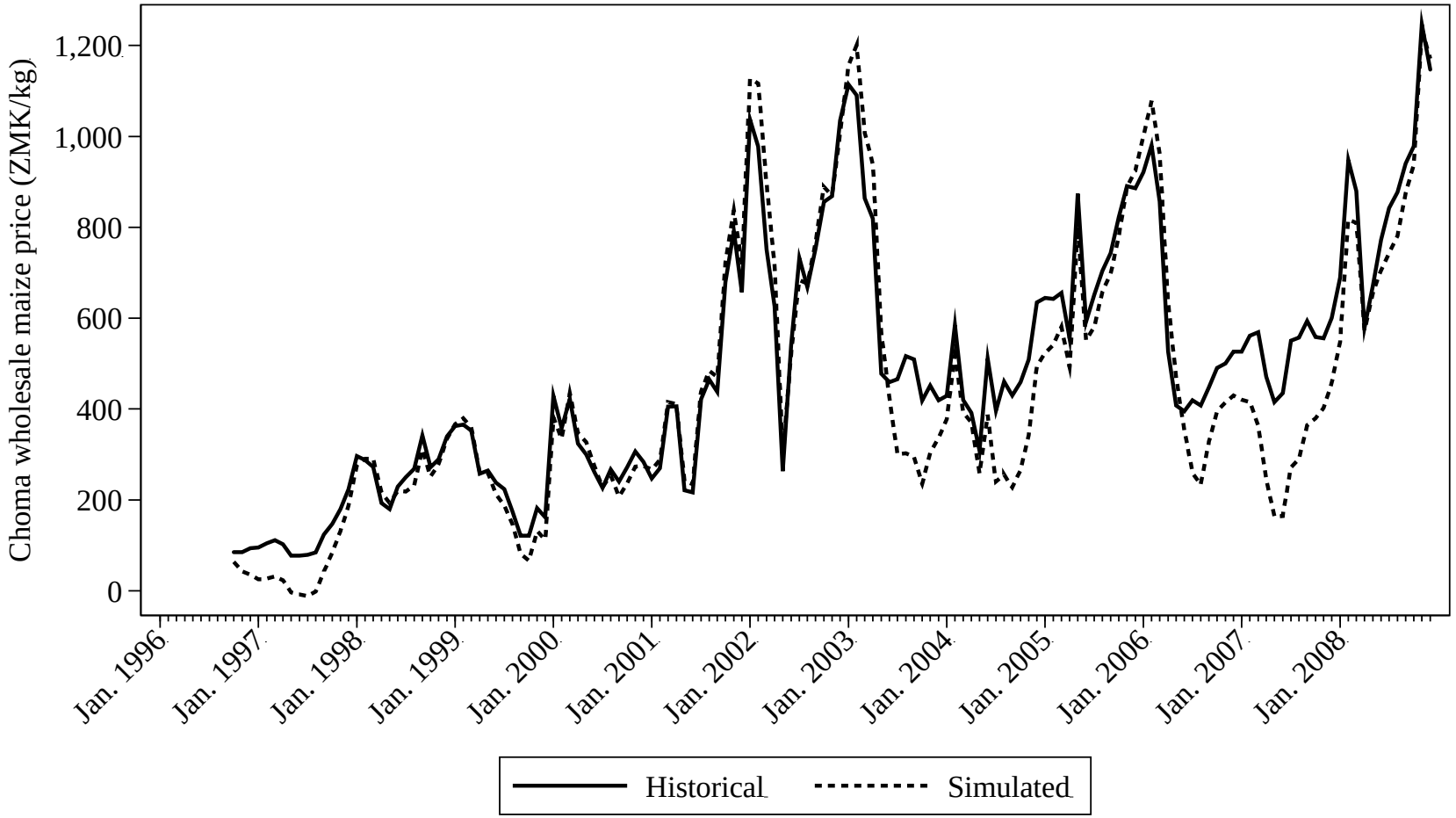
