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Regional trade, government policy and food security: Recent evidence from Zambia

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ABSTRACT

Given heavy dependence on rainfed maize production, countries in East and Southern Africa must routinely cope with pronounced production and consumption volatility in their primary food staple. Typical policy responses include increased food aid flows, government commercial imports and stock releases, and tight controls on private sector trade. This paper examines recent evidence from Zambia, using a simple economic model to assess the likely impact of maize production shocks on the domestic maize price and on staple food consumption under alternative policy regimes. In addition to an array of public policy instruments, the analysis evaluates the impact of two key private sector responses in moderating food consumption volatility – private cross-border maize trade and consumer substitution of an alternate food staple (cassava) for maize. The analysis suggests that, given a favorable policy environment, private imports and increased cassava consumption together could fill roughly two-thirds of the maize consumption shortfall facing vulnerable households during drought years.

Introduction

Maize, Africa's number one food staple, provides over half of all calories consumed in Zambia. Yet dependence on rainfed maize production leads to highly volatile output from 1 year to the next, in Zambia as in many parts of Sub-Saharan Africa (Fig. 1). Given erratic rainfall, and less than 5% of cropped land under irrigation, Zambia's maize crop fails to satisfy national market demand, on average, in 1 year out of 3. In years of poor harvests, when drought, reduced planting area, or input supply bottlenecks constrict output, Zambia has imported maize. In good harvest years, Zambia produces a maize surplus, enabling the country to export maize. Given this pronounced production volatility, trade becomes a valuable tool for stabilizing national food supplies and prices.

Yet, as in much of Africa, government mistrusts traders. Policy makers fear a loss of government control over maize supplies and the politically sensitive maize price. They fear that collusion by traders may lead to market manipulation and profiteering that could, in turn, lead to politically damaging food shortages and price spikes. As a result, in recent years, Zambia's default policy has been to restrict private sector cross-border maize flows. Following the deficit harvest of 2005, the Zambian government restricted maize *imports*. And following successive good harvests, in 2006 and 2007, the government tightly controlled *exports*.

The mistrust is mutual. In part, traders have difficulty anticipating what government will actually do. During the first half of 2007, the Zambian government position on maize exports changed three times (Zinyama, 2007; Chalu, 2007; Times, 2007a; Malan, 2007; ZNFU, 2007). And in the all too common deficit years, private traders are reluctant to bring in commercial grain, which they would then be able to sell only at a loss if the government gives in to the political pressure to subsidize public sector maize imports. Zambian traders remember the risks they incurred under these conditions in both 2000/2001 and 2005/2006 (Nijhoff et al., 2003; Mwanaumo et al., 2005). Uncertainty about government intentions, coupled with the fear of being undercut by subsidized public sales, induces private grain traders to remain on the sidelines or to limit their exposure by bringing in only small lots. In response, governments complain that they cannot rely on the private sector to import adequate quantities of food in times of need. Where private traders and African governments fail to solve staple food supply problem themselves, food aid donors stand ready to fill the gap.

In Zambia, as in much of southern Africa, three sets of actors, with three sets of tools, stand willing to help buffer maize shortfalls and surpluses. Private traders lobby actively for unrestrained cross-border trade as a means of moderating domestic surpluses and deficits. Governments, however, often prefer direct public import or export by parastatal food agencies such as Zambia's Food Reserve Agency or Malawi's National Food Reserve Agency. Food aid agencies, together with governments, estimate potential supply gaps that need to be filled by public or food aid imports. In

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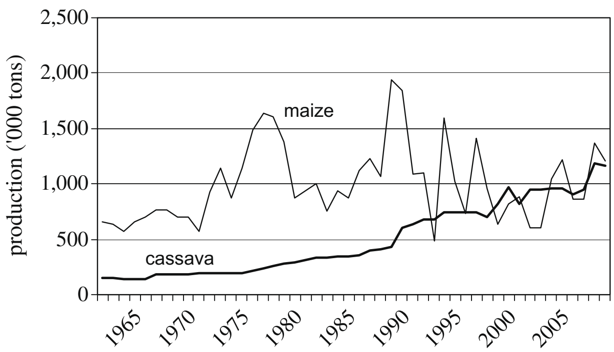

Fig. 1. Production trends in food staples in Zambia. Source: FAOSTAT and Zambia Ministry of Agriculture and Cooperatives.

surplus years, governments favor local procurement by public grain marketing agencies as a means of supporting farm prices. Simultaneously, some donors conduct local procurement for export to neighboring deficit countries or refugee camps. The food aid agencies likewise closely monitor within-country variations in food availability, prices and income and stand willing to provide targeted food or income support to vulnerable groups. All three groups – the private traders, governments and food aid agencies – respond in related ways to the pressures and opportunities created by intermittent maize supply shocks.

Where these three actors cooperate, their actions can prove complementary. However, where they misjudge or mistrust each other, one or another may over-react, potentially aggravating both price volatility and swings in food availability. During the drought of 2002/2003, for example, the Malawian government failed to anticipate the roughly 200,000 tons of private sector maize imports from northern Mozambique, attracted by high maize prices in drought-stricken Malawi. This miscalculation led to excessive public imports, subsequent sales to unload surplus public stocks, government financial losses, and depressed maize prices both during the lean season and early in the following harvest season (Tschirley et al., 2004; Whiteside, 2003). In addition to dampening incentives for Malawian farmers, this overshooting on public and food aid imports discouraged seasonal private sector storage and reduced incentives for Mozambican farmers to produce for the Malawian market in future years. Clearly, each set of actors needs to anticipate accurately the actions of the others.

This paper aims to help facilitate dialogue among these three groups by presenting a simple economic model developed to enable government, the private sector and food aid agencies quickly assess the likely impact of production shocks on domestic maize prices, incentives for private sector import, national food availability and consumption of vulnerable groups. The model aims to predict the potential responsiveness and impact of private trade as well as the likely consequences of food aid, public procurement and other common policy interventions. Section 2 of this paper sets the stage by describing the staple food economy of Zambia. Section 3 then presents the analytical framework used to examine the impact of year-to-year production fluctuations as well as the consequences of potential private and public sector responses. Sections 4 and 5 illustrate how public policy makers, food aid donors and the private sector can apply this framework to assess the effectiveness of various private and public responses during both a drought year (Section 4) and a bumper harvest year (Section 5). Section 5 likewise describes a specific application of the model where the authors used this model to estimate the likely impact of alternate export quotas during stakeholder discussions of Zambia's 2006 maize export controls. Section 6 presents a sensitivity analysis of the results, while Section 7 concludes by summarizing key policy and operational implications.

The Zambian food economy

Production of staple foods

Maize, Zambia's principle food staple, accounts for 60% of national calorie consumption and serves as the dietary mainstay in central, southern and eastern Zambia. Because rainfed smallholder farms accounts for over two-thirds of national maize production, under erratic rainfall conditions, maize output has proven highly volatile over time (Fig. 1). Following the withdrawal of maize marketing and input subsidies, beginning in the early 1990s, maize production in Zambia trended gradually downward over the ensuing decade and a half, though amid wide weather-induced variation (Zulu et al., 2000). The abandonment of large-scale government procurement and pan-territorial pricing likewise reduced price incentives for maize cultivation, particularly in more remote areas. Consequently farmers reduced the area devoted to maize production and diversified into other food staples and export crops such as cotton, tobacco and paprika (Jayne et al., 2007). In 2006 and 2007, maize production recovered somewhat as a result of favorable rains, the resumption of fertilizer subsidies and large-scale government maize procurement through the newly reconstituted Food Reserve Agency (Fig. 1).

Cassava, the nation's second largest source of calories, accounts for roughly 15% of national calorie consumption. Production has grown rapidly since the early 1990s (Fig. 1), when government breeders released their first wave of highly productive new cassava varieties. Cassava serves as the principle staple in northern Zambia and is widely grown in western Zambia, where the Lozi people consume a diversified diet of rice, cassava, sorghum and maize. Production of sweet potatoes, though not well captured in national food balance sheets, has likewise grown rapidly over the past decade, following the release of several new cultivars by Zambia's Root and Tuber Improvement Programme. Sorghum and millet, widely grown minor crops, supplement diets in southern, western, northern and central Zambia. While Zambia's predominantly rainfed maize crop proves highly susceptible to drought, diversification into alternate staples such as cassava, sweet potatoes, sorghum and millet has moderated this volatility by expanding the country's portfolio of drought-resistant alternate foods.

Prices

Because of variability in rainfall and government maize policy, both maize production and prices have varied substantially, with the domestic wholesale price ranging between $100 and $350 per ton (Fig. 2). In drought years – such as 1992, 1995, 1998, 2001, 2002 and 2005 – as maize production has fallen, domestic price has risen sharply, up to and sometimes surpassing import parity, leading to strong incentives for private commercial maize imports during years of domestic production shortfall (Fig. 2). Zambia's maize imports come primarily from South Africa, though in some seasons the country has imported maize from southern Tanzania, northern Mozambique and even as far away as Uganda.

