FOOD SECURITY RESEARCH PROJECT
and
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THE STRUCTURE AND BEHAVIOR OF VEGETABLE MARKETS SERVING LUSAKA: MAIN REPORT[1]

By

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The views expressed in this document are exclusively those of the authors.

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EXECUTIVE SUMMARY

Background

Rapid growth in urban populations and renewed growth in per capita incomes in Sub-Saharan Africa (SSA) are creating major opportunities for local farmers by driving rapid growth in domestic market demand for food. At the same time, these trends plus rising income are putting enormous stress on the supply chains that these farmers rely on to respond to this increasing demand: demand for marketed food is likely to grow more than 5% per year on the continent, doubling marketed volumes in 12-14 years. Currently, fresh produce marketing systems are the biggest users of *public* marketing infrastructure, and have been most severely affected by the lack of investment in these systems across much of the continent . This lack of investment has led to an exploding informal marketing sector, rising concerns about congestion and hygiene, and few if any comprehensive programs to actively link farmers to these markets.

Since about 2000, a great deal of attention has been paid to the *supermarket revolution* in developing countries. Yet after the initial burst of enthusiasm through the middle part of this decade, there now exists a broad consensus that this phenomenon is likely to proceed much more slowly than once thought in SSA. This emerging consensus suggests that private investment in modern, integrated supply chains cannot be relied upon to solve the multitude of problems and that public engagement, based on a solid understanding of these systems and on new approaches to public-private sector collaboration, will be central to any improvement in these areas. Yet little comparative knowledge has been generated to quantify the range of observed performance across these systems. We begin filling this gap by examining the marketing structure and price behavior of the systems supplying Lusaka with the three most important *staple vegetables* in East and Southern Africa: tomato, rape, and onion.

Data and Methods

Primary data for this study comes from three sources. Michigan State University's Food Security Research Project (FSRP) has collaborated with the Zambia National Farmers' Union (ZNFU) since January 2007 to collect detailed information on prices and quantities of tomato, rape, and onion in Lusaka's dominant wholesale market (Soweto) on Mondays, Wednesdays and Fridays. Retail prices are collected these same days a week in one open-air retail market (Chilenje), and on Tuesdays and Thursdays in three supermarkets (Shoprite, Spar, and Melissa).

Additional primary data comes from the FSRP Urban Consumption Survey (UCS). This survey interviewed over 1,800 households in four cities and towns of Zambia, including over 600 in Lusaka, over two rounds in August 2007 and February 2008. Detailed data on household food consumption and places of purchase allow us to estimate the total size of the Lusaka market for these three products and the market share of various types of retail outlets (open air markets, street vendors, supermarkets, and others) in consumer expenditure.

Findings

We highlight seven key findings regarding staple vegetable markets serving Lusaka. The most basic finding is that *these vegetables are a quantitatively important component of urban*

diets in Zambia. The top three staple vegetables – tomato, rape, and onion – account for a higher share of consumer expenditure (9.1%) than any food group other than cereals and staples and meat and eggs, and account for two-thirds of all vegetable consumption. Expenditure on all vegetables is four times that on fruit. While the share of expenditure devoted to all vegetables falls with income (while fruit's share rises), absolute expenditure on vegetables increases by four times from the bottom to the top income tercile, due to sharp rises in incomes.

Previous work (Hichaambwa and Tschirley 2006) has shown that fresh produce marketing at farm level is highly concentrated, with 3% of farmers in 2004 accounting for 75% of all sales in the country. This paper reinforces this finding: *the top three areas supply tomato, for example, accounting for over a third of total supply, had median lot sizes of 2.5 to nearly 4 metric tons.* Very few farmers in Zambia are able to finance the inputs, labor, and transport needed to produce and bring such quantities to market in a timely fashion several times over a production cycle.

A third finding is that *rural-urban market linkages, including regional linkages, are central to the availability and cost of these staple vegetables.* At least 98% of the value of consumed tomato, rape, and onion was purchased in markets, not produced and then consumed from small urban plots. Furthermore, with the partial exception of rape, the vast majority of the production of these vegetables took place in rural areas, not urban: peri-urban agriculture plays some role for rape, but little if any role for tomato and onion. Over half of onion (but none of the tomato) reaching Lusaka is imported from the region, not produced within Zambia. Other studies have found the same, and for a broader range of fresh produce commodities (Tschirley, Muendo, and Weber 2004 for Kenya; USAID 2005 and Louw et al. 2009 stress the importance of regional markets).

Fourth, *the traditional marketing system plays a dominant role in vegetable marketing, and Soweto wholesale market is at the center of this system.* Of the tomato, rape, and onion purchased by Lusaka consumers, over 90% comes from open air markets or the ka sector. While supermarkets are present and growing, and while their market share may begin to grow more rapidly at some point, the traditional marketing system will remain dominant for many years to come, and its performance will thus have an important impact on consumer welfare.

Our fifth finding is that, *while marketing channels are short, gross marketing margins are high.* Of produce originating in Zambia and consumed in fresh form, less than 40% of tomato passes through traders before reaching a wholesale market, none of the rape does so, and one-third of onion does so. About 8% of tomato and 65% of rape move directly from farmers to retail traders, by-passing both rural assembly and wholesale traders. Yet despite these short marketing chains, average gross markups from wholesale to retail (Chilenje market) are 224% for tomato, 356% for rape, and 131% for onion, showing a strong positive correlation with product perishability. From previous work (Hichaambwa and Tschirley, 2006), we suggest that these high margins are a direct result of the very small scale of operation of retail traders, leading to modest daily earnings despite high markups.

Brokers play a central role in Soweto market. *Our main finding in this regard (number six) is that evidence is mixed regarding the positive or negative impacts of their involvement, and that the issue requires more focused research.* The most serious concern is lack of transparency: many farmers feel obliged to sell through brokers, yet there are no official rules governing the brokers' behavior, and the sellers have no way of knowing with certainty what effective commission they are paying for the brokerage service. Reasonable concerns can

clearly be raised about opportunistic behavior under such circumstances. Yet we find that the largest sellers, presumably more likely to know the market and be able to bypass brokers if it were in their interest to do so, are the most likely to sell through brokers. Broker behavior and impact on the market requires more serious attention.

A seventh finding is that *quantities arriving on the market are highly unstable, that the system shows a surprising ability to dampen the impact of these fluctuations on prices, but that price instability within and across days remains a major problem.* Instability in quantities arriving on the market is due in part to production disruptions, as illustrated by the case of tomato in 2008, when problems with irrigation water disrupted expected seasonal production and price patterns. More fundamentally, however, quantity fluctuations are driven by very limited ability to coordinate across levels in the system to smooth the flow of product to the market. The system dampens the effects of these quantity fluctuations through shipments outside Lusaka (for tomato and onion), short-term storage at retail and in consumers' homes (onion, tomato, and to a lesser extent rape), and retail traders of rape arbitraging between buying at Soweto and buying from nearby plots. Yet even with these stabilizing mechanisms, wholesale prices are highly variable.

Implications for Policies, Programs, and Further Research

The highly concentrated structure of vegetable marketing in Zambia is similar to other countries in the region. This pattern reflects the management intensity of horticultural production and marketing – efficient production requires costly inputs, the knowledge to use them properly, and the ability to move quickly when a perishable crop is threatened by disease or ready for harvesting and marketing. Few smallholder farmers are able to bring all these factors to bear on a single crop or set of crops, or to manage the financial risk of crop failure when several hundreds of dollars have been spent on inputs and hired labor. Mwiinga (2009) did a detailed analysis of tomato production costs in Zambia. With the many programs currently in place to promote horticultural intensification in Africa, it is important that some of these undergo rigorous impact evaluation to learn what works for what types of farmers, and what approaches to avoid.

The importance of regional trade in onion (and probably other fresh produce as well) means that regional transport links, harmonization of trade regulations, avoidance of arbitrary border closings, and regional market information sharing – all issues typically addressed with vigor in cereals markets – are also important for improving performance of fresh produce markets, and reducing and stabilizing prices to consumers. We suggest that one reason for the greater predictability of onion prices compared to tomato and rape, in addition to its greater storability, is the ability to draw on a wider geographic range in supplying Lusaka. These two factors are clearly related: onion's physical characteristics that allow storage also allow it to withstand longer transport distances. Yet tomato is traded over substantially larger areas in Kenya, and between Tanzania and Kenya, than in Zambia. Widening the scope for trade through better infrastructure and trade facilitating policies and regulations should lead to less variable physical supplies and more stable prices. It is important to know to what extent trade barriers interfere with regional trade in fresh produce. Such barriers are a persistent problem in cereals markets in East and southern Africa, but less is known about their effect on fresh produce trade.

One implication of the short supply chains that we found is that *more programmatic emphasis should be placed on helping existing traders scale-up and gain better access to*

information. Helping farmers to bypass these traders and market their produce directly to supermarkets or processors will be appropriate in some circumstances, but most farmers will continue to rely on the existing fresh market trading system.

The extreme price variability in Lusaka's system points to the need for better production technologies, better access to inputs and agronomic advice for farmers, and better two-way vertical information flow through the system to match supply more closely to demand. A critical research need, in Zambia and other countries of the region, relates to the impact of existing legislative and regulatory structures on the ability to improve this two-way information flow. Wholesale markets need to be at the center of providing this service, but current ownership and management models dominated by the public sector do not appear conducive to these markets playing such a role. What legislative and regulatory changes are needed to provide scope for private sector investment in this area, and how can a dynamic stakeholder consultation process be launched and sustained to encourage such investment?

Three other areas merit further applied policy research. First, given the widespread presence of brokers in fresh produce markets and the controversy that they typically stir (see Tschirley, Muendo, and Weber 2004, for Kenya), rigorous assessment is needed in several regards: what economic function do they play, do they add value, and if so how and for whom?; are abuses such as threatening theft of product or lying about commissions widespread and persistent, or isolated?; what regulatory framework is needed to assure honest business practices that benefit farmers and consumers? These are key public policy issues in fresh produce marketing systems and will only become more important over time.

Second, comparative data is needed on gross margins across several countries; at this point, it is impossible to judge whether a mean gross margin above 200% for tomato (or above 300% for rape) reflects poor performance, and what levels these countries could reliably expect to reach. Systems for collecting this data must be designed carefully based on specific knowledge of the market chain being studied, to ensure comparability across countries. Third, the value chain for rape and other green leafy vegetables is poorly understood, especially the nature of retail trader links to farmers, the geographic location of those farmers who sell directly to retailers, and thus the quantitative importance of urban agriculture in these chains.

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LIST OF ACRONYMS

CSO	Central Statistical Office
CV	Coefficient of Variation
DRC	Democratic Republic of Congo
EU	European Union
FSRP	Food Security Research Project
GDP	Gross Domestic Product
K	Zambian Kwacha
Kg	Kilograms
MACO	Ministry of Agriculture and Cooperatives
MSU	Michigan State University
MT	Metric tons
SSA	Sub Saharan Africa
UCS	Urban Consumption Survey
US$	United States Dollar
USAID	United States Agency for International Development
ZAMTIE	Zambia Trade and Investment Enhancement Project
ZATAC	Zambia Agribusiness Technical Assistance Centre
ZNFU	Zambia National Farmers' Union

1. BACKGROUND

1.1. Introduction

Rapid growth in urban populations and renewed growth in per capita incomes in Sub-Saharan Africa (SSA) are creating major opportunities for local farmers by driving rapid growth in domestic market demand for food. At the same time, these trends are putting enormous stress on the supply chains that these farmers rely on to respond to this increasing demand. Africa has the highest urban population growth rate of any developing area, currently 3.7% per year and projected to remain above 3% through 2030. Urban population will grow about 170% over the next 30 years, far outstripping rural growth and pushing the urban population share above 50% (World Urbanization Prospects 2007). Rising incomes are intensifying the impact of growing populations on marketing systems. After essentially no growth in per capita incomes during the 1990s, SSA achieved total per capita gross domestic product (GDP) growth of 15% from 2000 to 2006, higher than in Latin America; six SSA countries ranked among the top 30 worldwide in per capita GDP growth during this period. Together, these two trends could fuel increases in demand for marketed food of more than 5% per year on the continent, meaning that marketed volumes will double in 12-14 years.

Currently, fresh produce marketing systems are the biggest users of public marketing infrastructure, and have been most severely affected by the startling lack of investment in these systems across much of the continent. As formal public market places have been overwhelmed by rising volumes of commodities and numbers of traders, the informal marketing sector has exploded, raising concerns about congestion and hygiene among city planners. The chaotic state of many of these markets also means that few if any comprehensive programs have been put into place to actively link farmers to them, making it much more difficult for these farmers to respond to the growing demand in urban areas.

Since about 2000, a great deal of attention has been paid to the supermarket revolution in developing countries[2]. Indeed, the term may be appropriate to describe what has happened in some countries of Latin America and East Asia, as income growth and openness to foreign direct investment drove widespread rapid growth in the market share of supermarkets, with important implications for farmers, traditional traders, consumers, and even municipal finances. Among many funding agencies, the phenomenon was viewed with concern for its potential to exclude small farmers, but also with more than a little hope as a way to deal with the distressingly complex challenge of how to modernize the chaotic and increasingly inadequate supply chains serving urban areas.

Yet after the initial burst of enthusiasm through the middle part of this decade, there now exists a broad consensus that this phenomenon is likely to proceed much more slowly than once thought in Sub-Saharan Africa (Tschirley et al. 2009; Humphrey 2006; Traill 2006; Minten 2008). While it is likely that supermarket shares will grow across the continent over time, and while this growth may at some point be rapid in selected countries, the overall rate of growth is likely to be much slower than was once expected in some circles. This is especially true in fresh produce supply chains, where both the promise and the perils of

[2] For early expositions of this theme on Latin America, see Reardon and Berdegué (2002) for a summary, and Alvarado and Charmel (2002), Schwentesius and Gomez (2002), Faiguenbaum et al. (2002), Farina (2002), and Ghezán et al (2002) for country studies. See also Reardon, Timmer, and Berdegué (2004). For Asia, see Reardon et al. (2003a), Reardon, Timmer, and Berdegué (2003b), Hu et al. (2004), and Coe and Hess (2005). For Africa, see Weatherspoon and Reardon (2003), Neven and Reardon (2004), and Neven et al. (2005).

supermarket expansion have received greatest attention. In nearly the entire continent, the so-called traditional marketing sector – open air markets, dispersed informal vendors, and traditional shops – is expected to play a dominant role in fresh produce marketing for several decades.

If correct, this emerging consensus has profound policy implications. Specifically, it suggests that private investment in modern, integrated supply chains cannot be relied upon to solve the multitude of problems – logistical inefficiencies, deteriorating infrastructure, high product wastage, urban congestion, and food safety concerns – that increasingly plague traditional production and marketing systems over a time frame acceptable to most policy makers and donors. What's more, Africa's high rate of urban population growth means that a rapidly rising share of the population will be subject to these problems over time. Public engagement (not to say full public funding) will be central to any improvement in these areas.

This public engagement must be based on a solid understanding of these systems and on new approaches to public-private sector collaboration to improve them. Yet, while there is wide appreciation of the poor performance of many of these systems, little comparative knowledge has been generated to quantify the range of observed performance. We begin filling this gap by examining the marketing structure and price behavior of the systems supplying tomato, rape, and onion to Lusaka. These crops are perhaps the three most important staple vegetables in east and southern Africa, being eaten on a daily basis by most people; in Lusaka, they account for more than half of all vegetable consumption. They also show great variability in production and perishability characteristics and so are likely to illustrate a substantial portion of the range of marketing structures and price behaviors seen in these traditional systems.

The next section discusses data and methods. Chapter two explores the relative importance of the three staple vegetables in consumption budgets of Lusaka's urban households as well as estimates annual trade flows. Chapter three generates a quantitative description of the market system for these vegetables that are serving Lusaka, including the geographical distribution of marketed production reaching the city, seasonality of supply, characteristics of main supply areas, the structure of the city's fresh produce marketing channels, and the role of brokers in the wholesale trade. Chapter four examines the price behavior of the three crops, including seasonality, price predictability, estimates of short-run price flexibility and its implications, price predictability and the level and behavior of wholesale-retail marketing margins. Chapter five concludes with initial thoughts regarding key challenges facing these systems and possible priorities for investment.

1.2. Data and Methods

Primary data for this study comes from three sources. Michigan State University's Food Security Research Project (FSRP) has collaborated with the Zambia National Farmers' Union (ZNFU) since January 2007 to collect detailed information on prices and quantities of tomato, rape, and onion in Lusaka's dominant wholesale market (Soweto). During Monday, Wednesday, and Friday of each week, market reporters collect three prices paid by buyers (primarily small-scale retailers) for each product during each hour from 6 am to 11 am. Market reporters also collect basic information on all trucks entering the market with the three products, including time of arrival, quantity, geographical origin of the product, and whether the seller will be working through a broker or selling directly. Retail prices are collected these same three days in one open-air retail market (Chilenje), and on Tuesdays and Thursdays in three supermarkets (Shoprite, Spar, and Melissa). Chilenje is one of the main

open air retail markets in the city serving lower and middle income Zambians. These data allow computation of total volumes and values flowing through Soweto market and detailed assessment of seasonality, intra- and inter-day price variability, and marketing margins. Building on their market knowledge and rapport with traders, market reporters in this system were also able to interview traders on the destination of product flowing out of Soweto market, among retail traders, institutional buyers, and destinations outside the city.

An important difficulty in conducting price analysis of fresh produce markets is the wide variation in quality that these products exhibit and the typical lack of formal systems of grades and standards to ensure that comparable qualities are being tracked and analyzed over time. Zambia is no different in this regard. Yet analysis in this study is facilitated by the fact that FSRP/ZNFU have worked with traders to develop a (still informal) set of standards for low, medium, and high standard quality for all three crops being monitored. All price collection focuses on medium standard quality, which should reduce artificial price variation in our data.

Additional primary data comes from the FSRP Urban Consumption Survey (UCS). This survey interviewed over 1,800 households in four cities and towns of Zambia, including over 600 in Lusaka, over two rounds in August 2007 and February 2008. Detailed data on household food consumption and places of purchase allow us to estimate the total size of the Lusaka market for these three products and the market share of various types of retail outlets (open air markets, street vendors, supermarkets, and others) in consumer expenditure. Together, the Soweto market monitoring data and the UCS provide most of the information needed for the detailed market maps in section three. These data were complemented with a retail *market mapping* exercise to estimate the share of Soweto market in retailer purchases of these three crops. This mapping exercise involved counts of the total number of fresh produce traders and number for each crop in the top 10 retail markets of the city, along with Likert scale questions to a sample of traders on the relative volumes purchased in Soweto market, in other wholesale markets, and directly from farmers in production areas.

2. OVERVIEW OF IMPORTANCE AND TRADE FLOWS

2.1. Vegetables in Lusaka Consumption Budgets

Vegetables are an important component of the diet of rural and urban households. While rural households mostly produce their own vegetables, urban households rely primarily on purchases.

Table Table 1 shows the overall share of vegetables and other food groups in Lusaka in total household food expenditure (including alcohol and tobacco) as well as the share for high, low, and medium income groups as categorized by total expenditure terciles. Vegetables account for 14% of total food expenditure, third after cereals and staples (24%) and meat and eggs (17%). This share is much higher among the low expenditure group (18%) than the high expenditure group (10%). However, because total expenditure rises so sharply across the groups, actual Kwacha value expended on vegetables increases by nearly four times from the lowest to the highest income group. Rape has the highest consumption share at 4.0%, followed by tomato (3.5%), onion (1.6%), and cabbage (0.7%). Local leaves (pumpkin, cassava, sweet potato, beans, and amaranthus) together take 2.2% and other vegetables such as green beans, egg plants, and okra take the remaining 1.6%. With a combined budget share of 9.1%, the three staple vegetables that we focus on here – tomato, rape, and onion – account for a higher share of expenditure than any food group other than cereals & staples and meat & eggs, and account for two-thirds (9.1/13.7) of all vegetable consumption, by value.