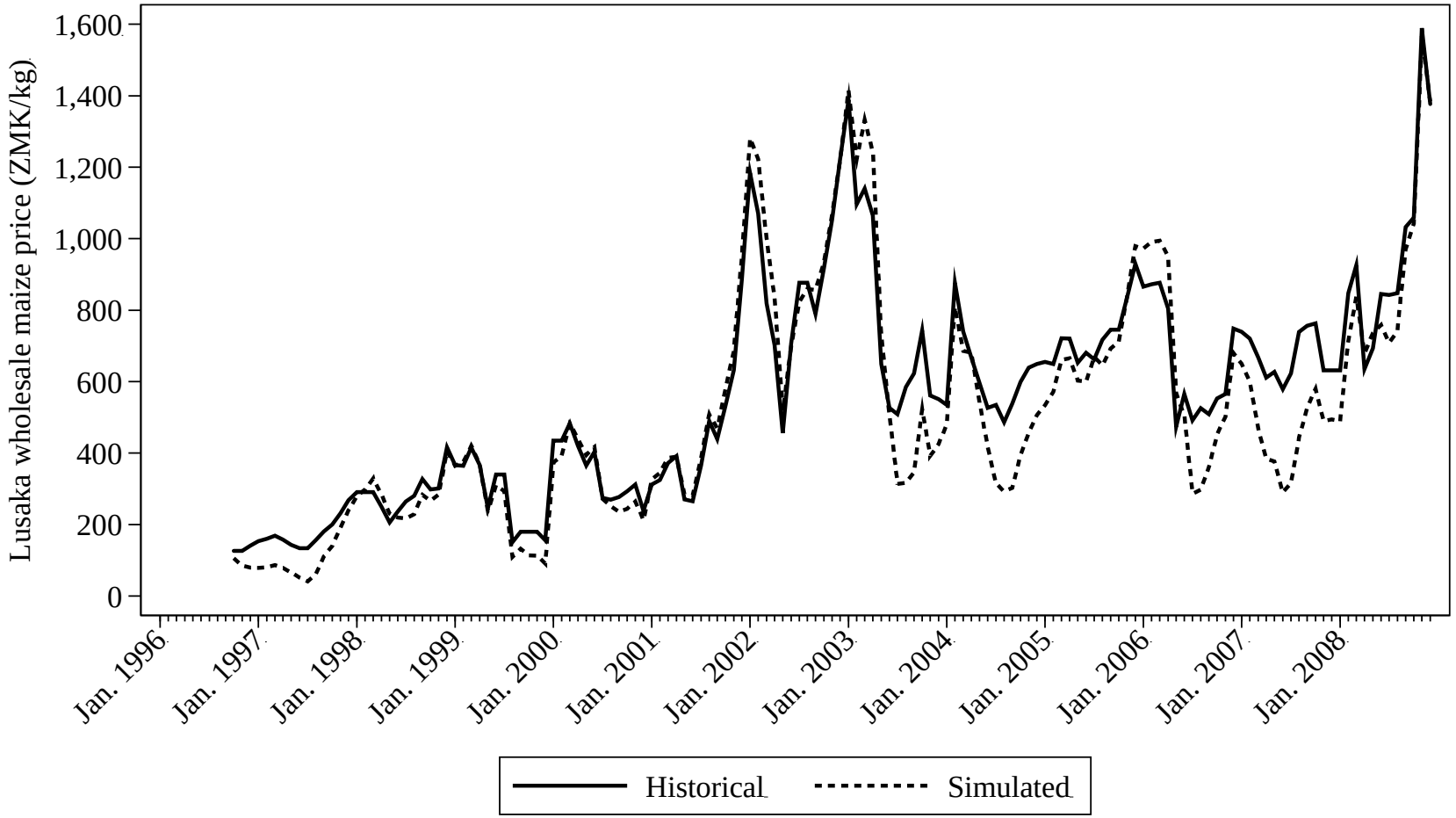