Domestic food policies

Zambia's governments have intervened heavily in maize markets since at least the 1930s. Before independence in 1964, maize pricing policies favored commercial white farmers, who received 75% of the Maize Control Board's internal purchasing quota and re-

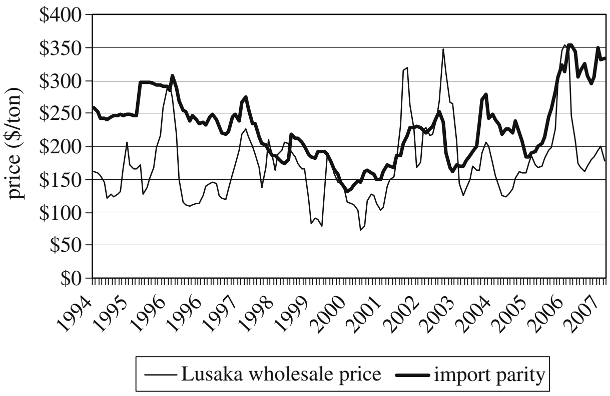

Fig. 2. Trends in import parity and domestic white maize prices. Nominal dollar prices converted from kwacha and rands at the mid-month exchange rate. Source: Agricultural Marketing Information Centre (AMIC), CHC Commodities monthly reports, South African Commodity Exchange (SAFEX).

ceived a 40% premium over the price paid to African farmers (Wood et al., 1990). But since independence, policies have favored smallholders, initially through pan-territorial pricing, expansion of government purchase to remote areas and input subsidies targeted to smallholder farmers (Govereh et al., 2008). While government-supported cooperatives and lending institutions supplied subsidized inputs of fertilizer and seeds to smallholder farmers, government's agricultural marketing parastatal, the National Agricultural Marketing Board (NAMBOARD), provided a guaranteed market, purchasing maize at a fixed pan-territorial price. At the same time, they subsidized urban consumers by controlling the price of maize meal. Through the NAMBOARD monopoly and strict foreign exchange regulations, government controlled maize imports and exports as well as the price and volumes traded on the domestic market. Gradual government control of the milling industry culminated in the nationalization of all large mills, in 1986, in order to directly control urban maize meal prices (Beveridge, 1974; Ojermark and Chabala, 1994). At their peak, in 1986, consumer and producer maize subsidies accounted for 17% of total government spending (Howard and Mungoma, 1996).

Ultimately, these heavy subsidies proved unsustainable, as copper prices plummeted and large losses in other parastatals paralyzed government finances, forcing a broad liberalization of economic policy in the late 1980s (Hill and McPherson, 2004). But liberalization of Zambia's maize markets has occurred more slowly than in other sectors of the economy. Early efforts to reduce urban maize subsidies, in 1986 and 1990, led to riots in the Copperbelt and Lusaka. As a result, Zambian political leaders remain acutely aware of the political sensitivity of maize policy. This has led to a hesitation waltz of partial reforms, periodic backtracking and intermittent inconsistencies between stated policy and actual implementation (see Mwanaumo, 1994, 1999; Howard and Mungoma, 1996; Jayne et al, 1999; Nijhoff et al., 2002, 2003 and Govereh et al., 2008). After campaigning on a platform of maize market reform, the newly installed Chiluba government began its reform efforts in 1991 by dismantling NAMBOARD and issuing licenses to private maize traders. But the halving of national maize production during the drought of 1992 led to immediate pressures to resume heavy government involvement in both import and domestic marketing. Not until the 1994/1995 production season did government refrain from announcing maize prices (Howard and Mungoma, 1996). After having dismantled the NAMBOARD in 1991, government established a new Food Reserve Agency (FRA) in 1995 to maintain security stocks. FRA purchases remained nominal until the early 2000s when they ranged between 50,000 and 75,000 tons per year. In 2006, a presidential election year, the FRA purchased roughly 400,000 tons of maize, controlling the majority of traded maize and becoming overwhelmingly the largest trader in market.

Trade policy

Even after liberalization of domestic trade, Zambia's government has continued to play an active role in influencing the level of maize imports and exports. Government has, at various times, imported directly, influenced the levels of food aid imports and issued publicly financed tenders for private import, in many cases for sale to privatized mills at subsidized prices. This public involvement has resulted in significant quantities of maize imports during the 1990s and 2000s, even during times when the spread between domestic and import parity prices would not have made purely commercial imports viable (see Table 1 and Fig. 2).

This active government involvement, coupled with unpredictable policy positions, has tended to discourage commercial cross-border maize trade. In response to the 2001/2002 drought, the Zambian government announced its intention to tender for the import of 200,000 tons of maize and to sell that grain at subsidized prices through selected large millers. Due to delayed financing for these government-sponsored imports, however, actual shipments did not begin until December, and by May 2002 only 130,000 tons had arrived. Under the government subsidy, sixteen designated millers sold the imported grain at $70–$100 below-market price. As a result, private traders declined to import maize at commercial prices for fear of losing money (Nijhoff et al., 2002, 2003).

In recent years, Zambia's policies have similarly restricted external trade flows. In calendar year 2005, a year of below-normal maize harvest, government initially refused to authorize maize imports Following heavy lobbying by millers and traders, the Ministry of Agriculture and Cooperatives (MACO) issued import permits for 200,000 tons of maize, 150,000 to the private sector and 50,000 through the government FRA. Government suspension of early shipments, under new GMO certification procedures, and confusion over maize import duties (which government initially increased and subsequently suspended temporarily), produced considerable uncertainty among potential private importers. Subsidized sales of FRA maize stocks to millers, late in the year at $60–$80 below import parity, introduced considerable risks for private traders as well as disincentives for millers looking to import maize. The resulting confusion and disincentives limited actual imports to less than half the allocated quota and delayed them until very late in the marketing season when import prices had risen by over $90 per ton (Mwanaumo et al., 2005).

The following season, in 2006, Zambian farmers produced a bumper maize crop. Even so, the government regulations restricting cross-border maize flows remained in effect, preventing maize exports. As domestic maize prices fell, traders and farmers lobbied for permission to export while, in the midst of a presidential election campaign, the government's FRA purchased over 400,000 tons of maize (Fynn, 2007). Ultimately, the government authorized export of 200,000 tons through the FRA.

In the 2007 harvest season, early flooding led to concerns about potential crop shortages. But as the season unfolded, the damage proved highly localized, and Zambia produced a bumper harvest of 1.4 million metric tons of maize. Early government statements suggesting they would allow maize and maize meal exports (Zinyama, 2007) gave way to a series of abrupt changes – reimposition of an export ban in mid-March (Times, 2007a, 2007b), a temporary lifting of the export restrictions in late March, along with a

Table 1
Historical maize production and price movements in Zambia.

Year[a]	Harvest category	Production (tons)	Price[b] ($/ton)	Maize imports: Nonaid	Maize imports: Food aid	Maize imports: Total	Maize exports
Annual data							
1990	Good	1,092,671	a.d.	100,000	13,388	113,388	14,119
1991	Good	1,095,908	a.d.	42,000	338,360	380,360	300
1992	Bad	483,492	a.d.	172,990	507,010	680,000	115
1993	Excellent	1,597,767	a.d.	312,640	3,360	316,000	7,032
1994	Good	1,020,749	$150	10,061	3,400	13,461	1,100
1995	Moderate	737,835	$208	41,406	60,815	102,221	2,950
1996	Excellent	1,409,485	$127	36,794	3,206	40,000	140
1997	Moderate	960,188	$173	50,073	2,324	52,397	6,975
1998	Bad	638,134	$183	380,237	34,763	415,000	100
1999	Moderate	822,056	$135	14,410	18,026	32,436	8,277
2000	Moderate	881,555	$116	3,741	1,740	5,481	14,189
2001	Bad	601,606	$192	10,334	57,412	67,746	11,726
2002	Bad	602,000	$244	195,526	73,575	269,101	4,885
2003	Good	1,161,000	$169	115,955	44,999	160,954	629
2004	Good	1,113,916	$150	6,223	20,000	26,223	103,245
2005	Moderate	866,187	$236	50,000	70,000	120,000	10,000
Averages values by category of harvest year, 1994–2005							
	Excellent	1,409,485	$127	174,717	3,283	178,000	3,586
	Good	1,098,555	$156	115,364	84,021	199,385	25,065
	Moderate	853,564	$174	31,926	30,581	62,507	8,478
	Bad	613,913	$206	189,772	168,190	357,962	4,207
Baseline values used in the simulation model							
	Good to moderate	945,436	$167	73,645	27,663	130,946	18,421

Source: Ministry of Agriculture and Cooperatives (MACO), Agricultural Marketing Information Center (AMIC), and FAOSTAT.
[a] These calendar years indicate the year in which the maize harvest took place. Under Zambia's single rainy season, the maize harvest occurs primarily in April and May. The calendar year 1990, therefore, corresponds to the cropping year 1989/1990.
[b] Lusaka into-mill wholesale price for the marketing year, May–April. a.d. = administratively determined price fixed by government.

statement reiterating government's commitment to maintain the export ban (Malan, 2007), and finally, in June of 2007, the issuance of export permits for 200,000 tons of maize, 50,000 through the FRA and 50,000 each through farmers, millers and traders (ZNFU, 2007; Times, 2007c).

Given the unpredictability of government behavior and the constant risk of subsidized public maize sales, many private traders and millers have proven reluctant to engage in commercial cross-border maize trade. In fact, several large players have exited the industry. Since the early 1990s, after maize market liberalization began, six international grain trading companies initiated maize trading operations in Zambia. But four of the six subsequently shut down their Zambian operations because of the unpredictability of government actions and the consequently high risk of commercial losses (Nijhoff et al., 2003).

Food aid

Potential food aid flows likewise affect trader incentives, food supply, prices and ultimately consumption. Each season, government and food aid agencies jointly assess potential needs for emergency food relief. These assessments typically compute a simple supply gap between domestic supply and a target consumption level that takes little account of price adjustments by traders or consumers. Without a simple method for assessing potential volumes of private sector imports or consumer shifts into alternative foods, these estimates normally overstate food aid requirements. In the short run, this can result in excessive food aid imports and high financial costs. In the medium term, outsized public food imports discourage private traders and dampen incentives for farm production as well as private sector storage and trade.