Table 1. Shares of Different Food Categories in Total Food Expenditure, by Per Expenditure Tercile in Lusaka

	Adult equivalent total expenditure tercile			
Food items	Overall	Low	Medium	High
Number of households	267,934	97,737	93,006	77,192
Mean adult equivalent income (K'000)	5,791	1,959	4,253	12,495
	---------- % budget share ----------			
Cereals & staples	24.1	28.4	24.2	18.7
Dairy items	5.2	3.5	5.9	6.7
Meat & eggs	16.8	14.1	18.0	18.6
Fish	7.6	8.8	7.3	6.5
Vegetables	13.7	17.6	12.9	9.8
Fruits	3.6	2.7	3.9	4.4
Pulses	3.7	4.7	3.4	2.8
Sugar & oils	7.9	10.1	7.5	5.6
Other foods	4.7	3.3	5.0	6.2
Tobacco & alcohol	5.3	3.0	5.6	7.8
Food away from home	7.3	3.8	6.3	12.9
Total	100	100	100	100

Source: CSO/MACO/FSRP Urban Consumption Survey 2007-2008.

Table 2. Share of Total Consumption from Own Production of Different Vegetables in Lusaka

Vegetable	Percent share from own production
Bean leaves	28
Pumpkin leaves	17
Cassava leaves	16
Sweet potato leaves	13
Amaranthus, Egg plant	5
Chinese cabbage	3
Rape, Impwa (local egg plant)	2
Tomato, Onion, Cabbage, Okra	1

Source: CSO/MACO/FSRP Urban Consumption Survey 2007-2008.

The share of vegetables from own production in total household consumption of vegetables in Lusaka is only 7%, meaning that over 90% of the value of consumption of vegetables passes through marketing channels as purchases. The share of own production of vegetables in consumption budgets tends to be higher for traditional leafy vegetables such as bean leaves, pumpkin leaves, and cassava leaves (Table 2). The own production share for the staple vegetables tomato, rape and onion is only 1-2%, highlighting the importance of markets for these vegetables.

2.2. Overview of Annual Trade Flows of the Three Staple Vegetables in Lusaka

We have seen that over 90% of the vegetables consumed by Lusaka's urban households pass through the marketing system involving wholesale as well as retail markets. Soweto market is at the center of this system. Soweto is a sprawling retail market – by far the largest in Lusaka and the country – that also serves as the dominant wholesale market in the city. Yet the market has almost no infrastructure specifically suited for fresh produce wholesaling; nearly all such wholesaling currently takes place in an uncovered dirt field at one end of the market complex with no dedicated entry and exit points, very limited storage capacity, and no cold storage of any kind. The area is in fact owned by a private individual and City Council considers that the traders operating there – who form the linchpin of horticultural marketing in the country – are squatting. The Urban Markets Development Program, funded by the European Union (EU), has made substantial investments in several retail markets of the city, including Soweto, but due to the legal status of this wholesale trading area, the program has ended without making any improvements in the area.

The vegetable retailing system is made up of the *traditional system* composed of open air markets and the *ka* sector, the multitude of small vendors outside of organized market places that pursue sales by locating along busy pedestrian walkways and in residential neighborhoods[3]. The other component of the fresh produce retailing system is the so-called *modern system*, composed of supermarkets, minimarts, and grocery shops. We analyzed data

[3] Ka is the diminutive in Njala; thus, kashop is a small, rudimentary shop, katable is a small table on which a vendor sells her wares, kantemba is a small *ntemba* or kiosk. Note that small retail shops are also considered part of the broader traditional marketing system, but these sell almost no fresh produce.

from the UCS in which respondents were asked to indicate the specific type of retail outlet from which they purchased the three staple vegetables in order to assess the relative importance of the traditional versus the modern systems. Table 3 shows that the traditional market system has a market share of 95-96% leaving the modern system with only 4-5%. Further analysis has shown, as can be seen from the same table, that the traditional system is largely supplied by Soweto market accounting for 91% for onion, 78% for tomato, and 59% for rape.

Estimated annual average flow of tomatoes through Soweto market over the two year period January 15 2007 to January 15 2009 was 30,148 metric tons (Table 3).[4] This is higher than the Zambia Trade and Investment Enhancement Project (ZAMTIE) and Zambia Agribusiness Technical Assistance Centre (ZATAC) estimate from 2001 of 13,200 metric tons (Kanchela and LaFleur 2001)[5]. The total monitored flows of rape during the period (the commodity was not captured under the ZATAC study) translates to an average annual flow of 5,946 metric tons, while we estimate that 14,664 metric tons of onion moved through the market; this is much more than the 2,862 tons estimated by the ZAMTIE and ZATAC study. The overall importance of Soweto market can be underlined by these large quantities and values of these vegetables that flow through it annually. This is worth a total of K 66 billion or US$ 13 million at wholesale prices as is also shown in Table 3.

We compared the retail value of annual flow of these vegetables in Soweto market, with annual consumption by Lusaka urban households as estimated using UCS data. The UCS data was collected at the retail value level and so the quantities flowing in Soweto were multiplied by the weighted retail prices of these vegetables in order to derive values of flows at retail level. Table 4 shows the annual flows and their retail values as well as the value of annual household consumption. The estimated retail value of these vegetables flowing through Soweto market is higher than the annual value of consumption (K 186 billion or US$ 37 million of flows compared to K 164 billion or US$ 33 million of consumption).

Table 3. Estimated Quantities and Wholesale Values of Tomato, Rape, and Onion Flowing through Soweto Market,1/15/07 to 1/15/09

Crop	Share of traditional retail markets and ka sector in total retail sales in Lusaka	Estimated share of Soweto wholesale market in total supply to retail markets and ka sector[6]	Average volume per annum (MT)	Mean wholesale price (K/Kg)	Total nominal value of annual flow	
					K'000,000	US$'000
Tomato	0.95	0.78	30,148	1,106	33,344	6,669
Rape	0.96	0.59	5,946	847	5,036	1,007
Onion	0.96	0.91	14,664	1,876	27,509	5,502
Total					65,889	13,178

Sources: FSRP retail markets mapping survey 2007/2009; CSO/MACO/FSRP Urban Consumption Survey 2007/8; FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

[4] The total volumes collected for the entire period was adjusted to a full two year basis by multiplying daily totals by (30/number of days data was collected each crop in a month). This was then divided by two to get estimated average flows per year.

[5] A sample of at least three traders of each commodity was interviewed capturing frequency and average quantities brought in which were then extrapolated for the whole market and then annualized.

[6] Based on proportion of traders obtaining commodity from Soweto Market and other sources.

This difference is attributed, as will later be seen from the market channel maps, to the following:

1. The higher value of annual flows compared to annual consumption for tomato and onion is attributed to significant quantities being exported out of Soweto (Lusaka) to other areas such as Livingstone, Copperbelt and the Democratic Republic of Congo (DRC), and
2. The lower value of annual flows of rape in Soweto market compared to the value of annual rape consumption is attributed to more quantities of rape going straight to retail markets from nearby production areas and to lack of exports of rape out of Soweto (Lusaka) to other areas.

Table 4. Soweto Market Flows and Total Annual Consumption of Tomato, Rape, and Onion in Lusaka, at Retail Prices

Crop	Average annual volume (MT)	Average retail price (K/Kg)	Value in K'000,000	Value in US'000	Value of total annual consumption in Lusaka K'000,000
Tomato	30,148	3,220	97,077	19,415	64,097
Rape	5,946	3,492	20,763	4,153	70,769
Onion	14,664	4,668	68,449	13,690	29,214
Total			186,289	37,258	164,080

Sources: CSO/MACO/FSRP Urban Consumption Survey 2007/8; FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

3. MARKET STRUCTURE

3.1. Characteristics of Wholesale Supply into Lusaka

3.1.1. Level and Seasonality of Supply

Vegetables require particular environmental and climatic conditions for optimal growth and their production tends to be seasonal in nature. For every season, areas with appropriate conditions will supply the market with the type of fresh produce concerned. Soweto market is supplied by a number of areas each with its own seasonal characteristics. To establish the overall seasonal nature of supply of the three vegetables to Soweto market, we graphed total volume entering the market by month and year for the data spanning 15 January 2007 to 15 January 2009 (Figure 1).

The shows that all three vegetables show some seasonality in supplying Soweto market with a few out of trend peaks here and there. The level of supply of tomato was generally lower in 2008 than 2007 due to problems accessing irrigation water during part of the year in one of the major supply areas. Overall, however, the main supply months were April/May to August with average monthly supply of about 2,500 metric tons, while the lowest supply months were October/November and February/March with average monthly supply being less than 2,000 metric tons.

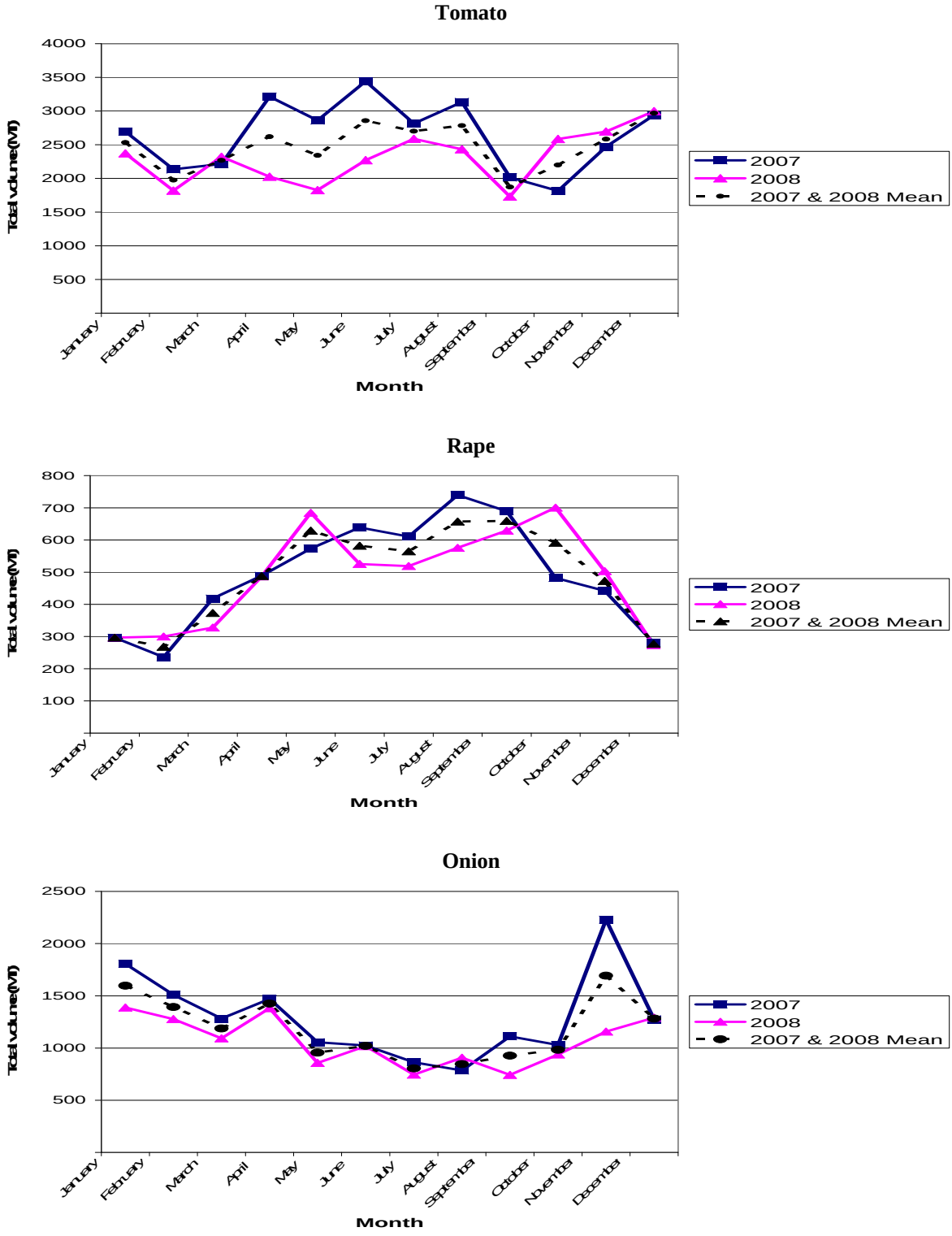
The seasonal supply pattern for rape was more consistent over the two years, with high supply months being May to October/November (average monthly supply of at least 500 metric tons) while the rest of the months supplied less than this amount. This seasonal pattern is consistent with rape being a cool season crop, and the coolest part of the year in Lusaka being May to July/August.

Seasonality of supply for onion was also similar across the two years. Low supply months were May to October during which average monthly supply was equal or less than 1,000 metric tons while supply was more than this for the rest of the months. The onion supply in November 2007 was much higher than in November 2008 because due to low prices and large volumes coming in from the Zambia-Malawi border in 2007, apparently due to good harvest in that area.

3.1.2. Lusaka "Market Sheds": The Geographical Distribution of Marketed Production

Based on information on the district of origin of each lot of product entering the market, we mapped the geographical distribution of marketed production of the three vegetables. Table 5 shows the district shares of the total supply to Soweto market during the period January 15, 2007 to January 15, 2009. Tomato was supplied from a total of 17 districts, while onion came from 19 and rape from only 9 districts. The three main supply districts for tomato are Lusaka, Mkushi, and Chibombo in that order. These three districts accounted for 60% of the total supply. The three main supply districts for rape are Chongwe, Chibombo, and Mumbwa. Chongwe alone accounted for 77% of the total supply and the top three districts accounted for 96%. The Zambia-Malawi border area and Johannesburg accounted for 58% of the onion going into Soweto. Lusaka is the third leading district in the supply of onion. These three top districts accounted for 82% of the total onion supply.

Figure 1. Total Supply of the Three Vegetables to Soweto Market, by Month and Year, January 15, 2007 to January 15, 2009



Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

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Table 5. District Shares of Total Supply to Soweto Market, 1/15/07 to 1/15/09

Tomato			Rape			Onion		
District	Total volume (MT)	Share	District	Total volume (MT)	Share	District	Total volume (MT)	Share
Chongwe	13,006	0.216	Chongwe	8,452	0.711	Zambia/Malawi border	8,873	0.303
Lusaka	11,455	0.190	Chibombo	1,468	0.123	S/Africa	8,055	0.275
Mkushi	10,227	0.170	Mumbwa	1,424	0.120	Lusaka	6,170	0.210
Chibombo	8,804	0.146	Lusaka	386	0.032	Chibombo	2,360	0.080
Mumbwa	8,420	0.140	Kafue	120	0.010	Chongwe	1,528	0.052
Kafue	4,683	0.078	K/Mposhi	22	0.002	Kafue	1,481	0.050
K/Mposhi	1,941	0.032	Kabwe	7	0.001	Chipata	341	0.012
Kabwe	694	0.012	Serenje	6	0.001	Tanzania	135	0.005
Petauke	333	0.006	Mkushi	6	0.000	Siavonga	123	0.004
Mazabuka	314	0.005	Siavonga	2	0.000	Nakonde	93	0.003
Siavonga	313	0.005	Total	11,892	1.000	Mpongwe	79	0.003
Chipata	23	0.000				Livingstone	35	0.001
Malawi	23	0.000				Kabwe	24	0.001
Mufulira	23	0.000				Katete	7	0.000
Mbala	16	0.000				Mazabuka	6	0.000
Ndola	8	0.000				Mbala	6	0.000
Kitwe	4	0.000				Mumbwa	6	0.000
Monze	3	0.000				Petauke	5	0.000
Livingstone	3	0.000				Zimbabwe	1	0.000
Katete	1	0.000				Total	29,327	1.000
Choma	1	0.000						
Nyimba	0	0.000						
Total	60,296	1.000						

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

We conceive of Lusaka's market sheds as the geographical extent over which marketed product flows to Lusaka. Figure 2 maps these market sheds based on the districts that together provided 80% of Lusaka's supply of each crop from mid-January 2007 through mid-January 2009[7]. The geographical extent of these market sheds clearly follows the perishability characteristics of the crops: the city draws nearly 60% of its onion from imports, with half of this coming from Johannesburg, about 1,200 km away; the city draws on five districts clustered around it for 87% of its tomato supply, while it needs only the two closest districts to assemble 83% of its rape supply. Rough estimates of the mean distance to market are 44 km for rape, 69 km for tomato, and 539 km for onion.[8] Notably, very little of the

[7] We limited the period to 24 full months to control for seasonality in supply.

[8] For rape and tomato, these figures are based on straight line (air) distances from district capital towns to central Lusaka. For imported onion, we used distance from Johannesburg and mean distance from Blantyre and Lilongwe to Lusaka. Driving distances will be higher.

supply reaching Soweto comes from what could be considered peri-urban areas. Even for rape, the most perishable of the three, production areas in the two main supply districts, though close to Lusaka, are rural in nature, and not peri-urban.

3.1.3. Seasonality of Supply from Different Districts

We have seen that supply of these vegetables into Soweto market has seasonal trends. We also wanted to know if this seasonality differed by the different districts from which the vegetables were sourced or produced. We thus graphed the total quantity of the vegetable supplied by each of the top three supply districts by month. Results are shown in Figures 3 to 5 for tomato, rape, and onion respectively.

According to Figure 3 about 300 to 400 metric tons per month of tomato from Lusaka district are supplied to Soweto market mostly from April/May to November with peak supply months being July to September. After this period most of the tomato comes from Mkushi up to April, with peak supply months from Mkushi being December and January when monthly average quantities also range between 300 and 400 metric tons. This is the rain season when tomato production is hampered by high incidence of diseases. Tomato in Mkushi is produced primarily by large-scale farmers who are better able to control these diseases.

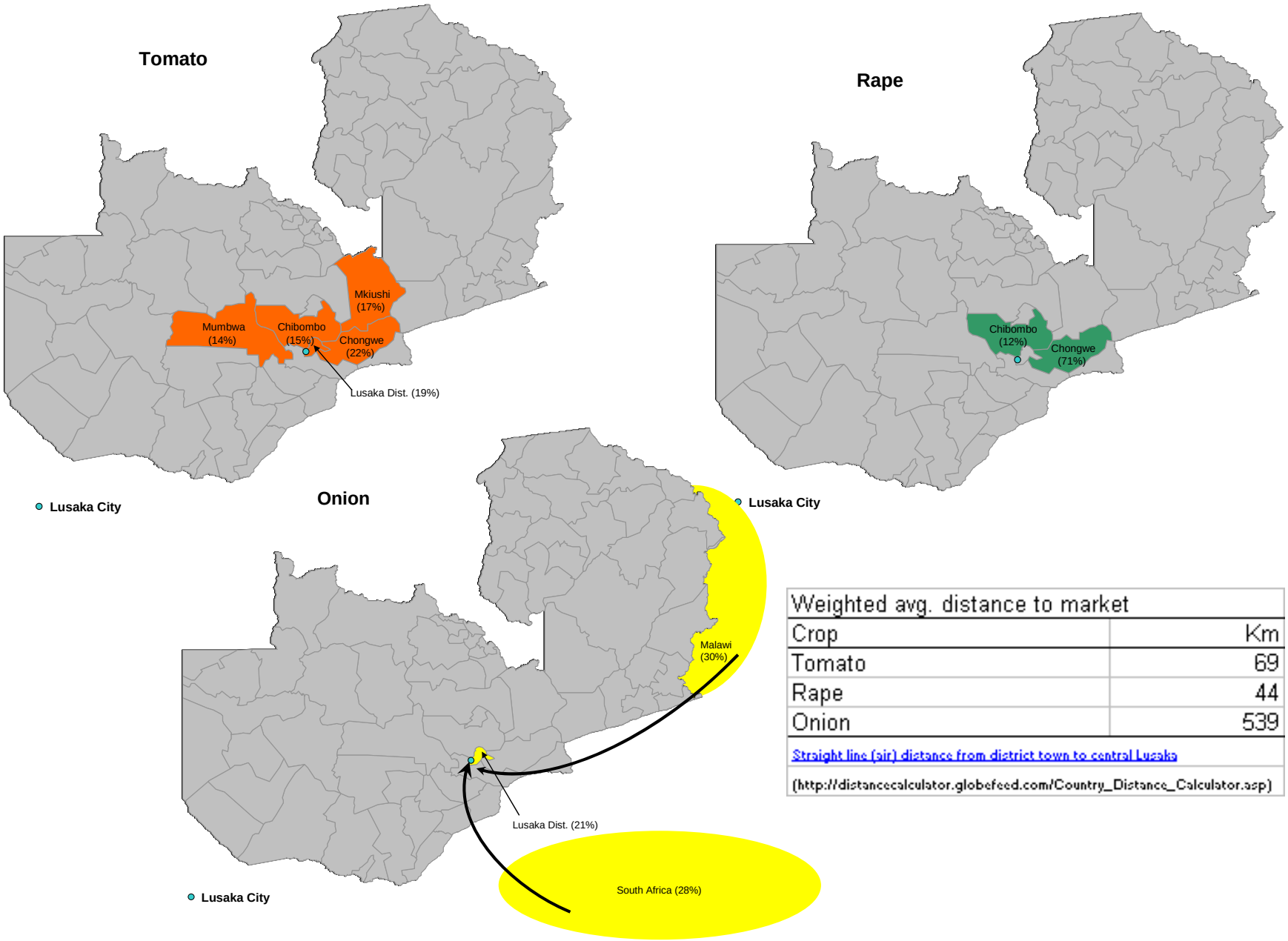
Tomato from Chibombo, though not shown in the figure, is supplied primarily between May and August from small farmer irrigation in wetlands with the peak supply month being June. That from Chongwe and Kafue follows the trend of the tomato from Chibombo but peak supplies occur much later in July/August/September.