Figure 2. Historical and Simulated (no FRA) Lusaka Wholesale Maize Prices



6. CONCLUSIONS AND POLICY IMPLICATIONS

Over the last decade, governments in ESA have shown a renewed interest in using strategic reserves and/or marketing boards to influence grain market outcomes. Kenya, Malawi, Zimbabwe, Ethiopia, Tanzania, and Zambia all have one or both of these entities, and their level of involvement in grain marketing has generally increased in recent years (Jayne, Chapoto, and Govereh 2007). Yet, to date, relatively little is known about how the resurgent activities of strategic reserves and marketing boards are affecting grain market prices.

In this paper, we follow Jayne, Myers, and Nyoro (2008) and estimate a VAR using monthly data from July 1996 through December 2008 to determine the impacts of FRA's pricing policies and net maize purchases on the level and variability of maize market prices in Zambia. The Zambia maize market prices in the VAR are wholesale prices in Lusaka (representing a major maize consumption area) and in Choma (representing a major maize production area). The FRA's pricing policies are modeled as a buy price premium (the FRA buy price minus the market price in Choma) and a sell price premium (the FRA sell price minus the market price in Lusaka). The estimated VAR is used to simulate the path of market prices that would have occurred in the absence of the FRA. Two key findings emerge from the analysis.

First, consistent with the general perception in Zambia (Govereh, Jayne, and Chapoto 2008), simulation results suggest that the FRA's activities have indeed raised average market prices, particularly since the Agency began buying maize directly from smallholders throughout Zambia at a pan-territorial price in mid-2003. FRA activities are estimated to have increased mean maize market prices between July 2003 and December 2008 by 17% in Lusaka and 19% in Choma.

Second, in line with the FRA's strategic goal to stabilize market prices (FRA n.d.), wholesale maize prices were less variable between October 1996 and December 2008 than they would have been in the absence of the FRA. Simulation results suggest that the FRA's activities reduced the CV of maize market prices by 14% between October 1996 and June 2003, and by 34-36% between July 2003 and December 2008.

The findings that the FRA's involvement in maize marketing raised the level and reduced the variability of maize market prices in Zambia between July 2003 and December 2008 are similar in direction and magnitude to the findings of Jayne, Myers, and Nyoro (2008) for the effects of the NCPB on maize market prices in Kenya. Their results suggest that NCPB policies raised average maize market prices in Kenya by approximately 20% and reduced the CV of these prices by 36-45% between July 1995 and October 2004. The FRA and NCPB seek to stabilize maize market prices and are involved in maize marketing in similar ways, the main exception being that the NCPB sources maize mainly from large-scale farmers while the FRA buys mainly from smallholders. It is therefore not surprising that the agencies' activities have similar effects on maize market prices in their respective countries.

The results in this paper suggest that two of the major outcomes of the FRA's activities since mid-2003 have been an increase in the average level of and a reduction in the variability of maize market prices in Zambia. Who are the likely winners and losers? In general, higher average maize market prices are beneficial for net sellers and detrimental for net buyers of maize (Weber et al. 1988). In Kenya, for example, Mghenyi, Myers, and Jayne (2011) find that a discrete 25% maize price increase is associated with significant welfare losses in areas where most households are net buyers (2011). In Zambia, nationally-representative household survey data collected by the government Central Statistical Office (CSO) and

Ministry of Agriculture and Cooperatives (MACO) indicate that only approximately 28% of smallholder farm households sell more maize than they buy; the remaining 72% either buy more maize than they sell (49%) or neither buy nor sell maize (23%) (2008 CSO/MACO/ FSRP Supplemental Survey). Thus higher maize prices hurt urban consumers and the nearly 50% of smallholders that are net buyers of maize. Large-scale farmers and the 28% of smallholders that are net-maize sellers benefit from higher average maize prices. (The 23% of smallholders that neither buy nor sell maize are not directly affected by higher maize market prices.)

Among smallholder net-maize sellers, gains from higher maize market prices would be highly concentrated in the hands of the 3% to 5% of maize-growing smallholders that account for 50% of all smallholder marketed maize (Kuteya et al. 2011). This group tends to have more land and non-land assets than other smallholders do. Therefore, to the extent that they raise average maize market prices in Zambia, the FRA's policies are regressive: higher maize prices harm urban consumers and a large proportion of rural households, and help large-scale farmers and a small number of relatively better off smallholders.