Food aid agencies recognize that they would benefit from a simple tool for assessing the likely impact of weather-induced supply shocks on maize production, prices, consumption and trade flows. In response to a specific request from one major food aid donor, we have developed the following simple model.

Analytical framework

This paper presents a simple, two-commodity economic model developed to quantify the impact of production shocks on domestic food prices. In turn, the model assesses the impact of these changing prices on consumer, farmer and trader behavior and on the food consumption of vulnerable groups. As an aid to policy makers and traders, the model likewise evaluates prospects for using trade policy, food aid or various government policy interventions to insulate consumers from production-induced shocks in staple food consumption.

Based on our interactions with the Zambian government, private sector and food aid agencies, we considered two sets of criteria in formulating this analytical framework. To be meaningful, the framework needs to estimate the price consequences of a production shock as well as key price responses by consumers, traders and farmers. To be feasible, the framework must be simple to use, easy to understand and, once baseline data are assembled, parsimonious in data inputs required.

The simple model proposed here differs from standard methods used in government food aid needs assessments primarily through its explicit modeling of market prices for key staple foods (maize and cassava) and the resulting impact of price changes on farm household income, food consumption by various household groups, staple food imports and exports, and next season's production. To anticipate these multiple outcomes, the framework incorporates price responses by three key groups: poor consumers, who reduce maize consumption and increase consumption of alternate staples as maize price rises; traders and millers, who import and export in response to differentials between domestic and border prices; and farmers, who alter planting decisions in response to changing prices.[1]

[1] Given the highly elastic supply of cassava, its price remains unchanged in this simple model. Therefore, consumer responses to changes in the cassava price become moot.

Policy instruments

As exogenous variables, the model includes a range of potential instruments wielded by government and donors. These include trade quotas, tariffs, public imports, government exports, local procurement, government stockholding and sales, and targeted income transfers to vulnerable groups.

Model structure

At its core, the model estimates how much the domestic maize price will change following an exogenous shock – a drought, flood or pest infestation affecting farm production; a change in world prices; public food imports; food aid; or an array of government policy changes. Fig. 3 illustrates by depicting the impact of a major supply shock, most frequently a drought, which causes production to decrease from S_0 to S_1. Changes in maize output (which falls from Q_0 to Q_1) and maize price (which increases from P_0 to P_1), in turn, affect the income of maize-producing households as well as consumption decisions of all household groups. With even a rudimentary knowledge of the price elasticity of demand (depicted in Fig. 3 as the slope of the demand curve, D), the model is able to estimate approximate orders of magnitude for the resulting shift in market price, by tracing out movement along the aggregate demand curve (D) for maize.

When the domestic maize price (P_0) lies between import parity (P_m) and export parity (P_x), no trade takes place and the domestic price (P_0) prevails. But when a drought or other supply shock causes the domestic maize price to rise, import parity (P_m) sets an upper limit on the price increase. In the absence of trade, the domestic maize price would spike to P_1 during a drought. But when governments allows imports, private traders import grain (an amount $M_1 = Q_2 - Q_1$) at the import parity price (P_m), capping the domestic price increase at import parity. Conversely, in years of bumper maize harvest, when domestic prices plunge, the export parity price (P_x) sets a floor price below which the domestic price will not fall. Only when government policy limits imports or exports does domestic price move outside these import and export parity bands. The import and export flows modeled in this paper include both formal and informal trade.

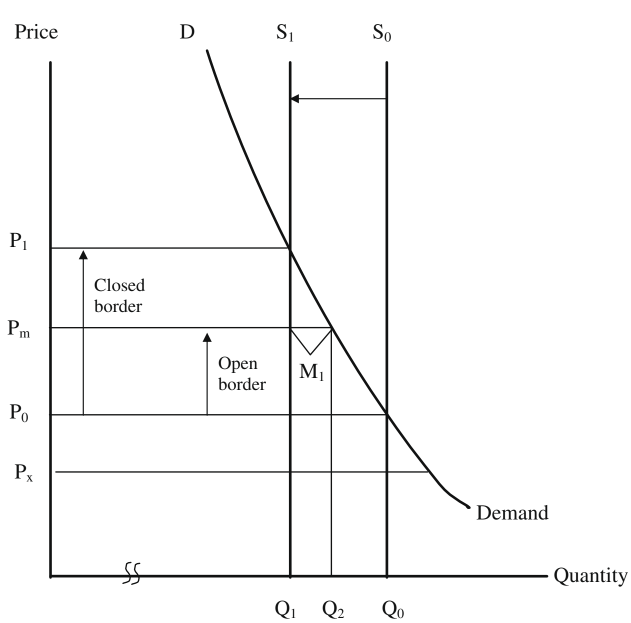

Fig. 3. Effects of private imports in moderating a production shortfall.

To capture key consumption responses to a price shock, the model includes Zambia's two principal food staples, maize and cassava. In the event of a drought, the maize price rises and consumers reduce their consumption of maize. At the same time, they reorient consumption towards more readily available, typically more drought-tolerant staple foods such as cassava, sweet potatoes, millet and sorghum.

For simplicity, the model illustrates this substitution effect by including a single alternate food, Zambia's number two food staple, cassava. In addition to its scale, cassava offers another important property – a perfectly elastic supply in the short run. Farmer's plant cassava in one season and can harvest the starchy roots any time from eighteen months to 3 years after planting. The energy reserves in the roots enable the cassava plant to survive severe drought and to store food *in situ* in farmer fields for up to 3 years. Under the common 3-year cassava cropping cycle, farmers harvest roughly one-third of their cassava plots over the course of a normal year. In the event of a precipitous fall in maize availability, farmers can simply harvest more cassava than they would have otherwise and free up maize for sale or for consumption by others. For this reason, consumption of both maize and cassava respond to changes in the maize price. In our policy work, we have experimented with varying levels of household aggregation. In the simplest version of the model, we consider only a single "poor" household group. The present exposition, however, considers responses by ten different household groups (Table 2). It partitions households geographically, splitting the heavy cassava-consuming regions of the northern and western Zambia from the primarily maize-consuming regions of central, southern and eastern Zambia. As shorthand labels, we refer to the cassava-consuming zones as northern Zambia and the maize-consuming zones as southern Zambia. Within each geographic region, the model distinguishes urban from rural households, maize producers from non-producer households, and three groups of vulnerable households: poor farm households, rural nonfarm households and the urban poor.

Consumption substitution among food staples occurs principally among rural households in the north, where people consume slightly more cassava than maize, when converted to calorie-based cereal-equivalents. Given lower cassava consumption in urban areas, northern households overall consume an average of 74 kg of maize per capita each year along with 54 kg of dried cassava equivalents (Table 2). Although cassava consumption remains low in southern Zambia, fresh and toasted cassava is growing in popularity as a snack food there, stimulating a growing cassava trade in the south (Haggblade and Nyembe, 2008). Aggregate cassava consumption, nonetheless, remains low in the south, where maize remains the preferred food. Because northern households consume both staple foods; and because they account for over 40% of national maize consumption, slight changes in consumption patterns there can release significant quantities of maize for consumption in the south.

Annex 1 describes the model formally, while Tables 2 and 3 detail the baseline data and model parameters. Annex 2 describes how we have estimated the model parameters by using available secondary data combined with our own estimates of demand parameters for each household group using the 1998 Living Conditions Monitoring Survey, the most recent national household consumption survey available to us from Zambia's Central Statistical Office (CSO). Given the importance of the price elasticities in determining the simulation results, we have conducted sensitivity analysis under a range of plausible parameter values. Note that for the simulations below, we use an elasticity of supply of zero for maize in order to analyze the short-term policy response options for the period between the time of the current year maize harvest and the start of the next season's maize harvest. Medium-term analysis

Table 2
Household baseline data.

Household groups	Population		Income per capita	Maize consumption			Cassava consumption			Production share	
	Thousands	Share (%)		kg/capita	000 tons	National share (%)	kg/capita[a] (dry)	000 tons (fresh)	National share (%)	Maize (%)	Cassava (%)
Northern Zambia[a]											
Commercial farms	899,213	8	$1,395	135	122	14	105	315	33	14	36
Poor farms	2,323,917	21	$337	43	99	11	62	482	51	15	59
Rural nonfarm	352,127	3	$337	43	15	2	62	73	8	0	0
Middle and rich urban	893,125	8	$2,287	114	102	11	8	23	2	2	2
Urban poor	595,417	5	$520	64	38	4	8	16	2	1	1
Total north	5,063,799	45	$890	74	376	42	54	909	96	32	99
Southern Zambia[a]											
Commercial farms	1,245,304	11	$1,534	136	170	19	4	15	2	30	0
Poor farms	3,218,350	29	$336	68	219	24	2	16	2	36	1
Rural nonfarm	487,654	4	$336	68		4	2	2	0	0	0
Middle and rich urban	678,672	6	$2,324	115	78	9	2	5	0	1	0
Urban poor	452,448	4	$521	56	25	3	2	3	0	1	0
Total south	6,082,428	55	$817	86	525	58	2	41	4	68	1
Total	11,146,227	100	$850	81	902	100	26	950	100	100	100

Sources: 2002 Zambia Social Accounting Matrix, 2000 population census, Post-Harvest Survey 2002/2003, household consumption survey of 1998.
[a] Northern Zambia encompasses all of Agro-ecological Zone 3, which corresponds roughly to Northern, Luapula, Copperbelt, Northwest and Western Provinces. Southern Zambia includes Agro-Ecological Zones 1 and 2, which encompass most of Central, Southern and Eastern Provinces.