Slightly less than three-quarters of total annual rape supplies to Soweto market come from Chongwe district. This district shows a robust seasonal pattern over the two years, with most supply during the cool dry months of May to November, followed by a collapse in December/January (Figure 4). This pattern is driven by small farmers who irrigate during the cool/dry season using perennial streams, then concentrate on field crops during the rainy season. This pattern for Chongwe is similar for rape from Chibombo, though the latter supplies lesser volumes. Small farmer irrigation in Chibombo is mostly done in wetlands.

Rape supplied from Mumbwa is generally rain fed, as the district has few water bodies for dry season irrigation. Rape from this district comes into Soweto in the months of December/January to March/April. The rape from Kafue and Lusaka, though not shown in the figure, show no distinct seasonality, but supply seems to be higher in the cool dry season.

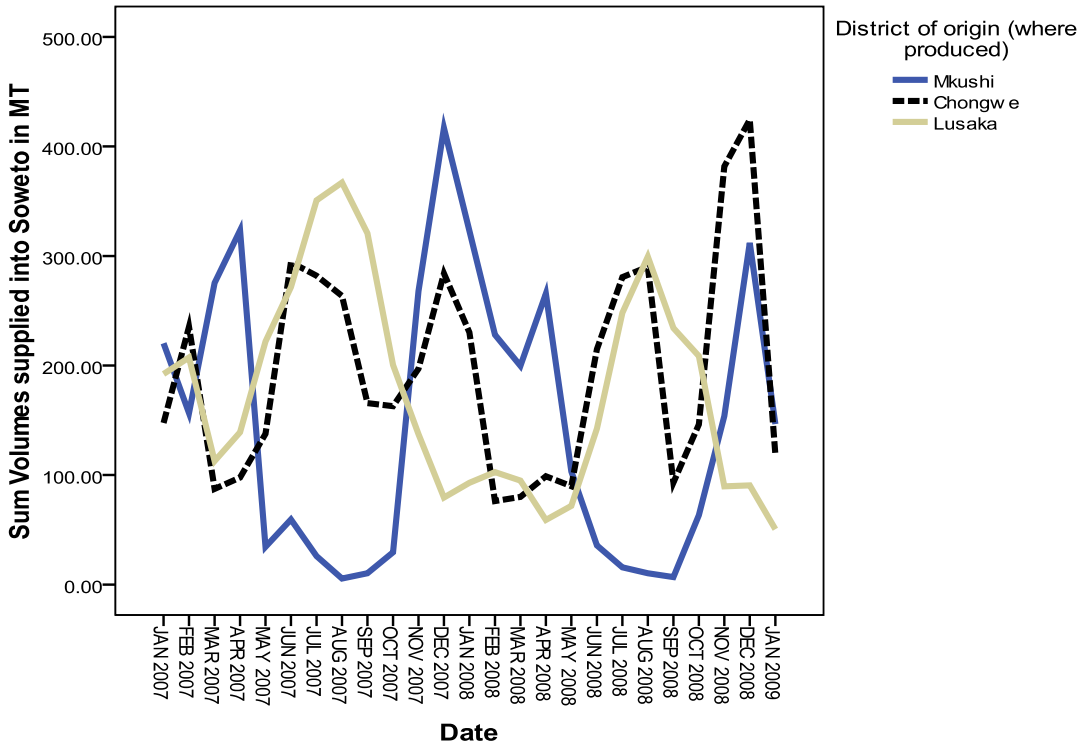
Most of the onion in Soweto Market comes from the Zambia-Malawi border area (November to February) and South Africa (February to July) while that from Lusaka, Kafue and Chibombo districts mostly comes in the dry season (Table 5). These districts, however, provide some rain season supplies as well. Traders obtain their onion at the start of the rain season from freshly produced onion from the Zambia-Malawi border area and, later in the season, cured onion from South Africa until the cool dry season when supplies of locally

Figure 2. District Shares of Tomato, Rape, and Onion Supplied to Soweto Market, Lusaka



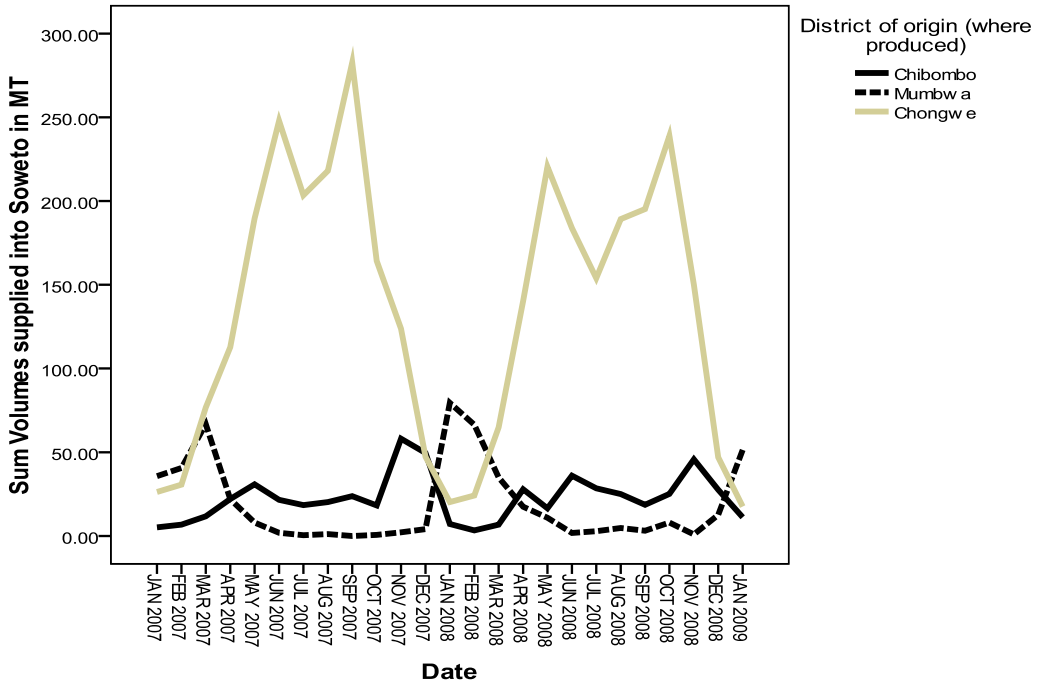
Weighted avg. distance to market	
Crop	Km
Tomato	69
Rape	44
Onion	539
Straight line (air) distance from district town to central Lusaka	
(http://distancecalculator.globefeed.com/Country_Distance_Calculator.asp)	

Figure 3. Total Supply of Tomato to Soweto Market, by Month and District (Top Three Districts), January 15, 2007 to January 15, 2009



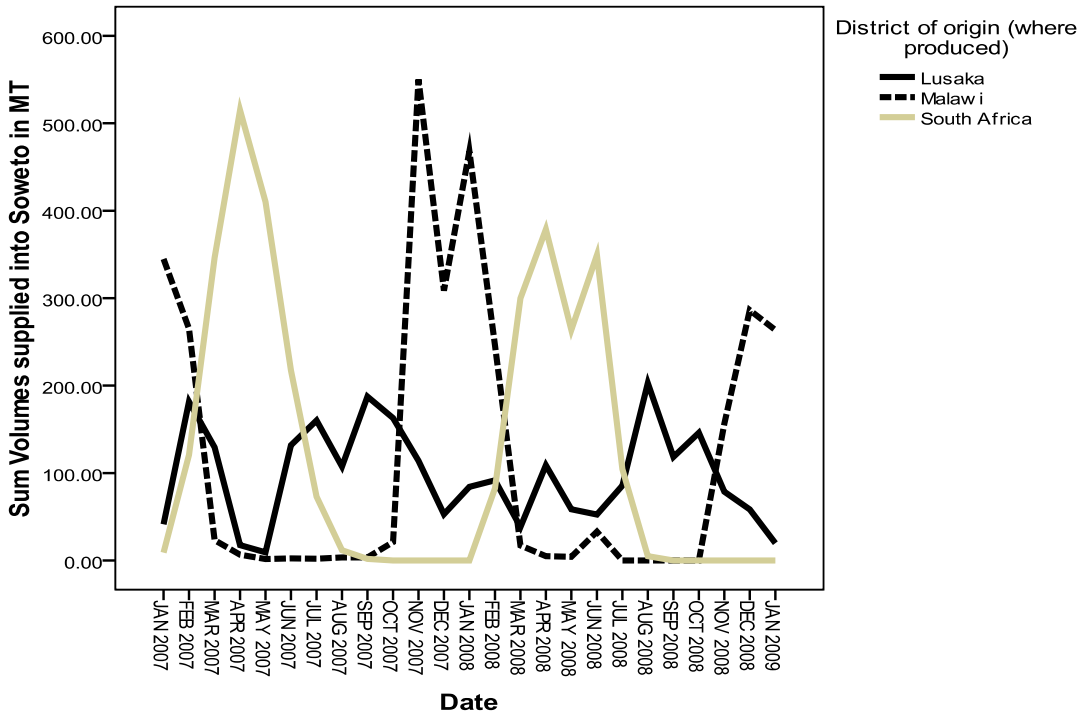
Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Figure 4. Total Supply of Rape to Soweto Market, by Month and District (Top Three Districts), January 15, 2007 to January 15, 2009



Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Figure 5. Total Supply of Onion to Soweto Market, by Month and District (Top Three Districts), January 15, 2007 to January 15, 2009



Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

produced uncured onion start coming in. Onion is largely produced during this season in Zambia and may be only one commercial farm in Lusaka has artificial curing facilities unlike in South Africa where almost all onion is cured and can be stored over long periods of time.

3.2. Characteristics of Main Supply Areas

Within each producing district, smaller production areas were identified based on definitions used by farmers and traders selling in Soweto market; typically these areas follow existing local boundaries, which could include one or several villages. In addition to these areas, responses of vegetables simply being sourced from a district, without specifying a specific area, were recorded. These general responses accounted for 6%, 3%, and 2% of the total quantities of tomato, rape, and onion supplied into Soweto market during the period under review. Looking at the shares of the total quantities supplied by each of these areas showed that production is quite concentrated. Table 6 shows top 10 supply areas for the three vegetables.

We saw from the market sheds in Figure 2 that production of rape is substantially more concentrated than that of tomato based on production data from the districts. Analysis of data based on specific production areas reinforces this finding: 53% of total rape supply to Lusaka comes from three sub-district areas, while only 28% of tomato comes from the top three (Table 7). Figures for onion are misleading in the sense that Malawi and Johannesburg were each classified as a single area, though each undoubtedly draws on many production areas within those countries for the supplies that reach Lusaka.

Table 6. Top 10 Supply Areas for Each Crop to Soweto Market, 1/15/07 to 1/15/09

Tomato			Rape			Onion		
Area (District)	Total volume (MT)	Share	Area (District)	Total volume (MT)	Share	Area (District)	Total volume (MT)	Share
Lusaka West (Lusaka)	6,814	0.113	Kasisi (Chongwe)	2,782	0.234	Mugabi (Zam/Malawi)	8,731	0.298
Chisamba (Chibombo)	5,042	0.084	Manyika (Chongwe)	2,718	0.229	Johannesburg (South Africa)	8,055	0.275
Masansa (Mkushi)	4,806	0.080	Mungule (Chibombo)	754	0.063	Eco Veg (Chibombo)	2,152	0.073
Choona (Mumbwa)	3,364	0.056	10 miles (Chibombo)	417	0.035	Makeni (Lusaka)	1,524	0.052
Manyika (Chongwe)	3,239	0.054	Chalimbana Chongwe)	389	0.033	Lusaka West (Lusaka)	1,515	0.052
Mwembeshi (Kafue)	3,158	0.052	Nangoma (Mumbwa)	351	0.030	York Farm (Lusaka)	1,450	0.049
Chalimbana (Chongwe)	2,834	0.047	Njolwe (Chongwe	333	0.028	Mr. Brown (Kafue)	1,398	0.048
Makeni (Lusaka)	2,709	0.045	Kanakantapa (Chongwe)	327	0.028	Ambrosia F (Lusaka)	1,201	0.041
Mwaalumina (Chongwe)	2,444	0.041	Katende (Chongwe)	303	0.025	Water Green (Chongwe)	1,051	0.036
Nkolonga (Mkushi)	2,218	0.037	Chongwe (Chongwe)	298	0.025	Palabana (Chongwe)	264	0.009
Total	36,628	0.609		8,671	0.730		27,342	0.933

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Key characteristics of the top 12 supply areas for the three vegetables were developed covering province, district, market share, median market lot size, decile ranking of lot size, farmer description, seasonality of supply and weighted average price. The decile ranking of lot size was developed by putting all lots from all areas together and ranking them into deciles. We then examined the frequency distribution of deciles by area, to develop an indication of relative farmer size predominantly found in each area. Areas with decile rankings predominantly of seven and above are referred to as large farm areas while those with rankings predominantly of three and below are called small farm areas; those with predominant rankings between three and seven we call medium farm areas. The number of lots supplied in the 24 months of data collection used in this study as well as the relative frequency of lot size decile ranking formed the description of farmers found in each area while seasonality of supply together with the average weighted price helped indicate whether the areas largely supplied during periods of high or low prices.

Table 7. Geographical Concentration of Marketed Production Flowing through Lusaka

Concentration measure	Crop		
	Tomato	Rape	Onion
Total number of identified production areas	115	93	42
Share of total supply from:			
Top 3 areas	0.28	0.53	0.65
Top 5 areas	0.39	0.59	0.75
Top 10 areas	0.61	0.73	0.93

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data, January 2007 to January 2009.

Table 8 shows key characteristics of the top 12 production areas supplying Lusaka with tomato, arranged in descending order of their market share. Out of the 12 areas seven are medium farm areas, four are large farm areas and only one is a small farm area. The 12 areas account for a total market share of 75%.

Only three of these areas' average weighted price received is higher than the overall average of K 1,127/kg: Mkushi Farm Block, Nkolonga, and Masansa. All three are large farm areas in Mkushi district supplying Lusaka with tomato predominantly in the wet, high-price season. Though these are large farm areas, their share of total supplies during the period of this study was only 11% for Masansa and about 4% each for Mkushi Farm Block and Nkolonga. Masansa is actually the second highest supply area for tomato in Lusaka following Lusaka West. Lusaka west is composed of a wide range of mostly medium-sized farmers supplying tomato throughout the year, though supply is low from February to April. The only small farm area in the top 12 is Choona in Mumbwa district, which ranks sixth in market share. The small farmers in this area largely rely on rainfall for their tomato production and consequently supply primarily from March to May.

Table 9 repeats the information from Table 8, for rape. As was the case with tomato, medium farm areas are the majority among the 12. Three of the 12 areas are small farm areas compared to only one for tomato. The 12 areas account for a total market share of 82%. Nine of these top 12 supplying areas are in Chongwe district while the remaining three are in Chibombo (2) and Mumbwa districts (1).

Kasisi and Manyika, both medium farm areas in Chongwe district, are the two highest suppliers of rape in Lusaka accounting for 27% and 26% of the market share respectively. Their average weighted prices are slightly lower than the overall average of K 786/Kg. The two areas achieving the highest prices were Nangoma in Mumbwa district and *10 miles* in Chibombo. Their market shares are only 2% and 3% respectively but have higher prices because of largely supplying rape in the low supply months in the wet season.

Table 10 presents the same information on onion supply areas. Seven of the 12 areas are medium farm areas while the rest are large farm areas. The two highest supplying areas represent imports from Malawi and South Africa respectively and each undoubtedly represents more than one production area. Of the remaining ten areas, seven are in Lusaka district and one each in Chibombo, Chongwe, and Kafue. The only other large farm areas are Eco Veg, Mr. Brown, and Water Green and Palabana, all of which are commercial farms in Chibombo, Kafue, and Chongwe respectively.

Table 8. Key Characteristics of Top 12 Production Areas Supplying Lusaka with Tomato, 1/15/07 to 1/15/09

Area	District (Province)	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (K/kg)
			Median Lot Size (MT)	Decile ranking of lot size	Farmer Description		
Lusaka West	Lusaka (Lusaka)	0.133	2.53	5.84	Wide range of mostly medium-size farmers: 683 lots supplied in all the 24 months, 35% with lot size decile ranking of more than 7, and 24% falling within the first 3 deciles.	Supplies all year round but supplies are very low in February to April. Peak supply periods are July to September.	1,083
Masansa	Mkushi (Central)	0.108	2.96	6.33	Mostly medium and larger farmers: 458 lots supplied in 21 out of the 24 months, 41% with lot size decile ranking of more than 7, and 21% falling within the first 3 deciles.	Main supply months are October/November to April/May.	1,280
Chisamba	Chibombo (Central)	0.104	3.85	7.15	Predominantly large farmers: 377 lots supplied in all the 24 months, 54% with lot size decile ranking of more than 7, and 9% falling within the first 3 deciles.	Peak supply months are July and October/November.	1,044
Makeni	Lusaka (Lusaka)	0.083	1.85	4.98	Wide range of mostly medium size farmers: 537 lots supplied in all the 24 months, 21% with lot size decile ranking of more than 7, and 34% falling within the first 3 deciles.	Main supply months are April/May to November.	999
Mwembeshi	Kafue (Lusaka)	0.080	2.81	6.27	A mixture of large and medium sized farmers: 355 lots supplied in 22 out of the 24 months, 40% with lot size decile ranking of more than 7, and 21% falling within the first 3 deciles.	Main supply months are May to November/December with peaks in July to September.	1,023
Choona	Mumbwa (Central)	0.047	1.24	3.63	Predominantly small farmers: 477 lots supplied in 21 out of the 24 months, 7% with lot size decile ranking of more than 7, and 56% falling within the first 3 deciles.	Main supply months are March to May.	1,081
Manyika	Chongwe (Lusaka)	0.045	1.63	4.58	Mostly medium sized farmers: 319 lots supplied in all the 24 months, 18% with lot size decile ranking of more than 7, and 39% falling within the first 3 deciles.	Supplies all year round but supplies are very little in October/November.	1,010
Nkolonga	Mkushi (Central)	0.044	3.80	7.31	Predominantly large farmers: 154 lots supplied in 13 out of the 24 months, 53% with lot size decile ranking of more than 7, and 9% falling within the	Main supply months are November to January.	1,191

Area	District (Province)	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (K/kg)
			Median Lot Size (MT)	Decile ranking of lot size	Farmer Description		
					first 3 deciles.		
Mkushi Farm Block	Mkushi (Central)	0.039	3.79	6.96	Predominantly large farmers: 126 lots supplied in 18 out of the 24 months, 51% with lot size decile ranking of more than 7, and 18% falling within the first 3 deciles.	Main supply months are December to March/April. Supply was also high in June/July 2007.	1,298
Palabana	Chongwe (Lusaka)	0.027	2.13	5.46	Mostly medium-size farmers: 153 lots supplied in 18 out of the 24 months, 24% with lot size decile ranking of more than 7, and 26% falling within the first 3 deciles.	Main supply months are May to November.	1,012
Chalimbana	Chongwe (Lusaka)	0.020	2.25	5.51	Mostly medium-size farmers: 113 lots supplied in 22 out of the 24 months, 24% with lot size decile ranking of more than 7, and 25% falling within the first 3 deciles.	Supply does not follow any seasonal pattern but peak supplies in May to September 2007, October, December, January 2008 and September to December 2008.	1,066
Mwaalumina	Chongwe (Lusaka)	0.018	1.88	4.80	Mostly medium-size farmers: 123 lots supplied in 13 out of the 24 months, 19% with lot size decile ranking of more than 7, and 35% falling within the first 3 deciles.	Main supply months are June to August and November/December.	1,055
Average for all areas		0.748	2.13	5.35			1,127