There may be additional welfare impacts associated with the market price stabilizing effects of FRA policies. However, the welfare effects of FRA-induced increases in the average *level* of maize market prices are likely to dwarf any welfare effects that result from price *stabilization* (Newbery and Stiglitz 1981). Furthermore, just as in the case of higher mean maize prices, relatively better off producers are likely to be the principal beneficiaries of more stable maize prices (Naylor and Falcon 2010). For example, simulations in Myers (2006) suggest that a large reduction in food price variability (i.e., from a CV of 0.3 to 0) results in a welfare increase equivalent to nearly 9% of income among affluent producers. The same degree of price stabilization results in the equivalent of income increases of only 2.7% and 1.4% among poor producers and poor consumers, respectively.

Similarly, empirical evidence from rural Ethiopia indicates that the benefits from food price stabilization are concentrated in the hands of the wealthiest 40% of households (Bellemare, Barrett, and Just 2011). Moreover, Bellemare, Barrett, and Just find that many poor rural households are actually hurt by more stable food prices.

If similar results hold in Zambia, it would indicate that both the mean maize price raising and the price stabilizing effects of FRA policies are regressive: they disproportionately benefit relatively better off households and have negative net effects on relatively poor households.

APPENDICES

Table A.1. Unit Root Test Results

Test and hypotheses	Choma price	Lusaka price	SAFEX price	Mchinji price	BPP	SPP
KPSS (H_1: Unit root)						
(1a) H_0: Trend stationary	0.186	0.233	0.110	0.242	0.147	0.085
	(<0.05)	(<0.01)	(>0.10)	(<0.01)	(<0.05)	(>0.10)
(1b) H_0: Level stationary	2.21	2.34	2.99	0.856	0.582	0.116
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.025)	(>0.10)
ADF (H_0: Unit root)						
(1c) H_1: Trend stationary	-3.382	-3.477	-2.972	-2.060	-4.033	-4.123
	(0.054)	(0.042)	(0.140)	(0.569)	(0.008)	(0.006)
(1d) H_1: Level stationary	-2.040	-1.974	-1.626	-1.615	-3.833	-4.112
	(0.269)	(0.298)	(0.470)	(0.476)	(0.003)	(0.001)
PP (H_0: Unit root)						
(1e) H_1: Trend stationary	-3.569	-3.377	-2.728	-2.218	-4.167	-3.913
	(0.033)	(0.055)	(0.225)	(0.480)	(0.005)	(0.012)
(1f) H_1: Level stationary	-2.069	-1.798	-1.500	-1.737	-3.987	-3.901
	(0.257)	(0.381)	(0.534)	(0.412)	(0.002)	(0.002)

Notes: Approximate p-values in parentheses. Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) statistics computed using automatic bandwidth selection and autocovariance function weighted by quadratic spectral kernel. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) values are $Z(t)$ statistics. The number of lags used for the KPSS, ADF, and PP tests were three, one, and four, respectively.