Table 3
Model parameters.

Household group		Price elasticity of demand				Expenditure elasticity of demand	
	For:	Maize		Cassava			
	w.r.t. price of:	Maize	Cassava	Cassava	Maize	EDYM	EDYC
Northern Zambia							
Commercial farms		−0.30	0.30	−0.10	0.10	0.80	2.90
Poor farms		−0.50	0.50	−0.20	0.20	1.65	0.50
Rural nonfarm		−0.50	0.50	−0.20	0.20	1.80	0.60
Middle and rich urban		−0.40	0.40	−0.20	0.20	0.75	−0.40
Urban poor		−0.40	0.40	−0.20	0.20	0.65	−0.30
Southern Zambia							
Commercial farms		−0.38	0.38	−0.10	0.10	0.87	0.35
Poor farms		−0.30	0.30	−0.20	0.20	0.65	0.50
Rural nonfarm		−0.30	0.30	−0.20	0.20	0.70	0.60
Middle and rich urban		−0.10	0.10	−0.20	0.20	0.20	−0.40
Urban poor		−0.20	0.20	−0.20	0.20	0.30	−0.30
Total		−0.4	0.40	−0.20	0.20	0.75	0.40
Supply elasticities							
Maize w.r.t. maize price		0.3	–	–	–	–	–
Cassava w.r.t. cassava price		–	Infinite	–	–	–	–

Source: authors' estimates. See Appendix 2 for details.

including a non-zero supply response could be incorporated into this framework by including within-period endogenous price expectations or simulating a sequence of years with producers' expected prices equal to a function of previous years' prices. This short-term analysis abstracts from changes in end of year private stock levels, given an absence of reliable data and behavioral parameters.[2]

Baseline data

The following simulations trace changes from a base maize production of 945,000 tons, the average level achieved during the eight moderate to good harvests since 1994. Though necessarily arbitrary, we have selected this period since it provides a recent, relatively long (12-year) period for which both production and seasonal price data are available. The domestic into-mill maize price during these years averaged $167 per ton in nominal prices. Given normal seasonal price movements, this results in a lean season (January–March) price of $198 per ton.

Regular publicly sponsored maize imports during the 1990s and 2000s, often released on the domestic market at subsidized prices, increased maize availability and depressed domestic maize prices below levels that would have prevailed in a fully liberalized market. To estimate a market equilibrium as the baseline price, the first simulation estimates what market price would have prevailed in the

[2] Medium-term analysis including a non-zero supply response could be incorporated into this framework by including within-period endogenous price expectations or simulating a sequence of years with producers' expected prices equal to a function of previous years' prices. This short-term analysis abstracts from changes in end of year private stock levels, given an absence of reliable data and behavioral parameters.

Table 4
Projected impact of drought in Zambia under alternative policy regimes.

	Baseline		Market responses			Government or food aid imports			Income transfers	
	a. Historic average, good to moderate years[b]	b. Historic average without public imports	c. Maize market under autarky	d. Autarky with cassava	e. Private maize import	f. Small public import	g. Large public import	h. Private imports impeded	i. Targetted cash transfer	j. Cash transfer under an import ban
Shock	None	No subsidized public imports	Drought	Drought	Drought	Drought	Drought	Drought	Drought	Drought
Policy responses										
Trade policy			Import ban	Import ban	Free trade	Free trade	Free trade	Traders spooked	Free trade	Import ban
Public imports (government or food aid)						Small	Large	Small		None
Targetted income transfers (as % poor household base in income)									0%	0%
What adjustments occur?										
Market price of maize		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Households reduce consumption of maize		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household substitution of cassava for maize				Yes	Yes	Yes	Yes	Yes	Yes	Yes
Private imports					Yes	Yes	Yes	Very small	Yes	No
Maize market impact										
Production shock			−0.30	−0.30	−0.30	−0.30	−0.30	−0.30	−0.30	−0.30
Production ('000 tons)	945	945	662	662	662	662	662	662	662	662
Net production ('000 tons)	851	851	596	596	596	596	596	596	596	596
Public imports (government or food aid)	28	0	0	0	0	50	255	50	0	0
Private imports										
Government controlled	23	0	0	0	0	0	0	0	0	0
Determined by commercial incentives	0	0	0	0	155	105	0	0	159	0
Supply	902	851	596	596	751	751	851	646	755	596
Price										
kwacha/kg	791	914	2,406	2,406	1,244	1,244	986	1,967	1,244	2,440
Dollars per ton	$198	$229	$601	$601	$311	$311	$247	$492	$311	$610
Percent change from base	−13%	0%	163%	163%	36%	36%	8%	115%	36%	167%
Demand										
Commercial farms	291	269	152	152	226	226	260	173	223	148
Poor farm households[a]	318	302	231	231	269	269	317	248	275	234
Rural nonfarm[a]	48	46	32	32	41	41	45	35	42	33
Middle and rich urban	180	174	135	135	160	160	170	142	160	135
Urban poor[a]	63	60	45	45	55	55	59	47	55	45
Total demand at market price	902	851	596	596	751	751	851	646	755	596
Maize production (next year)	−4%	0%	34%	34%	10%	10%	2%	26%	10%	34%

National consumption of food staples ('000 tons of maize-equivalent staples)										
Cassava consumption (dried weight)	285	285	285	364	298	298	315	352	298	365
Total maize plus cassava consumption	1,187	1,136	881	959	1,049	1,049	1,165	997	1,053	960
Change from base	51	0	−255	−177	−87	−87	30	−138	−82	−176
Food consumption of poor households ('000 tons of maize-equivalent staples)										
Maize	430	408	308	308	365	365	421	330	372	312
Cassava (in maize-equivalents)	178	178	178	221	189	189	185	212	189	222
Total maize-equivalents	607	586	485	529	553	553	606	542	561	534
Estimated change in staple consumption										
Poor northern households	10	0	−47	−5	−9	−9	10	−4	−9	−5
Poor southern households	11	0	−54	−52	−23	−23	9	−40	−16	−47
Total poor households	22	0	−101	−57	−33	−33	20	−44	−25	−52

Source: Zambia spreadsheet model projections.
[a] Designates poor households.
[b] Historical average, good to moderate years.

absence of these subsidized public imports. Doing so, the model projects that the lean-season maize price would have been approximately $229 per ton, or Kwacha 914 per kg. These results suggest that the publicly sponsored imports of roughly 50,000 tons per year depressed domestic maize prices by roughly 13% from the mid-1990s through the mid 2000s (Table 4, columns a and b).

The base scenario computes an import parity price based on delivery costs from South Africa, Zambia's most reliable supplier of large-scale maize imports over the past decade. Using lean-season prices on the Johannesburg (SAFEX) commodity exchange over the same eight moderate to good production years results in a Lusaka import parity price of $311 per ton. Export parity is computed on the basis of delivery costs to Lubumbashi, since northern Zambia routinely exports maize to Katanga Province in the Democratic Republic of Congo (DRC). Because reliable time series are not available for DRC, the baseline uses available 2006 prices from Lubumbashi, resulting in a Lusaka export parity price of $170 per ton.

Baseline incomes and consumption of maize and cassava are displayed in Table 2 for the ten household groups defined in this model. Data required for these computations come from the population census of 2000, the household consumption surveys of 1996 and 1998 and the 2001 social accounting matrix (SAM) for Zambia (Zambia, 2001).

Simulation 1. Impact of a drought

Market responses by consumers and traders

Autarky

For Zambia's low-income consumers, the worst of all worlds occurs when they are forced to contend with a production shortfall without recourse to maize imports which would cushion the fall in maize availability and the consequent increase in price. If Zambia were to prevent imports in the face of a drought – by failing to issue import permits to the private sector, by announcing large volumes of subsidized public imports and then failing to provide adequate funding (as in 2001), or by some combination of disincentives (as in 2005) – the domestic maize price would more than double. Without the moderating impact of private imports, which when flowing unimpeded cap price increases at import parity levels, Zambia's maize price would increase by over 160%. Because poor households bear the brunt of this weather-induced compression in food availability, their maize consumption would fall by roughly 25%, 101,000 tons below normal (Table 4, column c).

Consumer substitution of cassava for maize

Even in the unlikely event that government could maintain a completely closed economy in the presence of widespread informal trade flows, this worst-case scenario overstates the compression in food consumption by poor households, because Zambian consumers can fall back on alternative staple foods in situations where maize becomes scarce and the maize price spikes. The simulations from our simple multi-market model suggest a 160% increase in the maize price would induce Zambians to consume roughly an additional 43,000 tons of cassava (measured in dry weight or maize-equivalent calorie terms), thus offsetting about 40% of the shortfall in maize availability. In the cassava-producing regions of northern Zambia, this substitution of cassava for maize would largely eliminate the vulnerable households' maize deficit, freeing up maize they would have otherwise consumed for sale in other zones where consumers have developed a more pronounced preference for maize. In calorie terms, the maize-equivalent consumption shortfall among poor households would fall from 101,000 to 57,000 tons (Table 4, column d).

Free trade

Equally important to vulnerable households are private imports of maize. With both private imports and consumer substitution of cassava for maize, national food security improves markedly, even during a serious drought. The private sector imports 155,000 tons of maize, capping the maize price increase at import parity, or 36% above normal lean-season levels. Although this price rise still triggers a reduction in maize consumption, even among households who prefer maize as their staple food, the resulting shortfall in staple food consumption by poor households falls to 33,000 tons. These results suggest that a failure to anticipate price-induced responses by consumers and private importers would lead to an overstatement of poor household consumption shortfalls by 68,000 tons (Table 4, column e and c).