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Table 9. Key Characteristics of Top 12 Production Areas Supplying Lusaka with Rape, 1/15/07 to 1/15/09

Area	District (Province)	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (K/kg)
			Median Lot Size (MT)	Decile ranking of lot size	Farmer Description		
Kasisi	Chongwe (Lusaka)	0.269	0.54	5.63	Wide range of mostly medium-sized farmers: 1,321 lots supplied in 22ut of the 24 months, 30% with lot size decile ranking of more than 7, and 27% falling within the first 3 deciles.	Supplies mostly in period April to November with very negligible amounts thereafter. Peak supply is in May/June and August/September.	745
Manyika	Chongwe (Lusaka)	0.258	0.58	6.05	Predominantly large farmer: 1,041 lots supplied in all 24 months, 40% with lot size decile ranking of more than 7, and 28% falling within the first 3 deciles.	Supplies concentrated in the period May to October/Novembers. Supply peaks are in May/June and September/ October.	778
Mungule	Chibombo (Central)	0.062	0.40	4.40	Predominantly small farmers: 402 lots supplied in 22 of the 24 months, 17% with lot size decile ranking of more than 7, and 44% falling within the first 3 deciles.	Supply is mostly from April to December with peaks in May/June and September/November.	837
Chalimbana	Chongwe (Lusaka)	0.033	0.70	6.76	Predominantly large farmers: Supplied a total of 120 lots in 22 of the 24 months with 48% having lot size decile ranking of more than 7, and 18% falling up to the third decile.	Most supplies falling in the period April/May to October/ November. Peak supplies were recorded in May/June.	739
10 miles	Chibombo (Central)	0.032	0.42	4.88	Wide range of medium-sized farmers: 180 lots supplied in 22 out of the 24 months, 26% with lot size decile ranking of more than 7, and 40% falling within the first 3 deciles.	Very little supplies in most of 2007 (about 2-3MT though reached 17MT in November and 5MT in December). Supplies better in 2008 but still peaked to 18 MT in November from an average of 5MT/month.	957
Njolwe	Chongwe (Lusaka)	0.031	0.56	5.75	Wide range of medium-sized farmers: 147 lots supplied in 19 out of the 24 months, 31% with lot size decile ranking of more than 7, and 26% falling within the first 3 deciles.	Monthly supplies less than 5MT except for October/ November in 2007 and April to June and October and November in 2008.	788
Kanakantapa	Chongwe (Lusaka)	0.030	0.49	5.20	Predominantly small farmers: 159 lots supplied in 21 out of the 24 months, 23% with lot size decile ranking of more than 7, and 33% falling within the first 3 deciles.	Supplies generally less in 2008 than 2007. Supply concentrated in August to November with peaks in May as well.	793

Area	District (Province)	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (K/kg)
			Median Lot Size (MT)	Decile ranking of lot size	Farmer Description		
Chongwe	Chongwe (Lusaka)	0.024	0.49	5.45	Wide range of medium-sized farmers: 112 lots supplied in 16 of the 24 months with 30% having a lot size decile ranking of more than 7, and 31% falling within the first 3 deciles. Supplies more consistent and larger in 2008 than 2007.	Monthly supply was 4MT or less in 2007 but it exceeded this figure in 7 of the 10 months in which the area supplied. Peak months are May/June and October/November	848
Katende	Chongwe (Lusaka)	0.023	0.47	5.28	Wide range of medium-sized farmers: 115 lots supplied in 21 out of the 24 months, 28% with lot size decile ranking of more than 7, and 35% falling within the first 3 deciles.	Supplies concentrated in the period June to December with noticeable peaks in June/July and December.	854
Nangwenya	Chongwe (Lusaka)	0.022	0.92	7.33	Predominantly large farmers: Supplied a total of 70 lots in 15 of the 24 months with half of them having lot size decile ranking of more than 7 and only 11% falling up to the third decile.	Most supplies falling within the period May to October/November. Peak supplies were recorded in June/July and August/September	762
Nangoma	Mumbwa (Central)	0.020	0.43	4.57	Predominantly small farmers: 120 lots supplied in 21 of the 24 months, 15% with lot size decile ranking more than 7, and 41% falling in the first 3 deciles.	Supplies market with mostly rain fed crop during the period January to May with noticeable peaks in January, February and May. Very little is supplied after wards	980
Kampekete	Chongwe (Lusaka)	0.017	0.70	6.77	Predominantly large farmers: 61 lots supplied 18 out of the 24 months, 47% having lot size decile ranking of more than 7, and 15% falling within the first 3 deciles. Level of supply generally diminishing in 2008.	Supply exceeded 2MT in 6 of the 10 supply months in 2007, but only did so in 2 of the 9 supply months in 2008. Peak supply in period June to August.	726
Average for all areas		0.821	0.50	5.36			786

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Table 10. Key Characteristics of Top 12 Production Areas Supplying Lusaka with Onion, 1/15/07 to 1/15/09

Area	District (Province)	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (K/kg)
			Median Lot Size (MT)	Decile ranking of lot size	Farmer Description		
Mugabi	Zambia-Malawi border area	0.292	2.02	6.85	Predominantly large traders: 1,518 lots supplied in 21 out of the 24 months, 50% with lot size decile ranking of more than 7, and 18% falling within the first 3 deciles.	Supplies are mostly in the rain season from November to February.	1,400
Johannesburg	South Africa	0.286	1.15	5.14	Wide range to medium-sized traders: 2,415 lots supplied in 16 out of the 24 months, 24% with lot size decile ranking of more than 7, and 33% falling within the first 3 deciles.	Main supply months are February to June/July, peak supply month being April.	2,718
Eco Veg	Chibombo (Central)	0.068	1.76	6.35	Large farm: 248 lots supplied in 12 out of the 24 months, 43% with lot size decile ranking of more than 7, and 25% falling within the first 3 deciles.	Main supply months are June/July to November.	1,712
York Farm	Lusaka (Lusaka)	0.058	0.95	4.36	Large farm but purchases by mostly small traders: 716 lots supplied in 14 out of the 24 months, 15% with lot size decile ranking of more than 7, and 43% falling within the first 3 deciles.	Supplies do not seem to follow any season pattern.	2,259
Lusaka West	Lusaka (Lusaka)	0.054	1.19	5.26	Wide range of medium-sized farmers: 517 lots supplied in 17 out of the 24 months, 25% with lot size decile ranking of more than 7, and 28% falling within the first 3 deciles.	Main supply months are June/July to November.	1,952
Ambrosia Farm	Lusaka (Lusaka)	0.054	0.95	4.35	Large farm but purchases by mostly small traders: 677 lots supplied in 16 out of the 24 months, 12% with lot size decile ranking of more than 7, and 41% falling within the first 3 deciles.	Main supply months are June to October with peaks in August/September.	1,631
Makeni	Lusaka (Lusaka)	0.048	1.22	5.31	Wide range of medium-sized farmers: 414 lots supplied in 22 out of the 24 months, 27% with lot size decile ranking of more than 7, and 34% falling within the first 3 deciles.	Main supply months are July to February with peaks in October/November.	1,624
Mr. Brown	Kafue (Lusaka)	0.047	1.65	6.39	Large farm: 251 lots supplied in 15 out of the 24 months, 43% with lot size decile ranking of more than 7, and 21% falling within the first 3 deciles.	Main supply months are July to October/November.	1,723

Area	District (Province)	Market share	Farmer Size			Seasonality (Supply months)	Weighted Average Price Received (K/kg)
			Median Lot Size (MT)	Decile ranking of lot size	Farmer Description		
Water Green	Chongwe (Lusaka)	0.034	1.48	5.97	Large farm: 248 lots supplied in 17 out of the 24 months, 38% with lot size decile ranking of more than 7, and 23% falling within the first 3 deciles.	Main supply months are November to April with peak supplies in November/December.	1,518
Ever Green	Lusaka (Lusaka)	0.009	1.12	4.97	Large farm but purchases by mostly small traders: 94 lots supplied in 9 out of the 24 months, 21% with lot size decile ranking of more than 7, and 33% falling within the first 3 deciles.	Main supply months are January to July/August.	2,132
Palabana	Lusaka (Lusaka)	0.007	2.86	8.11	Predominantly large farmers: 28 lots supplied in 6 out of the 24 months, 69% with lot size decile ranking of more than 7, and 7% falling within the first 3 deciles.	Supplied only one lot in 2007 (September) and another larger one in 2008 (September). Supplied increased and peaked to more than 35MT in December, reduced again in January 2009 but was still higher than the 2007 levels.	1,249
Buya Bamba	Lusaka (Lusaka)	0.007	1.02	4.70	Large farm: 80 lots supplied in 8 out of the 24 months.,	Main supply months were January to May in 2008. Supply was very high in February (40 MT).	2,141
Average for all areas		0.964	1.50	6.04			1,839

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Only five of the 12 areas have their average weighted price higher than the overall average. These are South Africa, York Farm, Lusaka West, Ever Green, and Buya Bamba; the common factor across all is supplying onion from January to April/May, a high price period. In addition, three of these areas (York farm, Ever Green and Buya Bamba) are commercial farms. The rest of the areas mostly supply outside this period.

3.3. Main Market Channels and Their Characteristics

We characterize the market channels of the three vegetables in two ways. First, we compute weighted average price, market share, and seasonality of supply. The flow of each commodity from a supply area to Soweto can be either directly through farmers or through rural assemblers or traders who purchase the commodity from rural farmers and later supply Soweto market. Secondly, we used data from the price and quantity collection system in Soweto market, along with urban consumption survey results and interviews with sellers in Soweto to construct detailed channel maps for the three vegetables, tracking sources from production areas (local or imported) through traders or farmers to wholesale markets or directly to retail markets and from wholesale markets (mostly Soweto) to institutional buyers and exports outside Lusaka.

Retail channels for fresh produce include open air markets, the ka sector, modern supermarkets, and private households producing in or near the city and selling to other households. The main supermarket chain is Shoprite Checkers, which invested in 17 stores across Zambia (five in Lusaka) in 1997; over the past 3-4 years, Spar (a Dutch owned firm based on a franchising model) has opened four outlets, while the local chain Melisa now has three outlets. Shoprite Checkers procures fresh produce locally through Freshmark, its wholesaling partner.

Each map starts with three independent sets of numbers:

- The total reported value of in-home consumption by Lusaka households during February 2007 through January 2008, as estimated from UCS. This survey also allowed total consumption values to be broken down by the retail channel used by households (including own production and other households).
- The annualized total volume of product flowing through Soweto market from mid-January 2007 through mid-January 2009. This figure is converted to retail value – to be comparable to figures from UCS – using monthly retail prices weighted by monthly Soweto volumes.
- Volumes arriving into Soweto by supply area, and by whether the volumes are first purchased by traders in rural areas or taken directly to the market by farmers.

Information on supplies shipped from Soweto out of Lusaka and sold to institutional buyers is based on key informant interviews with brokers and wholesalers in Soweto, while volumes arriving into retail markets from other wholesale markets or directly from farmers come from the market mapping exercise discussed in the Data and Methods section. All percentages are based on our estimate of the total value at retail prices of all product flowing through the city; this is the sum of figures in all boxes located in the Retail section of each map. Sections 3.3.1 to 3.3.3 discuss the characteristics of retail channels and channel maps for each vegetable.

3.3.1. Tomato

Table 11 shows the market shares, weighted price and seasonality of supply of channels that supply Soweto market with tomato. Most tomato comes from large farm areas with a market share of 45% by volume followed by medium farm areas (44%) and lastly small farm areas (12%). Perhaps surprisingly, assembly traders play a greater role in large farm areas; in the other two areas, the volume of tomato sold directly by farmers in Soweto is greater than the volume sold to traders in rural areas, but in the large farm areas, this pattern is reversed. Deliveries from small farm areas through either direct farmer sales or sales through traders are mainly done in March to May. This crop is mainly rain fed, as small scale farmers in most areas do not have access to irrigation facilities. Deliveries from medium farm areas are done mostly in the dry season (May to December/January for direct farmer sales) when the crop is produced using late rains as well as irrigation from perennial streams or wetlands. Deliveries from large farm areas by either farmers or traders are done throughout the year. These are mainly from Mkushi in the rain season and then closer to Lusaka in the dry season.

Figure 6 shows a simplified channel map for the Lusaka tomato system. The independent rural farm sector provides 97% of the tomato marketed in Lusaka, with the remaining 3% likely coming from urban and peri-urban production and sold directly to households[9]. Only

Table 11. Characteristics of the Tomato Supply Channels into Soweto Market

Market channel	Weighted price (K/Kg)	Total value of quantities (K'million)	Market share by value (%)	Market share by volume (%)	Seasonality of supply
Small farm areas					
Direct farmer sales	1,089	1,220	7.3	7.3	Median lot size is 1.21MT and main supply months are March to May.
Sales to traders	963	651	3.9	4.4	Median lot size is 1.38MT and main supply months are March to May.
Total		1,871	11.2	11.7	
Medium farm areas					
Direct farmer sales	1,070	4,655	27.7	28.3	Median lot size is 2.41MT and main supply months are May to December/January.
Sales to traders	1,047	2,469	14.7	15.4	Median lot size is 1.77MT and main supply months are May to October.
Total		7,124	42.4	43.7	
Large farm areas					
Direct farmer sales	1,088	3,387	20.1	20.3	Median lot size is 3.42MT, supplied through out the year. Fifteen of the 24 months supplied more than 75MT.
Sales to traders	1,189	4,422	26.4	24.3	Median lot size is 3.26MT and main supply months are March to December. January and February are the only months with supplies less than 300MT
Total		7,809	46.5	44.6	

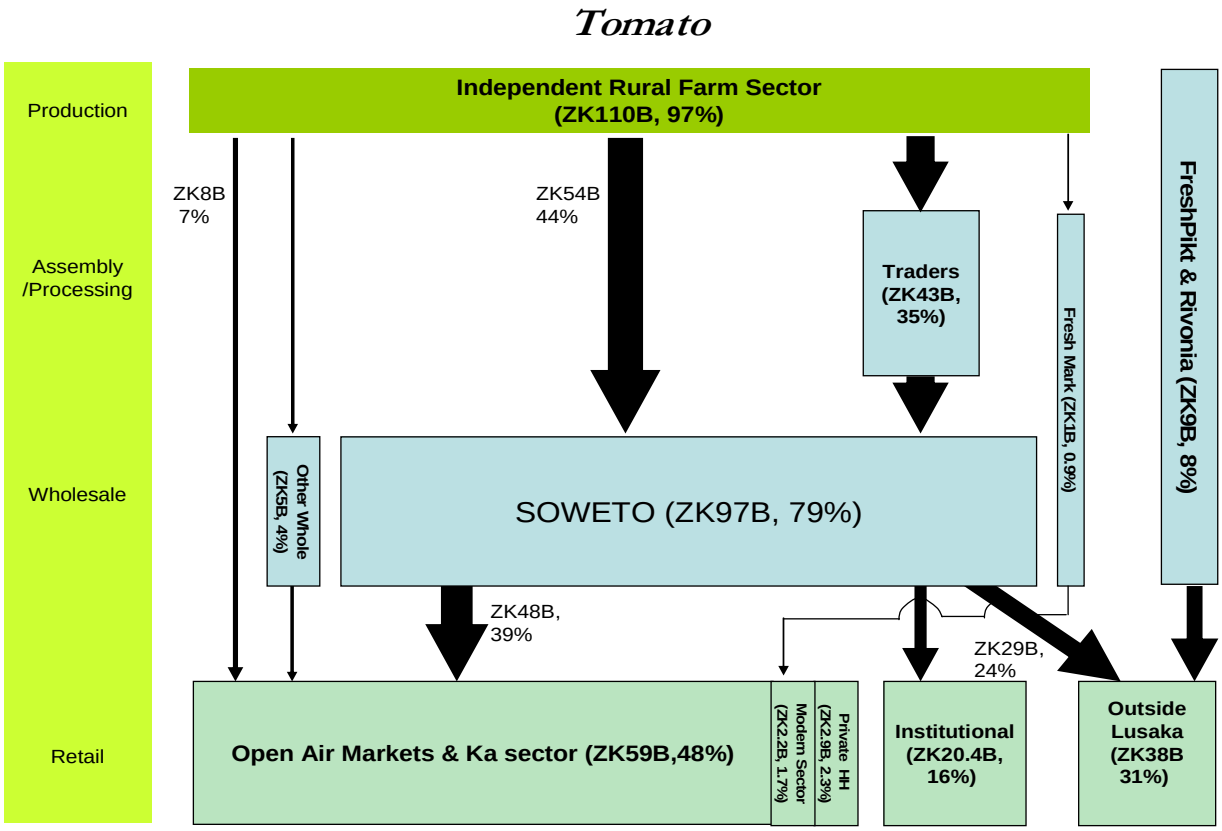
Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

[9] In all the maps, this value is approximately equal to the value in the *private hh* box at retail level.

35% of production from the independent rural farm sector is sold through traders or rural assemblers for sale to Soweto. Forty-four percent is sold by farmers directly to this wholesale market while 4% is sold by farmers to other smaller wholesale markets such as Bauleni market and Old Ngoma market and 7% is sold directly by farmers to retail markets. This shows that the market channels for the tomato system in Lusaka are quite short, contrary to common conception.

Of the quantity flowing into Soweto, 39% goes into open air retail markets and the ka sector with 31% going to institutional buyers such as restaurants, schools, hospitals, etc and 24% being exported out of Lusaka to places such as Livingstone, the Copperbelt, and the DRC. Some tomato from Freshmark is supplied into supermarkets, as is the case with processed tomato from Freshpikt and Rivonia, which is also exported. Thus, a total of 31% of tomato is shipped out of Lusaka. The market share of open air markets and ka sector dominates that of the modern markets (supermarkets, minimarts, grocers, etc). Its share is 48% compared to 1.7% for the modern sector and 2.3% for urban households[10].

Figure 6. Simplified Channel Map for the Lusaka Tomato System



Sources: CSO/MACO/FSRP Urban Consumption Survey 2007/08; FSRP Retail Markets Lightning Survey 2007; FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009, Mwiinga 2009.

[10] Note that, because all percentages have total supplies moving through Lusaka markets as the denominator, and because substantial supplies move out of Lusaka, the traditional sector's share in total retail trade within Lusaka – the typical indicator of market share -- is 48/(28+2.3+1.7) = 92%.

3.3.2. Rape

Table 12 shows main rape supply channels from production areas to Soweto market. Unlike tomato, the medium farm areas are the most important suppliers of rape, accounting for 50% of the total quantity supplied during the study period. The large farm areas accounted for 40% while the small farm areas accounted for only 10%. The flow of rape from all these areas through traders or rural assemblers to Soweto is insignificant (0.1-0.2%). The weighted price for rape supplied directly by farmers to Soweto from small farm areas is higher than that from medium and large farm areas. Rape in the small farm areas is produced and supplied in the rain season when supply is low and prices are high. Quite often, these small farmers do not have sufficient capacity for irrigated rape production. Conversely, farmers in the medium and large farm areas produce rape under irrigation and supply Soweto in the dry cool season when supply is high and prices are low.