Table A.2. VAR Estimation Results

	Equation					
Coefficient	Choma price	Lusaka price	SAFEX price	Mchinji price	BPP	SPP
Choma (t-1)	0.757***	0.431***	-0.034	0.670***	-0.164	-0.379**
	(4.976)	(3.069)	(-0.384)	(3.013)	(-1.340)	(-2.026)
Choma (t-2)	0.111	0.184	0.023	-0.218	0.070	-0.330
	(0.674)	(1.213)	(0.237)	(-0.910)	(0.529)	(-1.633)
Choma (t-3)	0.296**	0.132	0.063	-0.171	-0.074	-0.013
	(2.024)	(0.979)	(0.728)	(-0.799)	(-0.631)	(-0.071)
Lusaka (t-1)	0.179	0.548***	0.047	0.207	-0.027	0.241
	(1.468)	(4.859)	(0.654)	(1.160)	(-0.277)	(1.600)
Lusaka (t-2)	-0.253*	-0.250*	0.018	-0.381*	0.089	0.566***
	(-1.654)	(-1.773)	(0.196)	(-1.705)	(0.724)	(3.012)
Lusaka (t-3)	-0.303**	-0.273**	-0.059	-0.161	0.155	0.042
	(-2.298)	(-2.242)	(-0.767)	(-0.834)	(1.459)	(0.260)
SAFEX (t-1)	-0.127	0.002	1.072***	-0.041	0.116	-0.124
	(-0.893)	(0.016)	(12.843)	(-0.195)	(1.015)	(-0.707)
SAFEX (t-2)	0.408*	0.182	-0.165	-0.047	-0.269	-0.147
	(1.942)	(0.938)	(-1.339)	(-0.154)	(-1.592)	(-0.568)
SAFEX (t-3)	-0.183	-0.038	-0.004	0.150	0.202*	0.184
	(-1.278)	(-0.287)	(-0.043)	(0.717)	(1.749)	(1.045)
Mchinji (t-1)	0.239***	0.204***	0.043	0.729***	-0.030	-0.171**
	(3.885)	(3.596)	(1.197)	(8.119)	(-0.603)	(-2.262)
Mchinji (t-2)	-0.273***	-0.302***	-0.008	0.045	0.070	0.266***
	(-3.772)	(-4.524)	(-0.188)	(0.426)	(1.194)	(2.992)
Mchinji (t-3)	0.125**	0.241***	-0.018	0.164*	-0.119**	-0.204***
	(2.104)	(4.403)	(-0.508)	(1.890)	(-2.483)	(-2.790)
BPP (t-1)	0.144	0.029	0.094	0.330	0.616***	-0.077
	(0.970)	(0.210)	(1.081)	(1.522)	(5.148)	(-0.422)
BPP (t-2)	-0.010	0.282	0.055	0.126	0.150	-0.117
	(-0.053)	(1.642)	(0.506)	(0.462)	(1.002)	(-0.509)
BPP (t-3)	0.011	-0.167	0.024	-0.308	-0.104	0.046
	(0.077)	(-1.211)	(0.278)	(-1.407)	(-0.866)	(0.249)
SPP (t-1)	0.077	0.061	0.036	-0.120	-0.071	0.779***
	(0.936)	(0.796)	(0.732)	(-0.999)	(-1.061)	(7.672)
SPP (t-2)	0.047	0.076	0.034	-0.001	-0.028	-0.048
	(0.447)	(0.781)	(0.551)	(-0.006)	(-0.332)	(-0.372)
SPP (t-3)	-0.091	-0.075	-0.056	0.058	0.071	0.039
	(-1.114)	(-0.997)	(-1.169)	(0.485)	(1.084)	(0.384)
Constant	6.794	-4.777	8.456	55.360*	8.877	20.575
	(0.315)	(-0.240)	(0.667)	(1.756)	(0.511)	(0.776)
R-squared	0.876	0.9113	0.964	0.8943	0.6951	0.7626

Notes: Numbers in parentheses under the coefficient estimates are associated z-statistics.
*** p<0.01, ** p<0.05, * p<0.10. T=147. Three lags of each endogenous variable are included in the VAR because three is the minimum number of lags required to eliminate autocorrelation in the VAR residuals. Ljung-Box Q autocorrelation test results are reported in Appendix Table A.3.

Table A.3. Autocorrelation Test Results for Reduced Form VAR Residuals

	Equation					
Test	Choma price	Lusaka price	SAFEX price	Mchinji price	BPP	SPP
AR(1)	0.036	0.455	0.005	0.1224	0.208	0.122
	(0.849)	(0.500)	(0.942)	(0.726)	(0.648)	(0.727)
AR(6)	0.912	3.314	3.501	4.371	1.503	7.784
	(0.989)	(0.769)	(0.744)	(0.627)	(0.959)	(0.254)
AR(12)	12.439	14.925	7.295	11.770	9.917	14.138
	(0.411)	(0.246)	(0.838)	(0.464)	(0.623)	(0.292)

Note: Values in the AR(j) rows are Ljung-Box Q statistics for jth order autocorrelation in the residuals of the series. Numbers in parentheses under the statistics are associated p-values.
*** p<0.01, ** p<0.05, * p<0.10.

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