Public imports

Small volumes

If food aid agencies or the Zambian government were to import small volumes of maize to sell domestically at market price – where small is defined as any amount less than the 155,000 tons the private sector would bring in at import parity prices – the results would be the same as under free trade (Table 4, columns e and f). In this situation, public imports would simply displace an equivalent volume of private imports. For this combination of side-by-side public and private imports to occur, however, the private sector needs to have confidence that public food managers will operate under transparent, predictable decision rules governing quantities, timing and release prices. The private sector needs to have confidence that government will not sell imported grain at below-market prices, causing commercial losses for private importers. Government, likewise, needs to have confidence that private importers will not collude to artificially boost import prices above import parity. To develop this mutual trust will require good communications and good will on both sides.

Large public imports

If government or food aid agencies bring in maize volumes in excess of what consumers would purchase at import parity, these large-scale public imports will drive domestic prices down below import parity. In the present example, public imports of 255,000 tons (the maize supply gap projected in column c) would bring down prices below the $311 import parity level to $247 per ton, resulting in government trading losses of $64 per ton and a maize price only 8% above normal, in spite of the drought. While benefiting local maize consumers, this would dampen farmers' production response for the coming year from 10% to 2% (Table 4, column g).

Private imports impeded

Given late and unpredictable decision-making by Zambian authorities, many private firms have become wary of cross-border maize trade. Simulation 1 h considers a scenario, similar to 2001, in which government announces that it will import large volumes of maize, thus scaring off the commercial private trade. Then, due to a shortage of funds or to management difficulties, government ends up bringing in less maize than they intended. If government were to announce they would import 255,000 tons of maize (as in simulation 4 g), thus scaring away private traders, but then import only 50,000 tons, then maize prices would more than double and staple food consumption (of maize and cassava) by low-income consumers would fall 44,000 tons below normal and 10,000 tons below the free trade level (Table 4, columns e and h).

Targeted income transfers to vulnerable groups

Under free trade

Both food aid agencies and the Zambian government have experimented with temporary employment schemes and cash transfers aimed at increasing the purchasing power of vulnerable households so they can withstand economic shocks without compressing food consumption. The last two columns of Table 4 simulate the impact of a cash transfer equal to 5% of annual household income, targeted at low-income households in southern Zambia, at a cost of roughly $74 million. Under free trade, and upper bound household income elasticities of demand for maize (between 0.7 and 1.8), this increased purchasing power would reduce the deficit in food staple consumption among vulnerable households from 33,000 to 25,000 tons, for a gain of 8,000 tons (Table 4, column i).

With closed borders

Under closed borders, however, this income transfer would accomplish very little, other than a minor redistribution of purchasing power. Because wealthy households can outbid the poor, the net impact on maize consumption by vulnerable households becomes very small. Their food staple deficit surges to 52,000 tons, only a 5000 ton improvement over the autarky solution (Table 4, columns d and j). With no additional food supplies to purchase, poor households, even with additional disposable income, find themselves competing against the wealthy for the limited available food supplies. As a result, income transfer programs are of little use unless free trade, or public food imports, enable available supply to increase along with consumer spending power.

Simulation 2. Consequences of a bumper harvest

Market responses by consumers and traders

Export ban

With closed borders, a 30% increase in maize production, to 1.2 million metric tons, causes the lean-season maize price to fall in half, to $114 per ton. Given export parity at approximately $170 per ton, this affords significant opportunities for export to DRC, Angola and in some years to Malawi and Zimbabwe. In the absence of export authorization or long-term domestic stock build-up, national maize consumption will rise by 255,000 tons, assuming no cassava consumption response. Low-income consumers increase their consumption by 100,000 tons of maize-equivalents (Table 5, column c).

Consumption of cassava and other food substitutes decreases during a good maize harvest year because maize consumption increases as its price falls. Accounting for this substitution effect, cassava consumption by poor households falls by about 25,000 tons, thus reducing the net gain in grain equivalent consumption to roughly 75,000 tons (Table 4, column d).

Because of low maize prices, farmers would reduce area planted to maize by a projected 15%. Given weather-induced uncertainties, the combination of a 15% fall in planted area together with a drought the following season could lead to an exacerbated bust following an initial bumper harvest.

Open borders

If private trade is unconstrained, private traders would have incentives to export 150,000 tons at the estimated export parity price of $170 per ton. This would prevent domestic prices from falling below that level, thereby reducing the maize price fall from 50% of the base year price under autarky to 26% (Table 5, column e).

Table 5
Projected impact of bumper harvest in Zambia under alternative policy regimes.

	Baseline		Market responses			Export controls			Domestic Procurement	
	a. Historical average, good to moderate years	b. Historical average, without public imports	c. Maize market under autarky	d. Autarky with cassava	e. Private maize exports	f. Export ban	g. 100,000 tons exports	h. 200,000 tons exports	i. Procurement, no exports	j. Procurement, with exports
Shock	None	No subsidized public imports	Production increase	Production increase	Production increase	Production increase	Production increase	Production increase	Production increase	Production increase
Policy responses										
Trade policy			Export ban	Export ban	Free trade	Export ban	Export quota	Export quota	Export ban	Free trade
Government procurement, stockpiling or export									100	100
What adjustments occur?										
Market price of maize			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Households increase consumption of maize			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household substitution of maize for cassava			No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Private exports			No	No	Yes	No	100	200	No	Yes
Maize market impact										
Production shock			0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Production ('000 tons)	945	945	1,229	1,229	1,229	1,229	1,229	1,229	1,229	1,229
Net production ('000 tons)	851	851	1,106	1,106	1,106	1,106	1,106	1,106	1,106	1,106
Public net imports or procurement	28	0	0	0	0	0	0	0	100	100
Private trade, net imports										
Government controlled	23	0	0	0	0	0	−100	−200	0	0
Determined by commercial incentives	0	0	0	0	−150	0	0	0	0	−50
Supply	902	851	1,106	1,106	956	1,106	1,006	906	1,006	956
Price										
kwacha/kg	791	914	458	456	680	456	578	751	578	680
Dollars per ton	$198	$229	$114	$114	$170	$114	$145	$188	$145	$170
Percent change from base	−13%	0%	−50%	−50%	−26%	−50%	−37%	−18%	−37%	−26%
Demand										
Commercial farms	291	269	388	388	316	388	343	298	343	316
Poor farm households*	318	302	374	373	335	373	342	311	342	335
Rural nonfarm*	48	46	59	59	51	59	54	49	54	51
Middle and rich urban	180	174	210	210	188	210	197	183	197	188
Urban poor*	63	60	76	76	66	76	70	64	70	66
Total demand at market price	902	851	1,106	1,106	956	1,106	1,006	906	1,006	956
Maize production (next year)	−4%	0%	−15%	−15%	−4%	−15%	−9%	−2%	−9%	−4%
National consumption of food staples ('000 tons of maize-equivalent staples)										
Cassava consumption (dried weight)	285	285	285	243	270	243	253	264	253	270
Total maize plus cassava consumpt	1,187	1,136	1,391	1,350	1,227	1,350	1,259	1,171	1,259	1,227
Change from base	51	0	255	214	91	214	123	35	123	91
Food consumption of poor households (maize-equivalents)										
Maize	430	408	508	508	452	508	466	425	466	452
Cassava (maize-equivalents)	178	178	178	153	167	153	160	169	160	167
Total maize-equivalents	607	586	686	661	620	661	627	594	627	620
Estimated change in staple consumption										
Poor northern households	10	0	50	26	11	26	12	1	12	11
Poor southern households	11	0	50	49	23	49	28	7	28	23
Total poor households	22	0	100	75	34	75	41	8	41	34

Source: Zambia spreadsheet model projections.
* The poor household groups.

Export quotas

An export quota of 100,000 tons would moderate the fall in maize price, limiting it to 37%, or $145 per ton rather than the $114 projected under a full export ban (Table 5, column g). If the export quota is set at a level above the 150,000 tons expected at export parity, the quota becomes non-binding and the fall in maize price is limited to $188 per ton, or 18% below the base level (Table 5, column h). Since commercial exports are not profitable at this level, they can only occur through the Food Reserve Agency. In this situation, government subsidies are required to support farm prices above the $170 export parity level.

Domestic procurement

Procurement

Domestic procurement of 100,000 tons achieves the same impact as 100,000 tons of maize exports (Table 5, columns g and i). In both cases, the maize price falls to $145 per ton rather than to $114. This result, however, holds only if the Food Reserve Agency maintains the full 100,000 tons as carry-over stocks until the next season. Any uncertainties about the timing or pricing of FRA offtake will tend to depress market price and undercut the intended benefits of farm price support through domestic procurement.

Procurement plus exports

If domestic procurement occurs under a free trade regime, then the procurement simply displaces an equal amount of prospective exports (Table 6, columns i and j). Thus, domestic procurement or exports can achieve the same result, reducing domestic supply and boosting market price. The biggest difference between the two alternatives is that under a domestic procurement programme the public procurement agency will eventually have to dispose of its stocks. During Zambia's 2006 season, the large overhang in FRA stocks resulting from their 400,000 tons of procurement caused considerable uncertainty as to whether FRA would export or when and at what price they would ultimately dispose of their accumulated maize stocks.