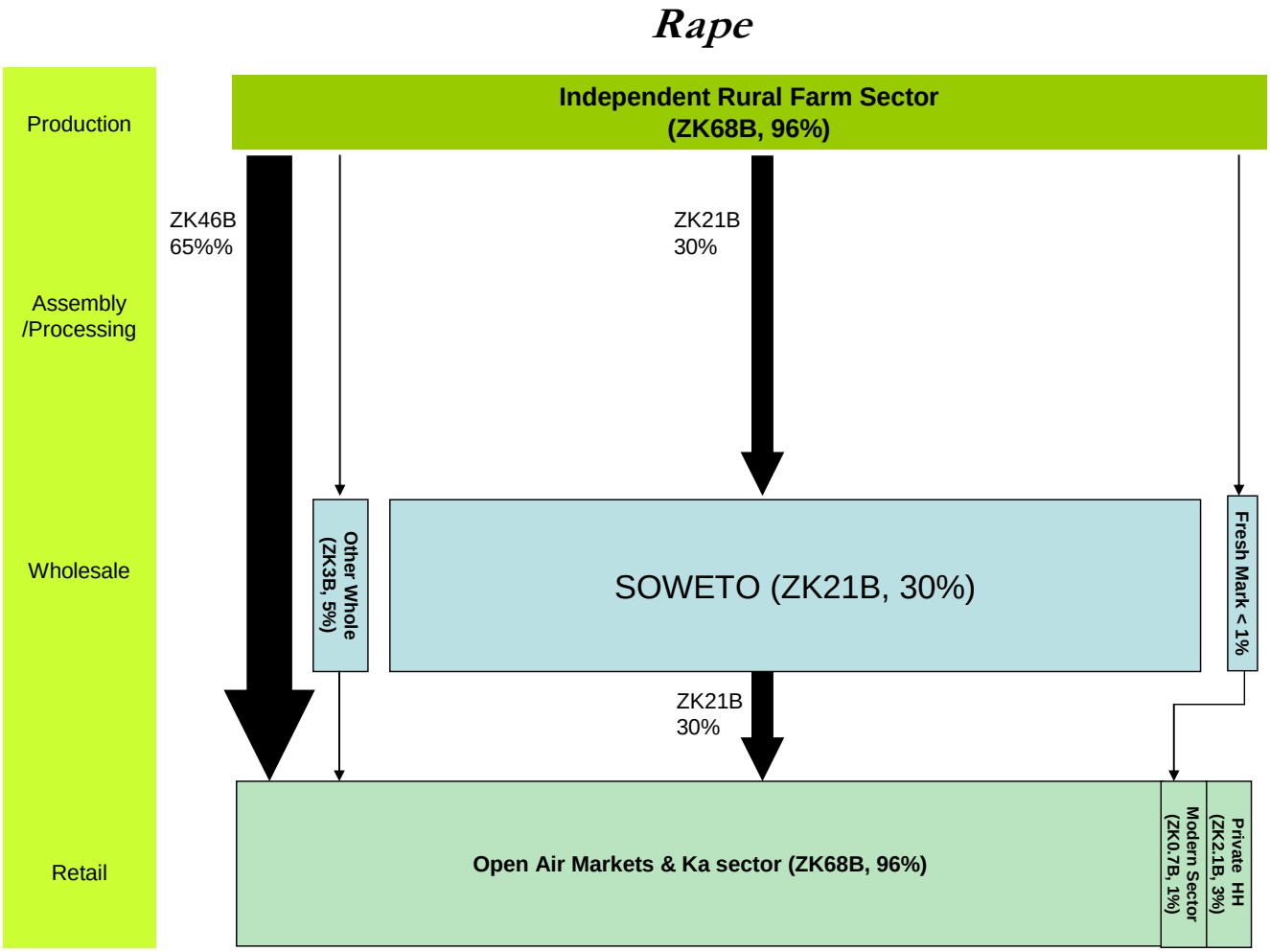
The simplified channel map for the Lusaka rape system is schematically shown in Figure 7. The figure highlights that the market channels for rape are even shorter than those of tomato, as 65% of the volumes supplied from the independent rural farm sector are directly sold by farmers to retail markets while 30% and 5% is supplied by farmers to Soweto market and to other smaller wholesale markets, respectively. There is no flow of rape through Soweto and then outside Lusaka and supplies to institutions are insignificant; institutions prefer cabbage, which is more convenient to handle and stores better. At the retail level, rape is marketed predominantly through open air markets and ka sector accounting for 96% of the market with the modern sector and private urban households accounting for only 1% and 3% respectively.

Table 12. Characteristics of the Rape Supply Channels into Soweto Market

Market channel	Weighted price (K/Kg)	Total value of quantities (K'million)	Market share by value (%)	Market share by volume (%)	Seasonality of supply
Small farm areas					
Direct farmer sales	898	281	11.5	10.3	Median lot size is 0.35MT. Had very low or no supplies passing through the channel in January to March. Seasonal supply variation/trend is not smooth with irregular peaks here and there.
Sales to traders	1.174	2	0.1	0.1	Had only 4 lots for the entire 24 months period
Total		283	11.6	10.4	
Medium farm areas					
Direct farmer sales	799	1,218	49.9	50.0	Median lot size is 0.51MT and main supply months are April to November
Sales to traders	1,174	4	0.2	0.1	Had only 4 lots for the entire 24 months period
Total		1,222	50.1	50.1	
Large farm areas					
Direct farmer sales	778	933	38.2	39.4	Median lot size is 0.63MT and main supply months are April/May to October/November.
Sales to traders	905	4	0.2	0.2	Had only 3 lots for the entire 24 months period
Total		937	38.4	39.6	

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Figure 7. Simplified Channel Map for the Lusaka Rape Marketing System



Sources: CSO/MACO/FSRP Urban Consumption Survey 2007/8; FSRP Retail Markets Lightning Survey 2007; FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

3.3.3. Onion

Table 13 shows the characteristics of the different onion market channels. Unlike the other two vegetables, most of the onion (58%) is imported and we considered these imports as a fourth area of supply. Within the local areas, onion is supplied mostly by medium (27%) followed by small (14%) and then large farm areas (2%). Onion from the small farm areas is predominantly supplied through traders (13% compared to 0.7% for direct farmer sales). This is not the case for the medium and large farm areas. Direct farmer sales in Soweto account for as much as two times that of trader sales in the large farm areas. The share of direct farmer sales in the medium farm areas is also higher but the difference is not as much as in the large farm areas. The weighted price obtained by traders is higher than that obtained by farmers for onion from all the local farm areas.

Table 13. Characteristics of the Onion Supply Channels into Soweto Market

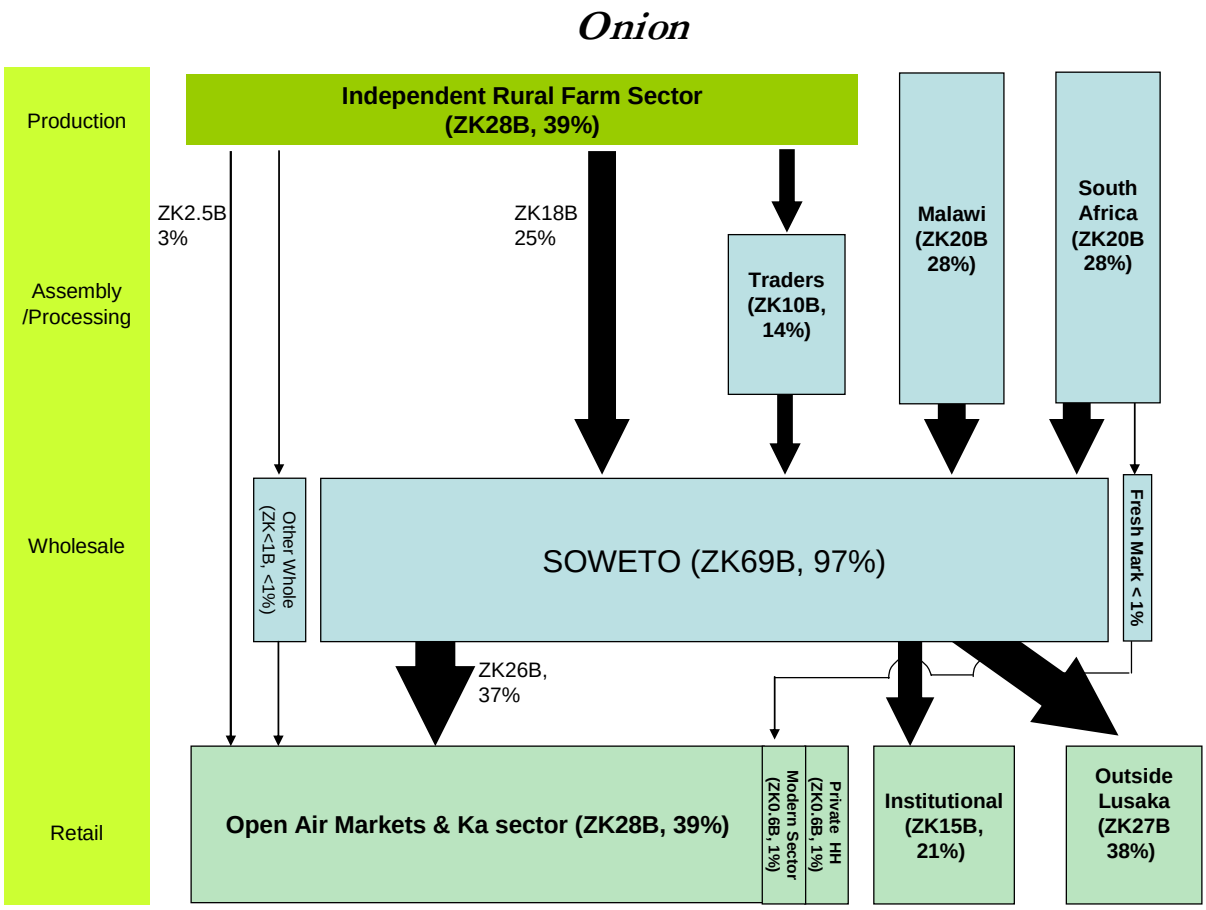
Market channel	Weighted price (K/Kg)	Total value of quantities (K'million)	Market share by value (%)	Market share by volume (%)	Seasonality of supply
Small farm areas					
Direct farmer sales	1,823	116	0.6	0.7	Median lot size is 1.32. Monthly volumes very low exceeding 5MT only in June, July and November 2007 and January 2008 (22MT).
Sales to traders	2,124	3,824	14.1	13.0	Median lot size is 0.95MT and main supply months are June to October and February/March.
Total		3,940	14.7	13.7	
Medium farm area					
Direct farmer	1,543	3,007	11.4	14.4	Median lot size is 2.11 MT and main supply months are August/September to November/December
Sales to traders	1,781	3,004	11.4	12.5	Median lot size is1.04MT and main supply months are June/July to December with peak supplies in August.
Total		6,011	22.8	26.9	
Large farm areas					
Direct farmer sales	1,235	111	0.8	1.2	Median lot size is 2.61MT. New supply entrants (September 2008) from Palabana, in Chongwe. Supply peaked in October (32MT) and continued to January 2009 at lower levels.
Sales to traders	1,406	12	0.6	0.5	Median lot size is 2.47MT. Supply months were October 2008, November and then December 2008 with supply volume ranking of that order.
Total		123	1.4	1.7	
Areas outside the country					
Sales from South Africa by traders	2,718	11,259	40.0	28.6	Median lot size is 1.15MT. Main supply months are February to June/July, peak supply month being April.
Sales from Mugabi by traders	1,400	5,930	21.1	29.2	Median lot size of 2.02MT. Supplies are mostly in the rain season from November to February. Supplies come from Mugabi area.
Total		17,189	61.1	57.8	

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

The onion from South Africa is the most expensive, which this understandable in view of the distance it has to be transported to Lusaka and the fact that it is of higher quality as it is cured and stores for a longer period of time. Very few onion producers in Zambia have facilities for artificial drying (curing) of onions. The onion from the Zambia-Malawi border area is the cheapest. It is usually sold fresh and is mostly supplied from November to February after which the South African onion starts coming in up to June/July. This is when most locally produced onion starts entering the market up to November/December.

Figure 8 presents a simplified channel map for the Lusaka onion marketing system. The independent rural farm sector supplies 42% of the onion flow into Lusaka. Out of this, 25% is sold directly by farmers to Soweto market while only 14% is supplied to this market through sales to traders. Another 3% is supplied by farmers directly to retail markets. From the onion reaching Soweto market, 37% moves to retail markets, 21% to institutional buyers and 38% is shipped out of Lusaka to places such as Livingstone, the Copperbelt, and the DRC. At retail, open air markets account for 39% of the onion market while the modern sector and urban households account for 1% each.

Figure 8. Simplified Channel Map for the Lusaka Onion Marketing System



Sources: CSO/MACO/FSRP Urban Consumption Survey 2007/8; FSRP Retail Markets Lightning Survey 2007; FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

3.4. The Role of Brokers

Brokers – agents who arrange sales without taking ownership of the commodity, earning their money on a commission – are a common and frequently controversial presence in wholesale markets of east and southern Africa.[11] Farmers in Zambia have mixed opinions of brokers. During a rapid appraisal of Zambia's domestic horticultural chain in 2006 (Hichaambwa and Tschirley 2006), some farmers intimated that they are forced to sell through brokers via threats of stealing products if they try to sell on their own. On the other hand, a group of fresh vegetable farmers involved in a micro-irrigation project in Chongwe district, who regularly supply Soweto market (and to a lesser extent other wholesale markets), were of the opinion that these brokers provide some level of service. Though brokers charged about 10% commission on sales, farmers developed mutual relationships with them over time that provided greater security for their product in the market and better sales opportunities. Yet even this group lodged a common complaint – incidents of the brokers adding price mark-ups, which they took for themselves without the farmers' knowledge, in addition to the commission; those farmers who do not know these agents well may be at higher risk of experiencing these problems.

Brokering services can improve market efficiency by economizing on search effort (Gabre-Madhin 2001); by developing expertise in gathering information on buyers and sellers and bringing them together to effect transactions, without having to put time and effort into managing the substantial price risk inherent in fresh produce markets, an efficient and competitive set of brokers can match supply with demand at lower cost than if all sellers and buyers engaged in *bilateral search* – each conducting their own search. Largely for this reason, South Africa's system of modern wholesale markets is legally based on a brokerage model: all produce arriving in these markets must be sold through brokers. Actual performance of a brokering system can be reduced in several ways: brokers may not behave competitively, they may be able to hinder the free flow of information on supply and demand conditions or on the commissions they are charging, or bilateral search costs may be low (suggesting little advantage from brokering for the system) but buyers and sellers may be prevented (either by law or by collusive behavior among brokers) from conducting their own search and negotiating their own transactions.

Formally testing for the efficiency of a brokering system would require data at the level of individual transactions on the search costs of buyers and sellers and on the commissions they paid, and estimates of the opportunity cost of their time. Higher search costs and opportunity costs of time should increase the likelihood of a transaction occurring through brokers, and commissions should be in line with the sum of these costs. In the absence of such data, we can nevertheless develop testable hypotheses and may be able to draw suggestive insights regarding the efficiency of this process in Soweto market.

First, in the absence of legal mechanisms either requiring or precluding brokering, and under the assumption that search costs and opportunity costs of time differ across buyers and sellers, we expect to find a mix of brokered sales and direct sales. Second, due to the absence of a cold chain, we expect that the more perishable items will more likely be sold through brokers, since failing to find a buyer early in the day can result in major financial losses for the seller. This suggests that rape should have the highest rate of brokerage and onion the lowest. Third, traders selling in the market should be less likely than farmers to use brokers, since traders have more frequent exposure to the market, more opportunity to develop

[11] Gabre-Madhin (2001) analyzes brokers' contribution to grain market efficiency in Ethiopia.

relationships with retail buyers, and so should have lower search costs. Finally, if brokerage services are offered competitively, we expect that sellers with large quantities to transact will be more likely to do so through a broker, since they face a higher risk of not selling their entire product and may also have higher opportunity costs of time, both of which favor brokering. We also suspect that such sellers are generally better connected and more knowledgeable of the market and its participants. If so, this means that such sellers have lower search costs (thus reducing the likelihood of brokering) and are less likely to be maneuvered into a brokered transaction against their will by non-competitive brokers. A finding that large sellers are more likely to sell through brokers may thus be evidence that, at least in their cases, brokers are offering a valued service to sellers. At the same time, such a result could suggest that smaller sellers who may benefit most from access to efficient brokering services (due to high search costs) are not able to gain that access, because brokers focus their effort on larger sellers.

Other factors may also affect the likelihood of a transaction being brokered, though we cannot form clear *a priori* expectations regarding the direction of effect:

- We know that nearly all brokers in Soweto are male; might they be more able to foreclose direct sales opportunities among female sellers, increasing the likelihood of brokered sales? On the other hand, females may value their time differently from males, resulting in differing decisions even in the absence of manipulative behavior by brokers. More conceptual and empirical work is needed to form clear expectations in this regard; here we can only test for the presence and direction of any effect.
- Total volumes arriving on the market will also have an ambiguous effect on brokering. Low volumes will be associated with fewer sellers, suggesting lower search costs, and reduced demand for brokering services. Yet because fluctuations in daily volumes arriving on the market are unpredictable (see section 4), the total number of brokers operating in the market on a given day may show little flexibility. This means that the supply of brokering services *per unit volume arriving on the market* may rise substantially when volumes unexpectedly fall. If this is the case, then the brokers' commission could fall and the likelihood of a brokered transaction could rise.

Tabular analysis suggests that our first three expectations are confirmed (Table 14): with the exception of rape, essentially all of which is sold through brokers, we see a mix of brokered and unbrokered transactions; onion as expected shows by far the lowest rate of brokered transactions; and for both tomato and onion, farmers are more likely than traders to sell through brokers. Differences between farmers and traders selling tomato, however, are not large – 99% of tomato farmers sell through brokers while 89% of tomato traders do so – suggesting that perishability may be a more important factor than search costs in driving the seller's decision.

Table 14. Role of Brokers in Lusaka, by Crop

	Crop		
	Tomato	Rape	Onion
	——— share of transactions using brokers ———		
Total	0.886	1.00	0.116
By farmer first sellers	0.985	1.00	0.861
By trader first sellers	0.851	1.00	0.027

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

To test our fourth hypothesis, and also to explore the relationship between brokering and the gender of the seller and the total quantity of product on the market, we conduct a probit analysis using data collected from 29 October 2007 to 16 November 2009[12]. Data is at the level of individual sales lot, allowing us to explore all the hypotheses and relationships discussed above, including our important fourth hypothesis. We exclude all rape transactions because essentially all of them are conducted through brokers. By including mean daily quantities transacted in the market over the past month in addition to monthly dummy variables, we control for two aspects of potential seasonality: total volumes being transacted through the lagged quantity variable, and weather effects (heat and precipitation and their effect on product quality) through the monthly dummies. Because seasonal patterns are different for onions and tomato, we run separate regressions for each crop, in addition to one regression pooling both crops.

Marginal effects are shown in Table 15 for the three regressions. Consistent with the bivariate results, farmers in all three regressions are much more likely than rural assembly traders to sell through brokers, and the small number of wholesalers that operate in the market are less likely than rural assembly traders to use brokers. Women in all three regressions are more likely than male sellers to use brokers.

Table 15. Marginal Effects from Probit Analysis of Determinants of Selling through a Broker

	Tomato & Onion	**Tomato**	**Onion**
Number of observations	21,592	13,642	7,211
Prob>chi2	0.000	0.000	0.000
Pseudo R2	0.797	0.660	0.615
Log likelihood	-2,952	-1,643	-1,058
Variable	**Dy/dx**	**Dy/dx**	**Dy/dx**
Continuous variables			
Log quantity being sold (seller's lot size)	0.082***	0.011***	0.021***
Log total quantity sold in market that day	-0.060***	0.008	-0.024***
Log mean daily quantity sold in market over past month	-0.042***	0.003	-0.023***
Trend (week)	-0.000	0.000	-0.000
0/1 variables			
Seller is a farmer (trader excluded)	0.661***	0.236***	0.756***
Sellers is a wholesaler (trader excluded)	-0.568***	-0.563***	-0.020*
Seller is female (male excluded)	0.171***	0.030***	0.108***
Product being sold is onion (tomato excluded)	-0.715***	–––	–––
January (relative to June)	-0.002	-0.033**	0.036*
February (relative to June)	0.068***	0.006	0.032
March (relative to June)	0.090***	-0.004	0.111***
April (relative to June)	0.027	0.015**	-0.038***
May (relative to June)	-0.025	.019***	–––
July (relative to June)	-0.011	-0.018	0.022
August (relative to June)	0.016	-0.023*	0.046*
September (relative to June)	0.029	-0.015	0.033
October (relative to June)	0.143***	0.002	0.141***
November (relative to June)	0.170***	0.010	0.168***
December (relative to June)	0.102***	0.011	0.108***

Dependent variable is 1=sale made through broker, 0=sale made directly to retailer
**** Significant at 1% level; ** 5%; * 10%*

[12] Data on whether a seller was selling through a broker only began to be collected at end of October 2007.

Seasonal patterns (monthly dummies) are not easily interpretable. Use of brokers for selling onions appears to be higher during the hot and wet months of October through March, but this pattern does not hold for tomato. These differential results may relate to the fact that tomato volumes in Soweto have shown a much less stable seasonal pattern since 2007 than has onion (see section 4.1).

Our most important result is that the seller's lot size in all three regressions is positively and significantly associated with the probability of selling through a broker. To further probe the robustness of this result, we ran two other regressions, one limited to farmers and another limited to traders. In each case, seller's lot size remained positive and significant. As argued above, this result may suggest that, at least for these larger sellers, brokering services are adding value and involve a free choice by the sellers. The results are also consistent with brokers being more interested in working with larger sellers and perhaps not making these services available to the smaller sellers who may be most in need of them. On balance the results, though suggestive rather than definitive, paint a less negative picture than is typically held of brokering activities. Key concerns do remain regarding the lack of transparency in commissions, and more understanding is needed regarding the details of the brokering relationships and the level of free choice by sellers who end-up transacting through brokers.

4. PRICE BEHAVIOR

This section examines price seasonality, estimates price flexibilities, and quantifies daily variability and predictability of prices.

4.1. Wholesale Price Seasonality

We estimate seasonal price indices for each crop by regressing daily average prices against monthly dummy variables, saving the predicted value, and standardizing it by dividing by the mean price over the entire period of analysis. To assess the stability of the seasonal price pattern, we plot three lines: the seasonal index, the index plus the median negative prediction error, and the index plus the median positive prediction error. The resulting bound is a 50% confidence interval on the index; 25% of daily price observations fall below the lower line and 25% above the upper line.

Based on weather patterns and interviews with brokers in Soweto, tomato is expected to show seasonal supply peaks (low price periods), immediately after the wet season from April to October, with very little supply and high prices in the rainy season from November to March. For rape we expect one long season of high supply and low prices during the dry months of May to November. Onion is expected to be similar to tomato, with low supplies and high prices from April to July.

Actual price seasonality follows these expectations most closely for rape, followed by onion, with tomato diverging widely from expectations (Figure 9). The 50% confidence intervals on the tomato seasonal index are also the widest, especially during the anticipated high price season of May through July. In fact, during only one month (August) did daily tomato prices have a better than 75% probability of lying above or below the mean price over the entire period of analysis[13]. Rape prices reached this threshold during five months (February and December above the mean; June, August and September below it) while onion prices reached the threshold during seven months (April through June above the mean; October through February below it). This instability in tomato's seasonal price pattern is linked to known problems with groundwater availability in key producing areas; in managing disease outbreaks may also have played a role. Rape's seasonal pattern is more stable because most of it is produced in low-lying areas near river banks during the dry season, minimizing the risk of water shortages and (by producing less during the rainy season) avoiding disease problems. Onion's relatively stable seasonal pattern derives primarily from the ability of traders to draw from a wider geographic range to supply Lusaka. Note, however, that onion shows greater (though stable) seasonal variation than the other two crops, with seasonal highs of 1.5 times the mean price, and lows of 0.5; equivalent figures were 1.2 and 0.62 for tomato, and 1.65 and 0.7 for rape.

[13] These months are identified by the top line lying below the mean – indicating a 75% probability of prices that month lying below the mean -- or the bottom line lying above it – indicating a 7% probability of prices that month exceeding the mean.

Figure 9. Seasonal Price Indices for Tomato, Rape, and Onion in Lusaka

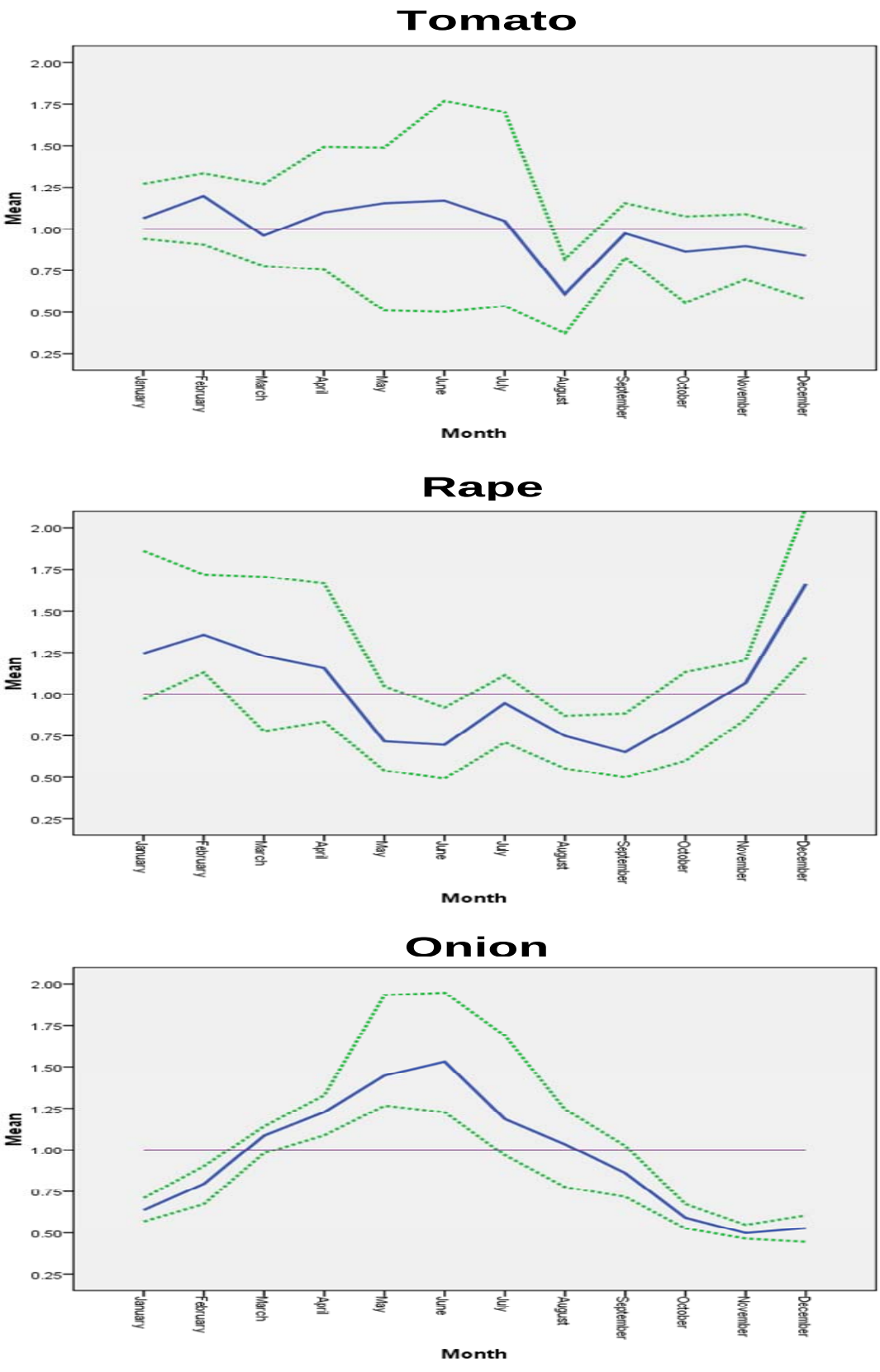


Figure 10 shows the observed price patterns of the three crops during the entire study period. While the expected low price periods for tomato were April and May and then from August to October, analysis of data shows that the period of low prices during 2007 actually extended over the entire period from April to October, though, there were small peaks and troughs within this period. The seasonal pattern in 2008 diverged sharply from expectations around April/May due to problems accessing irrigation water in Lusaka West, one of the major supply areas. Price patterns for rape and onion largely followed expectations.

4.2. Price Formation: Daily and Weekly Price Flexibility

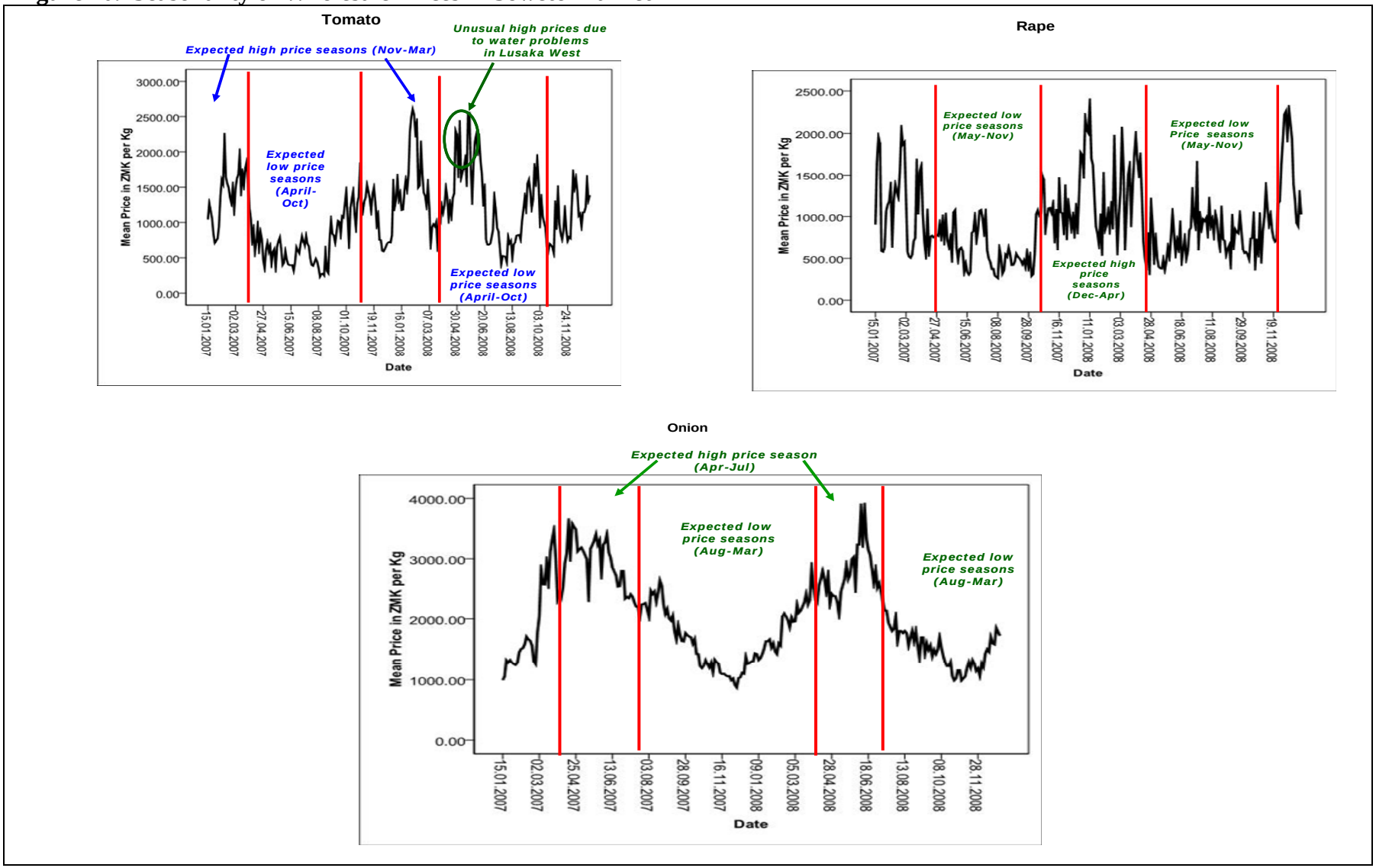
Perishable commodities depend on some combination of cold storage, strong information flows between buyers and sellers, and effective control of production environments (through irrigation and pest management) to regulate flow of product to the market and avoid dramatic price swings. South Africa has all three: very large producer-shippers that dominate that market have cold transport and access to the inputs and knowledge they need to avoid most dramatic fluctuations in output, and brokers operating in the country's wholesale markets communicate constantly with farmers and buyers to match supply to demand. In Zambia, traditional fresh produce supply chains handle over 90% of all marketed fresh produce (see section 3). Production in these chains is dominated by (compared to South Africa) small- and medium-scale farmers, many of whom have poor access to inputs and appropriate extension advice and thus face very high variability in yields. Most sales go into an atomistic retail sector that makes it very difficult for brokers to anticipate demand, even if farmers were able to respond to attempts at active coordination by the brokers. Finally, these chains have no cold storage, meaning that wholesale prices for products like tomato and (especially) rape must adjust daily to clear the market. Under these conditions, price variability can be extreme, with negative implications for farmers and consumers.[14]

This section first quantifies variability in daily prices and quantities at wholesale in Lusaka. It then estimates price flexibility coefficients for each crop and reaches tentative conclusions regarding market behavior on this basis. Table 16 presents selected measures of variability in daily average prices and market quantities in Soweto. The coefficient of variation captures both day-to-day fluctuations and longer seasonal variation; the other two measures eliminate seasonal variation to focus on day-to-day variability. Five points stand out. First, daily quantities arriving in the market fluctuate dramatically for each crop: mean day-to-day changes[15] (absolute value) in quantities arriving on the market are 29% for tomato, 32% for rape, and 56% for onion. For all three crops, these changes exceed 20% in absolute value more than half the time. Second, this variability in quantities drives great variability in prices for rape and tomato, which see mean day-to-day absolute price changes of 30% and 20%, respectively. Third, in all cases, prices vary less day-to-day than do quantities. This differential is dramatic for onion (which has the highest variability in quantities) but is explained by the storability of this crop, which allows market supply to differ from quantities arriving at the market; much of the onion arriving on any given day is put into storage rather than being offered for sale. For rape and tomato, neither of which can be stored to any significant degree, the pattern suggests a perhaps surprising elasticity of demand, at least in the short-run; if demand were relatively fixed, then fluctuations in quantities would drive even larger fluctuations in price, but instead we see the reverse.

[14] See Mwiinga 2009 for a detailed assessment of production and price risk for tomato in Zambia.

[15] Note that all these calculations are based on Monday-Wednesday-Friday data collection, meaning that two thirds of the computed *day-to-day* changes occur over two days, and one third over three days.

Figure 10. Seasonality of Wholesale Prices in Soweto Market



Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Table 16. Selected Measures of Variability in Prices and Quantities for Tomato, Rape, and Onion (Soweto Market, January 15, 2007 to November 16, 2009)

	Tomato		Rape		Onion	
Variability measure	Price	Quantity	Price	Quantity	Price	Quantity
CV	0.51	0.31	0.48	0.41	0.41	0.47
Mean day-to-day absolute % change	20%	29%	30%	32%	7%	56%
Share of day-to-day changes > 20%	39%	51%	52%	56%	5%	64%

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Finally, tomato prices vary substantially less day-to-day than do rape prices, despite comparable variability in quantities. We will explore the mechanisms behind these last two points below.

We now examine price behavior more formally by estimating price flexibilities for each crop. Price flexibility indicates how much prices change, in percentage terms, for a one percent change in quantity entering the market. They are a commonly used indicator of market behavior and are especially appropriate in a system such as Lusaka's, where various factors combine to make quantities entering the market a largely independent or "exogenous" factor. The question then is to what extent the marketing system is able to dampen the effects of fluctuating quantities on prices. Given physical characteristics of the crop and of consumer demand, high price flexibilities are associated with *less* flexible and less stable systems: systems that are less able to slow or speed the flow of product from farmer to consumer in response to changing circumstances and in which, for that reason, prices must bear the brunt of most adjustment. High price flexibilities mean high price instability for a given instability in quantities arriving on a market; when these quantities are themselves highly variable, the resulting price instability can impose high costs on farmers and consumers. Marketing systems as a result seek ways to reduce price flexibility.

Our regression takes the form:

$$\ln P_t = \alpha + \beta_1 \ln Q_t + \beta_2 \ln P_{t-1} + \beta_{3i} D_i + e_i \qquad (1)$$

where,

P_t = this period's average price,
Q_t = mean daily quantity arriving in the market this period,
P_{t-1} = last period's average price,
D_i = 11 monthly dummy variables,
e_i = a normally distributed error term, and
ln denotes the natural logarithm

Estimation is in Stata with Prais-Winsten correction for first order serial correlation and robust standard errors. β_1 is the price flexibility, indicating the percent change in price for a one percent change in quantity arriving on the market. Because our three crops are staple vegetables consumed on a nearly daily basis by most households, we expect their demand to be price inelastic, meaning that quantity demanded by consumers is likely to change little in response to price changes. In the extreme case of zero storage due to perishability past the day of harvest, we would therefore expect fluctuations in quantities to drive proportionally larger changes in price; price flexibilities would lie above unity. In the more realistic case

where some very short-term storage (2-3 days) is possible, flexibilities in high frequency (e.g., daily) data could lie below unity, rising and eventually exceeding unity as data frequency diminishes (e.g., from daily to weekly to monthly data, meaning that the period between successive rounds of data collection exceeds feasible storage times).

Storage can in principle occur at four levels in the system: at the farm, at the wholesale market, among retailers who do not sell all their product in one day, and among consumers who buy more than one day's supply at a time. Storage at farm level is not relevant to our analysis, since our quantity data is for volumes arriving at the market. These data show that ending stocks of tomato and rape average only 15% and 2%, respectively (compared to 89% for onion), of daily volumes arriving at the market; rape is essentially not stored at wholesale level, and tomato storage is also very low. On the other hand, we know that retailers typically keep tomatoes for 2-3 days, and may even keep rape until the next day if they don't succeed in selling it all. Urban Consumption Survey data indicates that 45% of Lusaka consumers own a refrigerator, suggesting that some of these households may be able to store 2-3 days' supply of rape and perhaps a week's supply of tomato.

Our channel maps highlight several other avenues for reducing price flexibility (instability) in Soweto. First, because retailers purchase a large share of their rape directly from farmers, they can decide whether to purchase from farmers or from brokers at Soweto depending on relative prices. Second, we know that retailers buy entire plots of rape and can then harvest it over a period of time. This procedure may help to reduce price flexibility by keeping the product for an additional day or two in the field if prices are low. The final potential mechanism for reducing price flexibility highlighted by the channel maps is shipping outside of Lusaka. If these shipments can be made on short notice, in response to large arrivals in Soweto, or delayed when little product arrives, they will reduce price flexibility (increase instability); if instead they are contracted and must be shipped on an agreed schedule, they can increase price instability. Given what we know of how the marketing system functions, we expect the former, more flexible situation to prevail and therefore expect that these shipments will reduce price flexibility. Note that rape is not shipped outside of Lusaka in any meaningful volume, suggesting another reason, in addition to its greater perishability, to expect high estimated price flexibilities for this crop.

We estimate two models for each crop: one with daily data and a second with weekly data (Table 17). Based on the discussion above, our expectation is that price flexibilities will be well below unity for onion in both models, will be highest for rape in both models, and will be substantially lower for tomato and rape in the daily model than in the weekly model.

Results strongly confirm these expectations. Daily onion prices are unaffected by the same day's quantity, being driven entirely by seasonal fluctuations in supply (captured by the monthly dummies) and by the previous day's price; together these explain nearly all the variation in the daily onion price. Onion's price flexibility becomes statistically significant but remains very small in the weekly model. Rape has the highest flexibility, at -0.79 in the daily model and nearly unity in the weekly model. The fact that rape's price flexibility does not exceed unity even in the weekly model – well beyond the time that the product can be stored except in refrigerators – suggests that retail traders' direct purchases from farmers help to stabilize wholesale market prices of this crop. Tomato has quite a low flexibility in the daily model (-0.28), suggesting that storage of 2-3 days at retail and consumer levels is quite common, and probably also that shipments outside of Lusaka act to stabilize the market. This crop's flexibility rises markedly in the weekly model, to -0.89.

All in all, this analysis suggests that Lusaka's traditional marketing system, despite no cold chain below the consumer level and difficulty coordinating supplies between a large number of small farmers and small traders, has found ways to reduce the effects of highly fluctuating quantities on price fluctuations. It is notable that flexibilities for tomato and rape remain below unity even beyond the time period that retailers and most households can reasonably be expected to store these products; shipment of tomato outside of Lusaka and procurement of rape directly from farmers are the two most likely mechanisms driving this result.

Yet even with these stabilizing mechanisms, wholesale prices are highly variable, due to even greater variability in the daily quantities flowing into the market (Table 16). Key challenges, then, are to assist farmers to better control their production environments (with irrigation, better access to inputs, and greater agronomic knowledge) and to improve the vertical flow of information in the chain so that demand and supply can be matched without the dramatic price adjustments seen in Table 17.