Regional food aid procurement

Given consistent access to regional markets, Zambia's grain traders believe that Zambia could increase production enough to routinely supply surplus maize to neighboring countries. In that eventuality, Zambia could become a regular supplier of regionally procured food aid. Indeed, the World Food Programme (WFP) has recently opened a regional food aid procurement office in Lusaka, and they have begun purchasing locally for distribution within Zambia as well for delivery to DRC, Malawi, Zimbabwe, Tanzania and Angola. Over the past 5 years, Zambia has become the fifth largest African food aid supplier to WFP (Tschirley and del Castillo, 2007). Certainly, in surplus production years, regional food aid procurement offers a potentially useful tool for assuring external markets for growing domestic production. But realizing this goal will require significant improvement in the predictability and transparency of government trade policy.

Table 6
Sensitivity analysis.

	Baseline projections		Sensitivity analysis	
	Historical	Drought: 30% production fall	S1. maize price elasticity	S2. cassava responsiveness to maize price
Parameters				
Emm	−0.4	−0.4	−0.6	−0.4
Ecm	0.2	0.2	0.2	0.4
d. Impact of a 30% shortfall in production under autarky with cassava substitution[a]				
Maize price				
Price ($/ton)	$229	$601	$422	$601
Percentage change from base	0	163%	85%	163%
National food staple consumption				
Maize	851	596	596	596
Cassava (dried equivalent)	285	364	326	426
Total	1136	959	922	1022
Change	0	−177	−214	−114
Poor household food staple consumption				
Maize	408	308	279	308
Cassava (dried equivalent)	178	221	203	268
Total	586	529	482	576
Change	0	−57	−104	−10
e. Impact of a 30% shortfall in production with private maize imports[a]				
Maize price				
Price ($/ton)	$229	$311	$311	$311
Percentage change from base	0	36%	43%	36%
National food staple consumption				
Maize	851	751	686	751
Cassava (dried equivalent)	285	298	298	314
Total	1136	1049	984	1065
Change	0	−87	−152	−71
Poor household food staple consumption				
Maize	408	365	331	365
Cassava (dried equivalent)	178	189	189	201
Total	586	553	520	566
Change	0	−33	−66	−20

Source: model simulations
[a] d. and e. refers to the comparable columns in Table 4.

Applying the model during the 2006 export debates

Following Zambia's excellent maize harvest of 2006, intense policy debates arose between government, farmers and trade groups, with millers advocating an export ban on maize grain while farmers and traders advocated exports. To help inform these debates, Zambia's Agricultural Consultative Forum (ACF) convened a group of stakeholders in July 2006 to discuss policy alternatives. As an input into those discussions, involving key ministry and private sector groups, the authors used the model to assess the likely impact of the bumper harvest on maize prices – without exports and under varying levels of export quotas (Haggblade, 2006b). Following presentation of these results at the ACF meeting and publication in the Zambian Farmer magazine (Haggblade, 2006a), the government ultimately authorized 100,000 tons of export through the FRA. In a highly politicized election year, it would be imprudent to impute any direct causality. However, we can say with some confidence that various stakeholder groups demonstrated an interest in objective empirical analysis and that these results did help to inform the ongoing policy discussions.

Sensitivity analysis

Two key parameters – the responsiveness of maize and cassava consumption to changes in the maize price – govern the magnitudes, although not the direction of change, projected in this two-commodity model. The own price elasticity of demand for maize (the steepness of the household demand curve in Fig. 3) governs maize price volatility following a supply shock as well as the quantity response of households as the maize price changes. Since suppliers and consumers typically identify more substitution possibilities in the medium run than in the short run, medium-run demand curves are typically flatter than short-run curves. Therefore, the sensitivity analysis in Table 6 examines the consequences of a 30% supply reduction in maize output, the same supply shock as in Table 4, when the average national own price elasticity of demand for maize increases (in absolute value) from −0.4 to −0.6. The results suggest that price volatility under trade controls will fall by about 50%. However, because quantity responses become more accentuated, maize consumption by poor households falls more than in the comparable baseline simulations. Because cassava substitution for maize also falls under a moderated price increase, the fall in calorie consumption of maize plus cassava nearly doubles, increasing from 57,000 to 105,000 tons. Under free trade, total national maize consumption and imports fall because the 36% price increase to export parity triggers a greater reduction in maize demand, given the flatter demand curve. As under autarky, the reduction in staple food consumption by poor households roughly doubles, in this instance from 33,000 to 66,000 tons.

The second key parameter, the cross-price effect of the maize price on cassava consumption, measures the willingness of households, particularly those in the dual-staple northern zones, to substitute cassava for maize when the maize price spikes. The final column in Table 6, therefore, explores the impact of a cross-price elasticity double that of its own price elasticity, increasing from 0.2 to 0.4 to the high-side estimate developed in Appendix 2. Under autarky, this higher price responsiveness of cassava consumption leads to a reduction of nearly 80% in the staple food deficit of poor households, whose food gap falls from 57,000 to 10,000 tons. Under free trade, the food staple deficit likewise falls, this time by about 40%, from 33,000 to 20,000 tons of cassava plus maize. Not surprisingly, greater substitutability for other foods helps to cushion the impact of a drop in maize supply.

The qualitative conclusions and directions of change remain unchanged under these sensitivity analyses. While we believe the empirical estimates of these elasticities used in the baseline simulations in Tables 4 and 5 offer the best approximation of quantitative responses by households, these sensitivity results help to underscore the importance of substitution of other food staples in moderating shortfalls in maize availability. Given a spectrum of drought-resistant alternative foods, and given the sizeable magnitude projected in these simulations for the cassava substitution effect alone, these alternative foods clearly merit greater attention in future empirical and policy work in Zambia.

Conclusions

Regional trade as a tool for moderating price volatility

Open borders offer a financially inexpensive means of reducing the domestic price volatility of staple foods. The import parity price sets an upper bound, while export parity sets a floor below which prices will not fall, assuming private traders enjoy the freedom to import and export maize when market conditions permit. The alternative policy of closing borders in small markets such as Zambia invites the prospect of significant price volatility. Under normal production fluctuations, a closed border can easily lead to price volatility in the range of 100% from 1 year to the next.

Moreover, common government interventions – such as export and import quotas and price subsidies – may inadvertently accentuate domestic price volatility. In the short run, uncertainties over government intentions about trade volumes, tariffs and pricing risk driving commercial traders out of the market, thereby exacerbating price fluctuations. In the medium run, price volatility poses serious problems for commercial farmers of all sizes, particularly under rainfed conditions, where low production and very high prices in one season may lead to significant expansion in planted area next season. Under common weather patterns, a poor season followed by good one could lead to exaggerated boom and bust pricing and production cycles.

Although policy makers labor to mediate the short-run conflict between consumer and farmer interests, over the long run both constituencies benefit from the stability afforded by import parity price ceilings and export parity price floors. Long-term agricultural production and productivity growth will certainly benefit from a reduction in year-to-year price volatility. Low-income consumers, in particular, benefit by avoiding the extreme compression in basic food consumption from 1 year to the next. Open borders, thus, offer an inexpensive means of moderating year-to-year swings in staple food prices and consumption.[3]

Substitution among food staples

Although food policy in much of Africa focuses primarily on maize, vulnerable households, in fact, consume a wide range of food staples. Drought-tolerant staples such as sorghum, millet, sweet potatoes and cassava allow consumers to substitute these foods for maize in response to highly variable maize availability. For this reason, policy makers increasingly appreciate the need for accurate information on secondary food staples as well as maize in evaluating national food needs (Devereux, 2002; Tschirley et al., 2004).

Across agro-ecological zones, the available mix of staple foods clearly varies. In arid zones, sorghum and millet produce the most reliable cereal yields. In areas of plentiful rainfall, however, maize typically generates higher yields than sorghum and millet, although generally less than cassava and yams (InterAcademy

[3] The more expensive alternative of government-held buffer stocks and market interventions has been reviewed by Byerlee et al. (2006).

Council, 2004). In some instances, therefore, farmer crop choices involve tradeoffs between productivity and risk.

Issues of taste and nutritional quality likewise affect prospects for consumer substitution among food staples (Nweke et al., 2002). Yet taste preferences vary across regions and over time.[4] Across central and southern Africa, large swaths of mixed-staple and dual-staple zones, such as those in northern Zambia, indicate that many households currently consume a range of staples (Haggblade and Nielsen, 2007).

As the evidence from Zambia suggests, neglecting these substitution effects will lead government and food aid agencies to overstate emergency food requirements. As an indicative order of magnitude, our simulations suggest that, together, open borders and consumer substitution of cassava for maize could absorb roughly two-thirds of the consumption shock to vulnerable households during a drought year.

Food aid assessments

To accurately project consumption shortfalls and food aid needs, food aid agencies must anticipate market responses by consumers and traders. Failure to anticipate private sector imports can lead to potentially significant overstatement of food aid needs, as the Malawian example of 2003 illustrates (Tschirley et al., 2004 and Whiteside, 2003). Failure to consider known substitution possibilities among food staples, such as root crops and drought-resistant cereals, will exacerbate the tendency to overestimate food shortages.

Trade likewise matters in the design of income transfer programs. In a closed market, without access to food imports, large-scale income transfers may not be effective in raising vulnerable household food consumption. Poor households will simply bid against the rich for limited food supplies. Food aid agencies, like poor consumers, benefit from open borders.

Importance of transparency and predictable signals from government

Predictability, transparency and policy consistency are crucial for maintaining incentives for private sector trade. Due to the unpredictability of government policy in Zambia, four out of six international grain trading firms exited the market between the early 1990s and the early 2000s. Zambia's frequent policy shifts have made cross-border maize trade a risky proposition and have clearly dampened trader incentives to import and export maize. Under these conditions, our empirical simulations suggest that no matter how well-intentioned, government interventions, when accompanied by execution failures or unclear policy signals, can potentially lower domestic food availability compared to what would have occurred under an open trade regime.