4.3. Wholesale Price Predictability

We have seen that wholesale prices of the three crops we are studying are quite variable though the degree of variation differs from vegetable to vegetable. While price variability refers to the state of prices being variable over a given period of time, price predictability

Table 17. Regression Results for Estimation of Daily and Weekly Price Flexibilities at Wholesale in Lusaka

	Daily			Weekly		
	Tomato	Rape	Onion	Tomato	Rape	Onion
N	357	353	343	139	140	137
R-square	0.92	0.91	0.99	0.85	0.82	0.98
Dependent var=log(price)						
Independent variable						
Log(quantity)	-0.28***	-0.791***	-0.001	-0.891	-0.966***	-0.091***
Log(lagged price)	0.16***	0.128***	0.615***	0.535	0.235***	0.932***
Log(time)	0.08***	0.048***	0.008	0.024	0.047***	-0.001
January	0.045	-0.040	-0.026	0.032	-0.031	-0.014
February	0.084	-0.023	—	0.006	-0.090**	—
March	0.056	0.025	0.058***	-0.010	0.012	-0.004
April	0.003	0.048	0.071***	0.006	0.018	-0.001
May	0.052	-0.029	0.090***	-0.019	-0.004	-0.001
June	-0.020	-0.070	0.087***	-0.047	-0.018	-0.032
July	-0.091	0.020	0.043*	-0.087	0.029	-0.062***
August	-0.166**	-0.022	0.032	-0.100	0.036	-0.040***
September	-0.098	-0.042	-0.019	-0.048	0.008	-0.067***
October	-0.110	-0.021	-0.074***	-0.121	0.004	-0.087***
November	—	—	-0.077***	—	—	-0.036**
December	0.049	-0.028	-0.069**	0.065	-0.092	-0.014
Constant	3.56***	3.56***	1.22***	5.71	6.13***	0.672***
Transformed Durbin Watson	2.00	1.92	1.69	1.98	1.98	2.06

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

refers to the degree to which prices can correctly be forecasted. Price variability is generally inversely related to price predictability: more variable prices are typically more difficult to predict. Prices normally exhibit seasonal variation based on the seasonality of production; when seasonal production patterns are stable across years, prices can be predicted with more accuracy. Yet as we have seen with tomato, expected seasonal production patterns can be disrupted some years. Price variability can also be compounded by random variations in arrivals on the market, which are more likely when information flow through the system is poor. As a result, predicting fresh produce prices can be exceptionally difficult. Knowledge of the patterns of price variability and the forces behind it helps better understand and manage price risks. This is very important because farmer incomes are directly affected by price levels in the market.

We used the conditional variance to determine the level of price predictability of the three crops. The conditional variance is simply the variance of prices around an *expected price*, rather than the variance around the mean. To estimate the expected price and then derive the conditional variance, we first generated a prediction model for each crop based on a simple farmer price expectation process. The model takes the following form;

$$\log P_t = \alpha + \beta_1 \log P_{t-1} + \beta_2 \ln T_t + \beta_{3i} D_i + e_i \qquad (1)$$

Where;

- P_t is the dependent variable and represents the predicted price in time t;
- D_i are dummy variables for the months of January through December, excluding the month which has a price closest to the mean. These dummy variables were included in the model to take account of the influence of seasonality in production on prices.
- P_{t-1} is the two period lagged price. This is included in the model to take into account the influence of the previous prices on the current price and it was taken as the price a farmer will most likely look at in forming a price expectation.
- T_t is a time variable to control for linear trends in the model; over this short time period, T can be interpreted as controlling for inflation.
- e_i is a normally distributed error term.

Estimation is in Stata with Prais-Winsten correction for first order serial correlation and robust standard errors. Note that the model is the same as that used in Table 17, except that it excludes the day's quantity, since farmers and traders cannot know them ahead of time and so cannot use them to form expectations. The results of the regression including model summaries, mean standardized price residuals by crop, and prices and standardized predicted values for the respective crops are found in Appendix A.

Using the residuals from the regression outputs, the conditional variance was calculated as:

$$\text{Conditional Variance} = \frac{\sum_{t=1}^{t=n}\left(\frac{P_t - \hat{P}_t}{P_t}\right)^2}{n} = \frac{\sum_{t=1}^{t=n}\left(\frac{u_t}{P_t}\right)^2}{n}$$

Where;

P_t is the observed prices in the market,

$\hat{P}_t$ is the predicted price in time t,

u_t is the error term or residual, and

n is the number of price observations

To ensure that the conditional variance is unit free and comparable across crops, it was standardized by first dividing the residual (u_t) by the price. The standardized residual in the model was then squared. Squaring of the residual widens the gap between a big price prediction error and a small one.

Based on the above analysis, tomato prices are the most difficult to predict, followed by rape and lastly onion. The mean conditional variances for the entire period under study were 2,997, 1,676, and 232, respectively. The very low value for onion is consistent with results from the flexibility and seasonality analyses, which showed (a) no effect of (unknown ahead of time) daily quantities on the daily price and (b) a fairly stable seasonal pattern over our two years of analysis. The seasonality and flexibility analyses for rape and tomato showed contrasting patterns: rape's seasonal pattern was much more stable than tomato's (this should increase price predictability for rape compared to tomato) but rape daily price was much more sensitive to daily quantities than tomato (reducing rape's price predictability). The very high conditional variance for tomato shows that the instability in its seasonal pattern dominated, making its prices less predictable than those of rape.

Conditional variances varied quite a bit across months, especially for tomato and rape. Figure 11 shows monthly mean conditional variances by crop. The conditional variance for tomato is highest from April to June and in August; prices were unusually high during these months in 2008 due to reductions in irrigation water availability in Lusaka West, which is one of the major supply areas. Rape's conditional variance was highest in March with peaks and troughs following each other across the months, but on average were much lower than that of tomato. As expected, the conditional variance of onion is almost constant across months and very low on average.

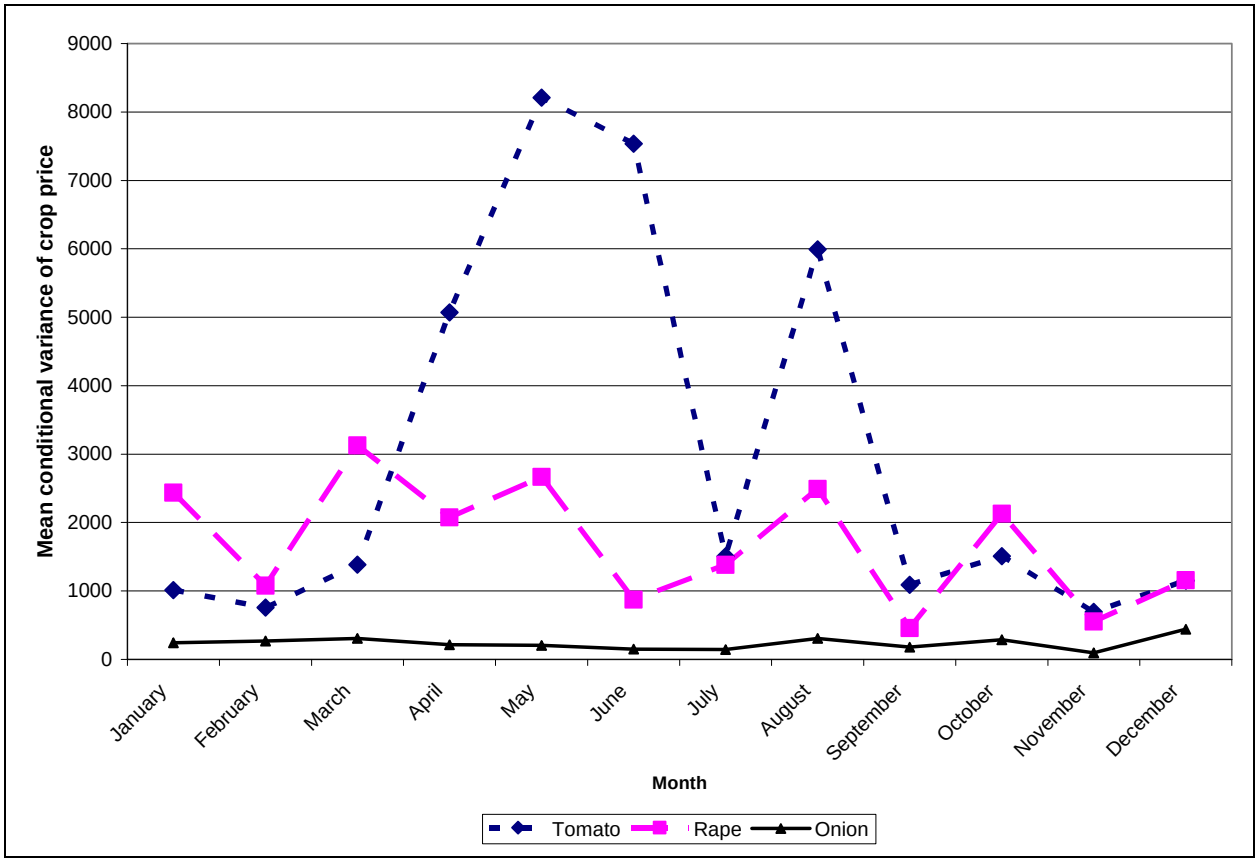
4.4. Retail Price Behavior

Retail prices of fresh produce, just like wholesale prices, are expected to vary due to seasonal and other factors. Yet different retail outlets may follow very different pricing strategies, based on their procurement practices and the role of fresh produce in their overall business. Table 18 presents the means, a measure of price correlation with Soweto wholesale prices, and two measures of instability for prices in Soweto and four retail outlets:

Table 18. Relative Importance of Soweto Market as a Wholesale Source by Retail Outlets

Retail outlet	Frequency (%) of sourcing from Soweto market		
	Tomato	Rape	Onion
Chilenje	57.8	55.7	98.7
Melisa minimart	0.0	0.0	46.1
Shoprite	0.0	0.0	0.3
Spar	0.0	0.0	0.0

Figure 11. Mean Conditional Variance of Crop Prices by Month



Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

1. Chilenje market, a traditional retail market in a middle income residential area,
2. Melisa mini-mart, a small supermarket chain with three outlets in Lusaka; we used the outlet located on a busy major road near a middle and high income residential area,
3. Spar, a large supermarket chain with four outlets in Lusaka; we used the outlet located in the central business district, and
4. Shoprite Checkers, also a supermarket chain with five outlets in Lusaka, we used the outlet located in the central business district.

The measure of price correlation between the retail markets and Soweto wholesale prices comes from a regression of the weekly log price in the retail outlet against the log Soweto price, 11 monthly dummies and week (as time variable) for each of the crops. We report the estimated regression coefficient on log retail price and its statistical significance. By controlling for seasonality with dummies and for time trend with the week variable, these results provide a better assessment of the correlation between markets than would a simple correlation coefficient. As in all previous regressions, estimation is in Stata with Prais-Winsten correction for first order serial correlation and robust standard errors. The results of the regression showing the model summaries and coefficients are found in Appendix B

As a visual complement to this analysis, Figures 12-14 graph the prices of each commodity across these five markets. Examining the table and figures together, seven points stand out. First, gross margins between Soweto and the mean retail price across the four retail outlets are about the same on all three crops – ZK2300-ZK2400 per kg, despite onion wholesale price being twice that of tomato and rape. Second, prices of all three commodities in Chilenje are highly correlated with those in Soweto, moving with them on a daily basis. This result is

Figure 12. Weekly Variation in Tomato Retail Prices as Compared to Wholesale Prices

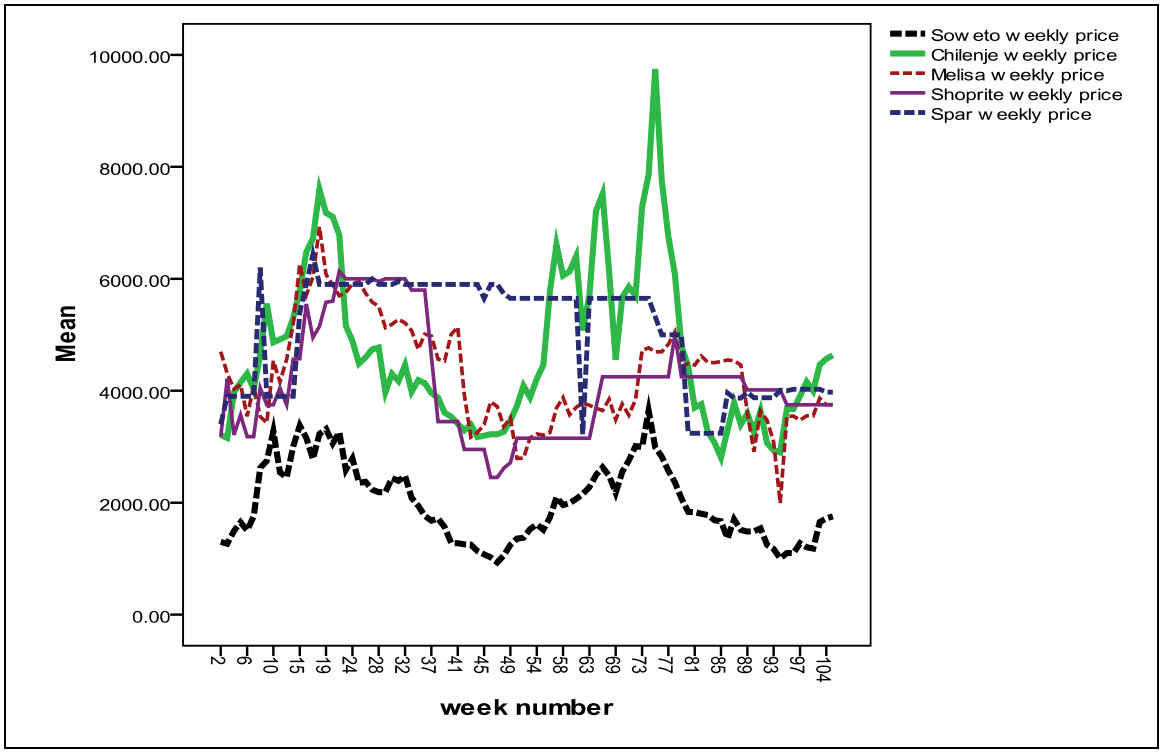


Figure 13. Weekly Variation in Rape Retail Prices as Compared to Wholesale Prices

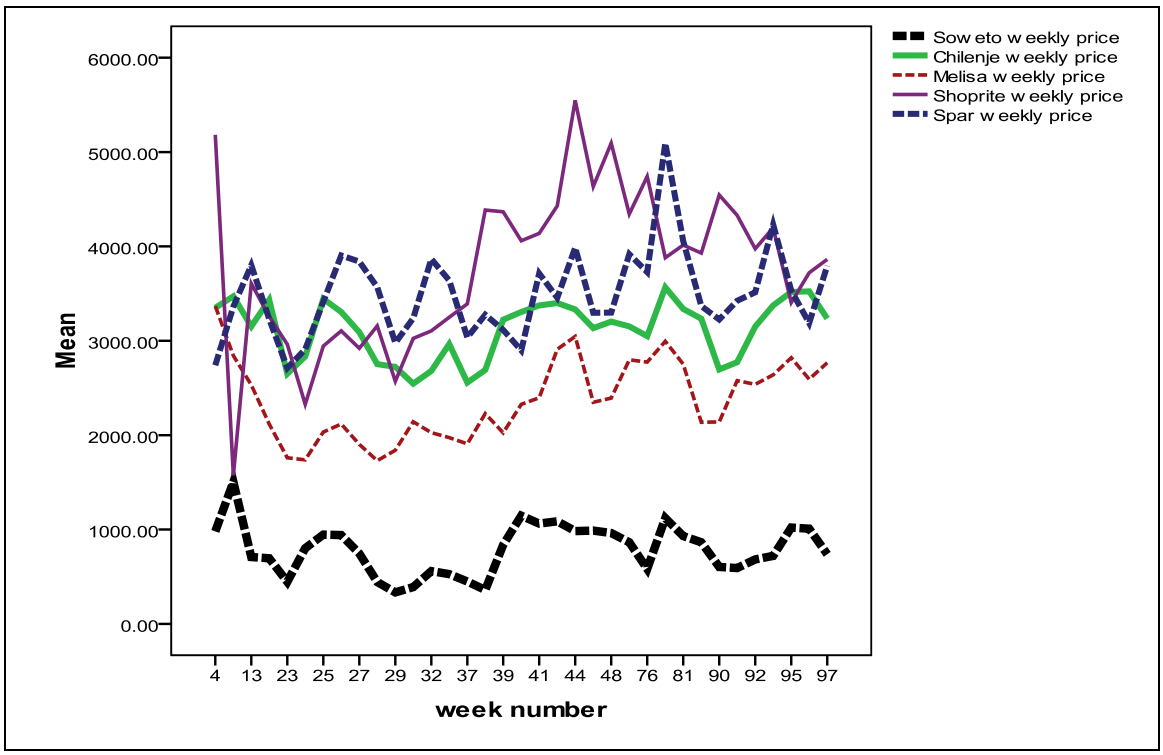
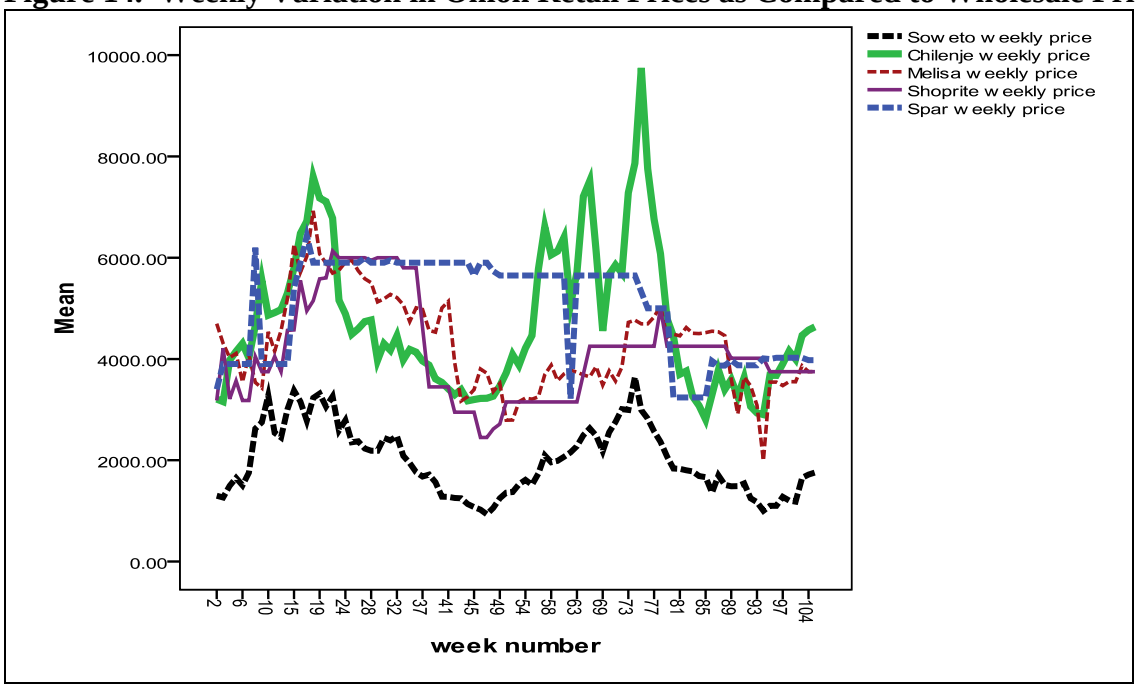


Figure 14. Weekly Variation in Onion Retail Prices as Compared to Wholesale Prices



entirely expected, given the dominance of Soweto in supply open air retail markets in Lusaka. In addition, price of onion in Melisa and (to a lesser extent) Shoprite are significantly correlated with those in Soweto, the coefficient of the Soweto onion price was *in*significant only for Spar Supermarket. Nevertheless, the influence of the Soweto price was strongest with Chilenje market (coefficient=0.487, 1%) followed by Melisa mini-mart (coefficient=0.383, 1%) and Shoprite (coefficient=0.151, 10%). This finding of a significant influence of the Soweto onion price on onion prices in Melisa and Shoprite suggests that these supermarkets may source relatively more of their onion from Soweto than the other crops. Analysis of data regarding the source of the commodity in the retail outlet at the time of collecting prices supports this contention for Melisa, which sources nearly 50 of its tomato from Soweto) but not for Shoprite, which claims to source almost none of its onion from Soweto (Table 18).