Political feasibility of opening borders

Despite the low cost and significant benefits – of food supply stabilization and reduced price volatility – afforded by open borders, maize remains a sensitive commodity. As Africa's primary food staple, maize availability and price are politically sensitive, particularly in urban areas. Fears of market manipulation and profiteering by traders lead consumers and governments to mistrust the private sector. Further complicating policy formulation, the short-run interests of farmers, consumers, trader and millers often diverge. During deficit years, farmers lobby for import controls to keep prices high, over the objections of traders, consumers and millers. During surplus years, millers and consumers advocate export controls to keep domestic prices low, to the detriment of farmers. Despite the medium-term gains to both farmers and consumers from the reduced volatility in maize availability and price resulting from regional trade, government policy makers face conflicting pressures to control borders in both good harvest years and in bad.

Highlighting the difficult position African policy makers face, Richard Mkandawire, Agricultural Advisor to the New Partnership for Africa's Development (NEPAD) Secretariat has observed,

> "Most analysts agree that policy failure has played an important role in the emergence and depth of the African development crisis. . . . Yet this does not imply that most governments are ignorant of good policies. Why then do most governments find it difficult to embrace programmes of economic reform and why do they leave it so late before introducing reform measures? Which stakeholders at the national level can be expected to be reliable allies in the quest for market led reforms? How might technocrats be insulated from undesirable interest group pressures that might compromise the integrity of policy reforms?" (Mkandawire, 2008, p.6).

Answers to these questions have begun to emerge from a variety of settings where experience in opening cross-border trade in food staples suggests several practical steps that can improve understanding and, over time, build trust between government policy makers and private sector groups. First, where governments mistrust traders and fear collusion, increased competition offers one potential antidote. The intense price competition among several hundred Bangladeshi rice importers proved key to their effective response to the 1998 floods in Bangladesh, when traders staved off supply shortages and capped domestic prices at import parity by importing several million tons of rice from neighboring India (Dorosh, 2001). Similarly, an ex-post assessment of the 2004 rice crisis in Madagascar concluded that improved competitiveness of grain import markets required development of clear and transparent policies along with a level playing field for all actors (Magnay and Jenn-Treyer, 2006). Second, where traders mistrust governments, active dialogue between the public and private sector serves to improve transparency and trust, as both the Madagascar and Bangladesh experiences emphasize (Dorosh, 2008). In Zambia, the recent launching of a joint maize monitoring and stocks review committee involving farmers, traders, millers and government represents an important step in this direction (ZNFU, 2007). More generally, ongoing discussions with traders about trade impediments and possible measures to reduce transaction costs and facilitate commercial flows serve to maintain open lines of communication on ways of improving market efficiency and reliability. Finally, governments and traders need to monitor staple food markets over time and make this information widely available (Minten and Dorosh, 2006). They need to track price movements, of both domestic and regional prices, in order to monitor domestic and import parity prices. Government monitoring of letters of credit can likewise prove helpful in maintaining a clear indication of private sector trading intentions. These market monitoring efforts require regional cooperation and data sharing. In Southern Africa, the South African Commodity Exchange (SAFEX) and Famine and Early Warning System Network (FEWSNET) provide an existing backbone on which

[4] Five decades of maize subsidies in Zambia, from the mid-1930s through the mid-1980s, gradually altered urban consumption patterns towards maize and away from millet, sorghum and cassava (Lukanty and Wood, 1990). More recently, the growing prominence of cassava as a snack food in Malawi and Zambia, in response to growing availability and lower prices compared to competing staples such as maize and bread, suggests fluidity in both directions (Phiri et al., 2001). Likewise in Kenya, trends in urban consumption patterns document a decline in maize consumption and an increase in wheat over the past decade (Muyanga et al., 2006).

to build active market information systems throughout the region. Ongoing market monitoring, broad diffusion of market information, and active market analysis, such as that provided in this paper, can help to improve understanding, trust and market performance, gradually over time.

A liberalized external trade regime is not a panacea for all price stabilization problems. In particular, liberalization of private sector imports does not cushion importing countries against the effects of high international prices, such as those occurring in 2007 and 2008, though even here import parity prices do still provide a price ceiling. In most circumstances, openness to trade increases price stability, benefiting farmers by preventing precipitous drops in producer prices and benefiting consumers by avoiding price spikes. Reaping the benefits of open trade, as illustrated here by the historical experience in Zambia and the model simulations, requires clear and consistent policy signals that enable the private sector to respond to trading opportunities and ultimately enable governments to place more confidence in private sector trade as a tool for price stabilization.

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Appendix A. Model equations

Production

$X^i = X^i o * (P^i/P^i o)^{ESii} * (P^j/P^j o)^{ESij}$

Consumption

$C^i_h = \alpha^i_h o * C_h o^i * (P^i/P^i o)^{EDhii} * (P^j/P^j o)^{EDhij} * (Y_h/Yho)^{EDYhi}$

Income

$Y_h = v^i * P^i * X^i_h + v^j * P^j * X^j_h + Y^k_h o + YTFR_h$

Trade

Private imports: under free trade $MPRIV^M = C^M - X^M - MPUB^M$

under quotas $MPRIV^M = \overline{MPRIV}^M$

Public imports: $MPUB^M = MGOV^M + MFOODAID^M$

Commodity supply

Maize $S^M = X^M - LOSS^M + MPRIV^M + MPUB^M$

Cassava $S^C = X^C$

Demand

Maize $D^M = C^M + \Delta STOCKS^M + GOVPURCH^M - GOVSALE^M$

Cassava $D^C = C^C$

Equilibrium

Maize $S^M = D^M$

Cassava $S^C = D^C$

Market price

$P^M = PIMP^M$ if $PD^M > PIMP^M$

$P^M = PD^M$ if $PEXP^M < PD^M < PIMP^M$

$P^M = PEXP^M$ if $PD^M < PEXP^M$

Note: because the supply of cassava is considered perfectly elastic in the short run, $P^C = P^C o$.

A.1. Variable names

C^i_h = consumption of commodity i by household group h, following a shock.

$C_h o^i$ = base level of consumption of commodity i by household group h.

C^i = total household consumption of commodity i, M = maize, C = cassava.

D^i = total demand for commodity i, M = maize, C = cassava.

$GOVPURCH^M$ = government purchases of maize.

$GOVSALE^M$ = government sales of maize.

$LOSS^M$ = national maize losses.

$MPRIV^M$ = net private maize imports (negative imports = exports).

$\overline{MPRIV}^M$ = level of net private imports fixed by government quota.

$MPUB^M$ = net public imports of maize.

$MGOV^M$ = net national government imports of maize.

$MFOODAID^M$ = net food aid imports of maize.

P^i = price of commodity after new equilibrium is reached following a shock.

$P^i o$ = base price of commodity i.

PD^M = autarky price = equilibrium price with MPRIV and MPUB = 0.

$PIMP^M$ = import parity price (Johannesburg to Lusaka).

$PEXP^M$ = export parity price (Lusaka to Lubumbashi).

S^i = total supply of commodity i, M = maize, C = cassava.

$\Delta STOCKS^M$ = changes in maize stocks.

X^j_h = production of commodity j by household group h.

X^i = total national production of commodity I, M = maize, C = cassava.

Y_h = income of household group h, following a shock.

Yho = base income of household group h.

$Y^k_h o$ = base income of household h from all other activities (k).

$YTFR_h$ = income transfers to household group h.

X^i = production of commodity i, following a production shock.

X^i_o = base level of commodity production.

A.2. Parameter names

ES_{ij} = elasticity of supply of commodity i with respect to price j.

$\alpha^i_h o$ = consumption function shift parameter.

$EDhii$ = own price elasticity of demand for commodity i by household group h.

$EDhij$ = cross-price elasticity of demand for commodity i by household group h.

$EDYhi$ = income elastity of demand by household group h for commodity i.

v^j = value added share of gross output.

A.3. Indices

i, j, k = the two commodities, maize (M) and cassava (C), all other activities (k) h = household groups; this model includes the following 10 household groups:

North commercial farms	South commercial farms
North poor farms	South poor farms
North rural nonfarm	South rural nonfarm
North urban nonpoor	South urban nonpoor
North urban poor	South urban poor

Table A.2.1
Secondary estimates of consumption and supply elasticities in Zambia.

Commodity	Year	Consumption elasticities		Supply elasticity	Source
		Expenditure	Own price	w.r.t. own price	
Maize	1984	n.a.	−0.50	0.21	Katepa (1984)
Maize	1992	n.a.	−0.04	0.51	Nakaponda (1992)
Maize	1992	n.a.	n.a.	0.80	Harber (1992)
Breads, cereals	1996	0.59	−0.48	n.a.	USDA (1996)
Cassava		n.a.	n.a.	n.a.	

n.a. = Not available.

Appendix B. Derivation of elasticities used in the model

B.1. Supply elasticities

For maize, Katepa (1984), Nakaponda (1992) and Harber (1992) have estimated supply elasticities ranging between 0.21 and 0.80 (Table A.2.1). The model uses a conservative estimate of 0.3 in projecting the maize supply response to a change in the previous year's price.

Because farmers can harvest cassava any time over a 3-year period, and because many maintain a surplus for food security purposes, the model takes the supply elasticity of cassava as perfectly elastic in the short run. For this reason, the price of cassava remains fixed in the model simulations.

B.2. Expenditure elasticities

Due the paucity of existing estimates of expenditure elasticities in Zambia, particularly for cassava, we have estimated these directly using the 1998 LCMS survey data, the latest released to outside researchers by the Central Statistics Office. Given regional differences in consumption preferences, we have estimated parameters separately for each region and household group in the model. In the presence of large numbers of zero observations (ranging from 20% to 50% for cassava in the north, from 10% to 60% for maize in the north) we have estimated Tobit regressions using two alternative functional forms (Table A.2.2). With over 95% zero observations for cassava in the south, we have been unable to estimate demand parameters and have simply used the elasticity estimates taken from the north. Given the tiny budget shares for cassava in the south, these parameters will not affect the model simulations.

B.3. Own price elasticities

Given the unavailability of price data in the LCMS survey, we were unable to estimate price elasticities directly. Therefore, we have estimated plausible ranges using standard relationships from the linear expenditure system. The results, summarized in Table A.2.3, conform to results available in the secondary literature (Table A.2.1).

B.4. Cross-price elasticities

B.4.1. Cassava consumption

Because the model considers the price of cassava to remain fixed, the key cross-price elasticity in this model becomes the elas-

Table A.2.2
Estimated expenditure elasticities of demand.

	Cassava				Maize			
	a. Semi-log	b. Log share	c. Average	d. Base value	a. Semi-log	b. Log share	c. Average	d. Base value
North								
Commercial farms	n.s.	0.35	0.35	0.35	0.80	ns	0.80	0.80
Small farm	0.35	0.64	0.49	0.50	1.69	1.64	1.67	1.65
Rural nonfarm	0.52	0.71	0.62	0.60	1.75	1.85	1.80	1.80
Middle and urban rich	−0.48	−0.31	−0.39	−0.40	0.66	0.84	0.75	0.75
Urban poor	−0.32	−0.30	−0.31	−0.30	0.57	0.74	0.65	0.65
Weighted av – north	0.32	0.50	0.41	0.40	1.01	1.20	1.10	1.10
Weighted av – rural	0.38	0.59	0.48	0.50	1.24	1.66	1.45	0.15
Estimated – rural	0.31	0.66	0.48	0.50	1.84	1.71	1.78	1.80
Weighted av – urban	−0.41	−0.30	−0.36	−0.40	0.64	0.81	0.73	0.70
Estimated – urban	−0.39	−0.33	−0.36	−0.40	0.58	0.75	0.67	0.70
South								
Commercial farms	Not estimated: over 95% zero obs.			0.35	0.27	0.76	0.51	0.50
Small farm	Not estimated: over 95% zero obs.			0.50	0.49	0.83	0.66	0.65
Rural nonfarm	Not estimated: over 95% zero obs.			0.60	0.47	0.89	0.68	0.70
Middle and urban rich	Not estimated: over 95% zero obs.			−0.40	0.17	0.25	0.21	0.20
Urban poor	Not estimated: over 95% zero obs.			−0.30	0.30	0.24	0.27	0.30
Weighted av – south					0.36	0.69	0.53	0.50
Weighted av – rural					0.40	0.80	0.60	0.60
Estimated – rural					0.47	0.83	0.65	0.65
Weighted av – urban					0.21	0.25	0.23	0.20
Estimated – urban					0.25	0.21	0.23	0.20
National total	0.32	0.50	0.41	0.40	0.63	0.90	0.77	0.75

Source: estimated using Zambia's 1998 living conditions monitoring survey data. All estimates significant at least the 90% level except where indicated as not significant (n.s.).
a. tobit semi-log $Vi = a + b \ln \text{Exp}$.
b. tobit share $Vi/\text{Exp} = a + b \ln \text{Exp}$.
where Vi = per capita value of spending on each commodity.
Exp = total household expenditure per capita.

Table A.2.3
Derivation of own price elasticities from estimated expenditure elasticities.

	Expenditure elasticity (εi)	Frisch parameter (F)		Subsitence share (S)		Calculated[a] own price elasticity (ηii)		Best estimate own price elasticity (ηii)	
		High	Low	High	Low	High	Low	Base	Upper bound
Cassava									
North									
Commercial farms	0.35	−3.85	−2.25	0.17	0.09	−0.22	−0.12	−0.10	−0.20
Small farm	0.50	−3.85	−2.25	0.33	0.17	−0.39	−0.21	−0.20	−0.40
Rural nonfarm	0.60	−3.85	−2.25	0.28	0.14	−0.44	−0.24	−0.20	−0.40
Middle and urban rich	−0.40	−2.00	−1.60	0.13	0.07	0.30	0.23	0.00	0.00
Urban poor	−0.30	−2.00	−1.60	0.10	0.05	0.22	0.17	0.00	0.00
South									
Commercial farms	0.35	−3.57	−2.17	0.06	0.03	−0.18	−0.11	−0.10	−0.20
Small farm	0.50	−3.57	−2.17	0.01	0.01	−0.24	−0.14	−0.20	−0.30
Rural nonfarm	0.60	−3.57	−2.17	0.01	0.00	−0.28	−0.17	−0.20	−0.30
Middle and urban rich	−0.40	−2.00	−1.60	0.00	0.00	0.25	0.20	0.00	0.00
Urban poor	−0.30	−2.00	−1.60	0.00	0.00	0.19	0.15	0.00	0.00
National aggregate	0.40	−2.27	−1.72	0.10	0.05	−0.27	−0.20	−0.20	−0.30
Maize									
North									
Commercial farms	0.80	−3.85	−2.25	0.16	0.08	−0.48	−0.27	−0.30	−0.50
Small farm	1.65	−3.85	−2.25	0.11	0.06	−0.92	−0.52	−0.50	−1.00
Rural nonfarm	1.80	−3.85	−2.25	0.13	0.07	−1.04	−0.59	−0.50	−1.00
Middle and urban rich	0.75	−2.00	−1.60	0.19	0.10	−0.61	−0.45	−0.40	−0.60
Urban poor	0.65	−2.00	−1.60	0.19	0.10	−0.53	−0.39	−0.40	−0.50
South									
Commercial farms	0.50	−3.57	−2.17	0.45	0.23	−0.46	−0.25	−0.20	−0.40
Small farm	0.65	−3.57	−2.17	0.47	0.24	−0.60	−0.33	−0.30	−0.60
Rural nonfarm	0.70	−3.57	−2.17	0.37	0.19	−0.58	−0.33	−0.30	−0.60
Middle and urban rich	0.20	−2.00	−1.60	0.16	0.08	−0.16	−0.12	−0.10	−0.20
Urban poor	0.30	−2.00	−1.60	0.17	0.09	−0.24	−0.18	−0.20	−0.20
National aggregate	0.75	−2.27	−1.72	0.27	0.14	−0.64	−0.43	−0.40	−0.60

where < ηii = own price elasticity of demand, εi = expenditure elasticity of demand, ssi = subsistence share of commodity i in total expenditure, F = Frisch parameter = $-Y/(Y-S)$, where Y = total expenditure S = sum of total subsistence expenditure.
[a] $\eta ii = -\varepsilon i(ssi - 1/F)$.

ticity of demand for cassava with respect to the price of maize. Because farmers and consumers in northern Zambia produce and grow both cassava and maize, and because they can adjust their cassava harvest and consumption as they wish over the 3-year harvest cycle, they are able to raise and lower cassava consumption quickly, thus releasing more or less maize for sale. In drought years, they benefit from the spike in maize prices by selling more maize and consuming more cassava. The cross-price elasticity of demand projects the resulting responsiveness of cassava consumption to changes in the maize price.

Without price data from our available household survey, we have adopted a simple rule of thumb based on cross-price elasticity estimates from elsewhere between major and secondary food staples (Table A.2.4). These results suggest that the cross-price elasticity of demand for the minor staple (wheat in Bangladesh and other cereals in South Africa) with respect to the price of the major staple (rice and maize, respectively) ranges between 1 and 2 times the value of the own price elasticity, signs reversed. As a conservative estimate of the cross-substitution effects, the base model simulations take the cross-price elasticity of demand for cassava with respect to the price of maize as equal to the negative of cassava's own price elasticity of demand, giving a base value of 0.2. However, the sensitivity analysis in Table 6 reports the larger impact resulting when the cross-price effect lies at the higher end of this range, double the own price effect.

B.4.2. Maize consumption

Following a similar procedure, we estimate that the demand for maize (the principal staple) with respect to cassava (the minor staple) will lie between zero (Bangladesh) and the absolute value of the own price elasticity of demand (South Africa). For consistency, we have adopted the South African rule of thumb and taken the

Table A.2.4
Secondary estimates of cross-price elasticities.

Country	Year	Demand for		With respect to	Elasticities		
		Commodity	Budget share		Cross price	Own price	Expenditure
South Africa, rural	1993	Maize	0.12	Other cereals	0.27	−0.23	0.31
South Africa, rural	1993	Other cereals	0.036	Maize	0.85	−1.03	0.77
South Africa, urban	1993	Maize	0.022	Other cereals	0.18	−0.44	0
South Africa, urban	1993	Other cereals	0.019	Maize	0.2	−0.06	0.61
Bangladesh, rural	1989	Wheat	0.024	Rice	2.05	−0.82	−0.44
Bangladesh, rural	1989	Rice	0.217	Wheat	0.01	−0.56	0.39
Bangladesh, urban	1989	Wheat	0.017	Rice	2.35	−1.06	−0.01
Bangladesh, urban	1989	Rice	0.155	Wheat	−0.01	−0.59	0.15

Source: Alderman and del Ninno (1999), Goletti (1993), Dorosh and Haggblade (1997).

cross-price elasticity as the absolute value of the own price elasticity of demand (see Table 3). However, given the infinite supply elasticity of cassava, its price does not change in this model, and so the value of this cross-price elasticity becomes moot.

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