Third, pricing behavior across retail outlets is similar for tomato and onion: Chilenje prices change daily in response to Soweto, Melisa shows daily price changes though without a significant correlation with Soweto, Shoprite tracks Soweto and Chilenje but in a stepwise fashion (prices remain constant for several days or weeks, then change), and Spar maintains stable prices for long periods of time.

Fourth, all four retail outlets show daily price fluctuations in rape; unlike onion and tomato, Shoprite and Spar do not follow their stabilizing pricing approach for rape. Fifth, as shown by the gaps in the lines for rape in Spar and (especially) Shoprite, this product is periodically unavailable in these two supermarkets: Shoprite carried the product only about 40% of the time during our period of analysis, while Spar carried it about 80% of the time, Melisa 90%, and Chilenje carried it every day.

Finally, no single retail outlet has a consistent price advantage nor does one offer unambiguously more stable prices across all products. Spar had the lowest average price for tomato, Melisa had by far the lowest price for rape, and Shoprite was lowest for onion.

Conclusions regarding instability depend on the measure used. Measured by standard deviation, no one retail outlet offers consistently more stable prices; measured by mean day-to-day price changes, prices of onion and tomato in the supermarket chains – Shoprite and Spar – are far more stable than in Chilenje or Melisa.

4.5. Marketing Margins

The behavior of marketing margins is a fundamental question in any supply chain analysis. We compute gross margins using daily average price data at wholesale and retail. Wholesale prices are those paid by buyers – primarily small-scale retailers – in Soweto market. Retail prices are those paid by consumers in Chilenje. These margins are thus a direct estimate of the gross margins earned by retail traders in open air markets of Lusaka

Mean absolute margins are similar across crops, while mean percent margins are an increasing function of the perishability of the crop (Table 19): 131% for onion, 224% for tomato, and 356% for rape. These dramatic differences in percent margins suggest the possibility of substantial quality related loss – perhaps hidden in the form of sharp price discounts at the end of the day[16] – for tomato and especially for rape, compared to onion.

Rape's absolute margins are relatively stable, with a coefficient of variation of only 0.15 and only 11% of all day-to-day changes surpassing 20% in absolute value. Tomato and onion margins are substantially more variable.

Comparing the two day-to-day change indicators in Table 16 and Table 19 allows us to assess the relative exposure of farmers and retail traders to unpredictable variation in their gross revenue per unit of sale. For farmers, price indicates gross revenue while for retail traders' gross revenue is indicated by their gross margin. For tomato, we find that the two are exposed to nearly identical price changes: means of 20%-21% and probabilities of changes exceeding 20% of about 0.39. Rape farmers selling in Soweto, however, face much greater unpredictable price change than do retail traders of rape: mean changes of 30% compared to 11%, and probabilities of changes above 20% of 0.52 compared to 0.14. Since many of these traders bypass Soweto and buy directly from farmers, this pattern raises the question of whether farmers engaged in those relationships with retail traders enjoy substantially more stable prices than do farmers selling in Soweto. Notably, onion retail traders face far more unpredictability than does the mix of farmers and traders selling onion in Soweto, for whom day-to-day price changes are quite modest.

Table 19. Gross Retail Margins from Soweto Wholesale to Chilenje Retail for Tomato, Rape, and Onion in Lusaka

Indicator	Tomato	Rape	Onion
Mean level (ZKW/kg)	2272	2438	2726
Mean %	224%	356%	131%
CV	0.29	0.15	0.45
Mean day-to-day absolute % change	21%	11%	22%
Share of day-to-day changes > 20%	39%	14%	37%

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

[16] Our retail prices are taken in mid to late morning to capture the prices at which we believe most product is sold.

We conducted a regression analysis of margins to explore specific questions about their behavior: are retail traders stabilizing prices to consumers by absorbing some share of any price change at wholesale?, do margins show any seasonal pattern?, and do margins vary by day of the week? As in the estimation of price flexibility, the prais-winsten method is used to correct for first order serial correlation in errors, and robust standard errors are reported for all coefficients.

We estimated two models for each crop, of the following general form:

$$M_t = \alpha + \beta_1 PW_t + \beta_2 M_{t-1} + \beta_{3i} DM_i + \beta_{4i} DD_i + e_i \qquad (2)$$

where,

M_t = this period's mean gross margin,
PW_t = mean wholesale market price this period,
M_{t-1} = last period's mean gross margin,
DM_i = 11 monthly dummy variables,
DD_i = 2 dummy variables for day of the week, and
e_i = a normally distributed error term

Models are estimated with M_t as a percent of the wholesale price, and as the natural logarithm of the margin. In the first case, PW_t and M_{t-1} are untransformed (linear), while in the second case they are in natural logs. A negative and significant coefficient on PW_t in the percent regression, combined with an insignificant coefficient in the log-log regression indicates pass-through of a fixed margin, i.e., no price stabilization by retail traders. Negative and significant coefficients in both regressions indicate that traders are absorbing some of the variability at wholesale, lowering absolute margins when wholesale prices rise and raising them when those prices fall.

Results suggest that rape and onion traders stabilize prices to consumers, while tomato traders fully pass through price changes at wholesale (Table 20). Tomato margins show slight evidence of seasonality, being significantly higher in June and lower in September and January. However, the unstable seasonal pattern in tomato prices at wholesale makes this weak pattern difficult to interpret. Rape margins show no meaningful seasonality. Onion margins show pronounced seasonality, being lower from July or August through January, when wholesale prices are also low. Coefficients for Monday and Wednesday dummies are nearly always negative, and are negative and significant in four out of the 12 cases, suggesting some tendency for margins to be higher on Friday.

Table 20. Regression Results for Gross Margin Behavior of Tomato, Rape, and Onion in Lusaka

	Tomato		Rape		Onion	
	% Margin	Log margin	% Margin	Log margin	% Margin	Log margin
N	386	386	386	386	383	382
R-square	0.54	0.51	0.63	0.50	0.38	0.73
Independent variable[1]						
Wholesale price	-.002***	0.029	-.004***	-.076***	-.001***	-.149**
Lagged margin	-.115**	.613***	-.062	.594***	-.140**	.692***
January	-0.465*	0.009	0.424	0.008	-0.182	-0.170**
February	-0.172	0.076	0.323	-0.010	0.020	-0.101
March	-0.111	0.067	-0.055	0.009	-0.104	-0.101
April	–		–	–	–	–
May	-0.009	-0.036	0.332	-0.028	0.258**	0.016
June	0.855***	0.117**	0.439	-0.019	0.399**	0.107
July	0.291	-0.045	-0.173	-0.008	-0.068	-0.150**
August	0.344	-0.031	0.172	-0.047*	-0.526***	-0.336***
September	-0.464*	0.028	0.933*	-0.012	-0.407**	-0.121*
October	-0.239	0.047	0.413	-0.032	-0.418**	-0.250***
November	-0.221	0.070	-0.372	-0.012	-0.269	-0.215**
December	-0.139	0.048	-0.090	0.013	-0.209	-0.205**
Monday	-0.174***	-0.047	-0.231***	0.003	-0.021	-0.050
Wednesday	-0.172***	-0.006	0.024	0.010	-0.032	-0.070**
Trend	0.000	0.000**	0.001	0.000**	0.001*	0.000
Constant	4.663***	3.118***	6.494***	3.65***	3.069***	3.679***
Transformed DW	2.00	2.00	2.19	1.98	1.99	1.99

[1] Wholesale price and lagged margins are untransformed in % margin regressions, natural logarithm in log regressions

Statistical significance denoted by * (significant at 10%), ** (significant at 5%), and *** (significant at 1%).

5. SUMMARY OF KEY FINDINGS, IMPLICATIONS, AND RESEARCH GAPS

5.1. Summary of Key Findings

We highlight seven key findings regarding staple vegetable markets serving Lusaka. The most basic finding is that these vegetables are a quantitatively important component of urban diets in Zambia. The top three staple vegetables – tomato, rape, and onion – account for a higher share of consumer expenditure (9.1%) than any food group other than cereals & staples and meat & eggs, and account for two-thirds of all vegetable consumption. Expenditure on all vegetables is four times that on fruit. While the share of expenditure devoted to all vegetables falls with income (while fruit's share rises), absolute expenditure on vegetables increases by four times from the bottom to the top income tercile, due to sharp rises in incomes.

Previous work (Hichaambwa and Tschirley 2006) has shown that fresh produce marketing at farm level is highly concentrated, with 3% of farmers in 2004 accounting for 75% of all sales in the country. This paper reinforces this finding: the top three areas supply tomato, for example, accounting for over a third of total supply, had median lot sizes of 2.5 to nearly 4 metric tons. Very few farmers in Zambia are able to finance the inputs, labor, and transport needed to produce and bring such quantities to market in a timely fashion several times over a production cycle.

A third finding is that rural-urban market linkages, including regional linkages, are central to the availability and cost of these staple vegetables. At least 98% of the value of consumed tomato, rape, and onion was purchased in markets, not produced and then consumed from small urban plots. Furthermore, with the partial exception of rape, the vast majority of the production of these vegetables took place in rural areas, not urban: peri-urban agriculture plays some role for rape, but little if any role for tomato and onion. Over half of onion (but none of the tomato) reaching Lusaka is imported from the region, not produced within Zambia. Other studies have found the same, and for a broader range of fresh produce commodities (Tschirley, Muendo, and Weber 2004 for Kenya; USAID 2005 and Louw et al. 2009 stress the importance of regional markets).

Fourth, the traditional marketing system plays a dominant role in vegetable marketing, and Soweto wholesale market is at the center of this system. Of the tomato, rape, and onion purchased by Lusaka consumers, well over 90% comes from open air markets or the ka sector. While supermarkets are present and growing, and while their market share may begin to grow more rapidly at some point, the traditional marketing system will remain dominant for many years to come, and its performance will thus have an important impact on consumer welfare.

Our fifth finding is that, while marketing channels are short, gross marketing margins are high. Of produce originating in Zambia and consumed in fresh form, less than 40% of tomato passes through traders before reaching a wholesale market, none of the rape does so, and one-third of onion does so. About 8% of tomato and 65% of rape move directly from farmers to retail traders, by-passing both rural assembly and wholesale traders. Yet despite these short marketing chains, average gross markups from wholesale to retail (Chilenje market) are 224% for tomato, 356% for rape, and 131% for onion, showing a strong positive correlation with product perishability. From previous work (Hichaambwa and Tschirley 2006), we suggest that these high margins are a direct result of the very small scale of operation of retail traders, leading to modest daily earnings despite high markups.

It is widely believed that brokers play a central role in Soweto market. Our main finding in this regard (number six) is that evidence is mixed regarding the positive or negative impacts of their involvement, and that the issue requires more focused research. The most serious concern is lack of transparency: many farmers feel obliged to sell through brokers, yet there are no official rules governing the brokers' behavior, and the sellers have no way of knowing with certainty what effective commission they are paying for the brokerage service. Reasonable concerns can clearly be raised about opportunistic behavior under such circumstances. Yet we find that the largest sellers, presumably more likely to know the market and be able to bypass brokers if it were in their interest to do so, are the most likely to sell through brokers. Broker behavior and impact on the market requires more serious attention.

A seventh finding is that quantities arriving on the market are highly unstable, that the system shows a surprising ability to dampen the impact of these fluctuations on prices, but that price instability within and across days remains a major problem. Instability in quantities arriving on the market is due in part to production disruptions, as illustrated by the case of tomato in 2008, when problems with irrigation water disrupted expected seasonal production and price patterns. More fundamentally, however, quantity fluctuations are driven by very limited ability to coordinate across levels in the system to smooth the flow of product to the market. The system dampens the effects of these quantity fluctuations through shipments outside Lusaka (for tomato and onion), short-term storage at retail and in consumers' homes (onion, tomato, and to a lesser extent rape), and retail traders of rape arbitraging between buying at Soweto and buying from nearby plots. Yet even with these stabilizing mechanisms, wholesale prices are highly variable.

5.2. Implications for Policies, Programs, and Further Research

The highly concentrated structure of vegetable marketing in Zambia is similar to other countries in the region. This pattern reflects the management intensity of horticultural production and marketing – efficient production requires costly inputs, the knowledge to use them properly, and the ability to move quickly when a perishable crop is threatened by disease or ready for harvesting and marketing. Few smallholder farmers are able to bring all these factors to bear on a single crop or set of crops, or to manage the financial risk of crop failure when several hundreds of dollars have been spent on inputs and hired labor[17]. With the many programs currently in place to promote horticultural intensification in Africa, it is important that some of these undergo rigorous impact evaluation to learn what works for what types of farmers, and what approaches to avoid.

The importance of regional trade in onion (and probably other fresh produce as well) means that regional transport links, harmonization of trade regulations, avoidance of arbitrary border closings, and regional market information sharing – all issues typically addressed with vigor in cereals markets – are also important for improving performance of fresh produce markets, and reducing and stabilizing prices to consumers. We suggest that one reason for the greater predictability of onion prices compared to tomato and rape, in addition to its greater storability, is the ability to draw on a wider geographic range in supplying Lusaka. These two factors are clearly related: onion's physical characteristics that allow storage also allow it to withstand longer transport distances. Yet tomato is traded over substantially larger areas in Kenya, and between Tanzania and Kenya, than in Zambia. Widening the scope for trade

[17] See Mwiinga 2009 for detail on tomato production costs in Zambia.

through better infrastructure and trade facilitating policies and regulations should lead to less variable physical supplies and more stable prices. It is important to know to what extent trade barriers interfere with regional trade in fresh produce. Such barriers are a persistent problem in cereals markets in east and southern Africa, but less is known about their effect on fresh produce trade.

One implication of the short supply chains that we found in this study is that more programmatic emphasis should be placed on helping existing traders scale-up and gain better access to information to do their job more effectively. Helping farmers to bypass these traders and market their produce directly to supermarkets or processors will be appropriate in some circumstances, but most farmers will continue to rely on the existing fresh market trading system.

The extreme price variability in Lusaka's system points to the need for better production technologies, better access to inputs and agronomic advice for farmers, and better two-way vertical information flow through the system to match supply more closely to demand. A critical research need, in Zambia and other countries of the region, relates to the impact of existing legislative and regulatory structures on the ability to improve this two-way information flow. Wholesale markets need to be at the center of providing this service, but current ownership and management models dominated by the public sector do not appear conducive to these markets playing such a role. What legislative and regulatory changes are needed to provide scope for private sector investment in this area, and how can a dynamic stakeholder consultation process be launched and sustained to encourage such investment?

Three other areas merit further applied policy research. First, given the widespread presence of brokers in fresh produce markets and the controversy that they typically stir (see Tschirley, Muendo, and Weber 2004, for Kenya), rigorous assessment is needed in several regards: what economic function do they play, do they add value, and if so how and for whom?; are abuses such as threatening theft of product or lying about commissions widespread and persistent, or isolated?; what regulatory framework is needed to assure honest business practices that benefit farmers and consumers? These are key public policy issues in fresh produce marketing systems and will only become more important over time.

Second, comparative data is needed on gross margins across several countries; at this point, it is impossible to judge whether a mean gross margin above 200% for tomato (or above 300% for rape) reflects poor performance, and what levels these countries could reliably expect to reach. Systems for collecting this data must be designed carefully based on specific knowledge of the market chain being studied, to ensure comparability across countries. Third, the value chain for rape and other green leafy vegetables is poorly understood, especially the nature of retail trader links to farmers, the geographic location of those farmers who sell directly to retailers, and thus the quantitative importance of urban agriculture in these chains.

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APPENDICES

APPENDIX A. PRICE PREDICTABILITY RESULTS

Table A1. Regression Model to Estimate Crop Price Predictability

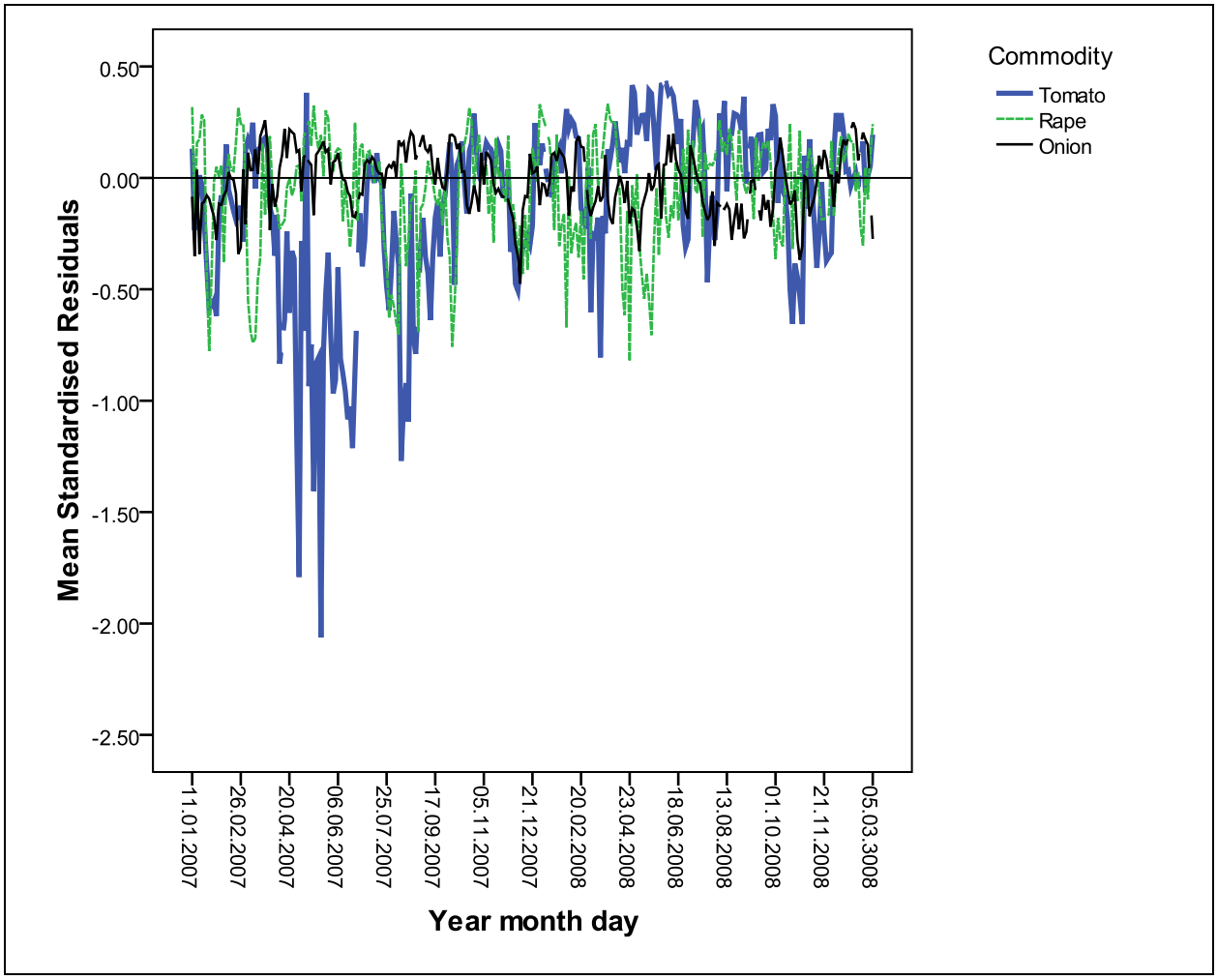
	Regression model values by crop		
Regression model parameters	Tomato	Rape	Onion
Number of observations	265	269	259
R Square	0.907	0.800	0.988
Dependent var=log(price)			
Independent variable			
Log(lagged price)	0.114*	0.219***	0.423***
Log(time)	0.072**	0.020	-0.005
January	0.084	0.102	-0.068***
February	0.146**	0.139*	-0.045*
March	0.093	0.074	0.063***
April	-0.013	-	0.075***
May	0.013	-0.128*	0.084***
June	0.068	-0.123*	0.083***
July	-0.162*	-0.037	0.012
August	-0.216**	-0.125*	-
September	-0.054	-0.156**	-0.057***
October	-0.111	-0.080	-0.111***
November	-	0.013	-0.124***
December	0.049	0.144**	-0.120***
Constant	2.342***	2.210***	1.928***
Transformed Dublin Watson	1.976	1.872	1.809

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Notes:

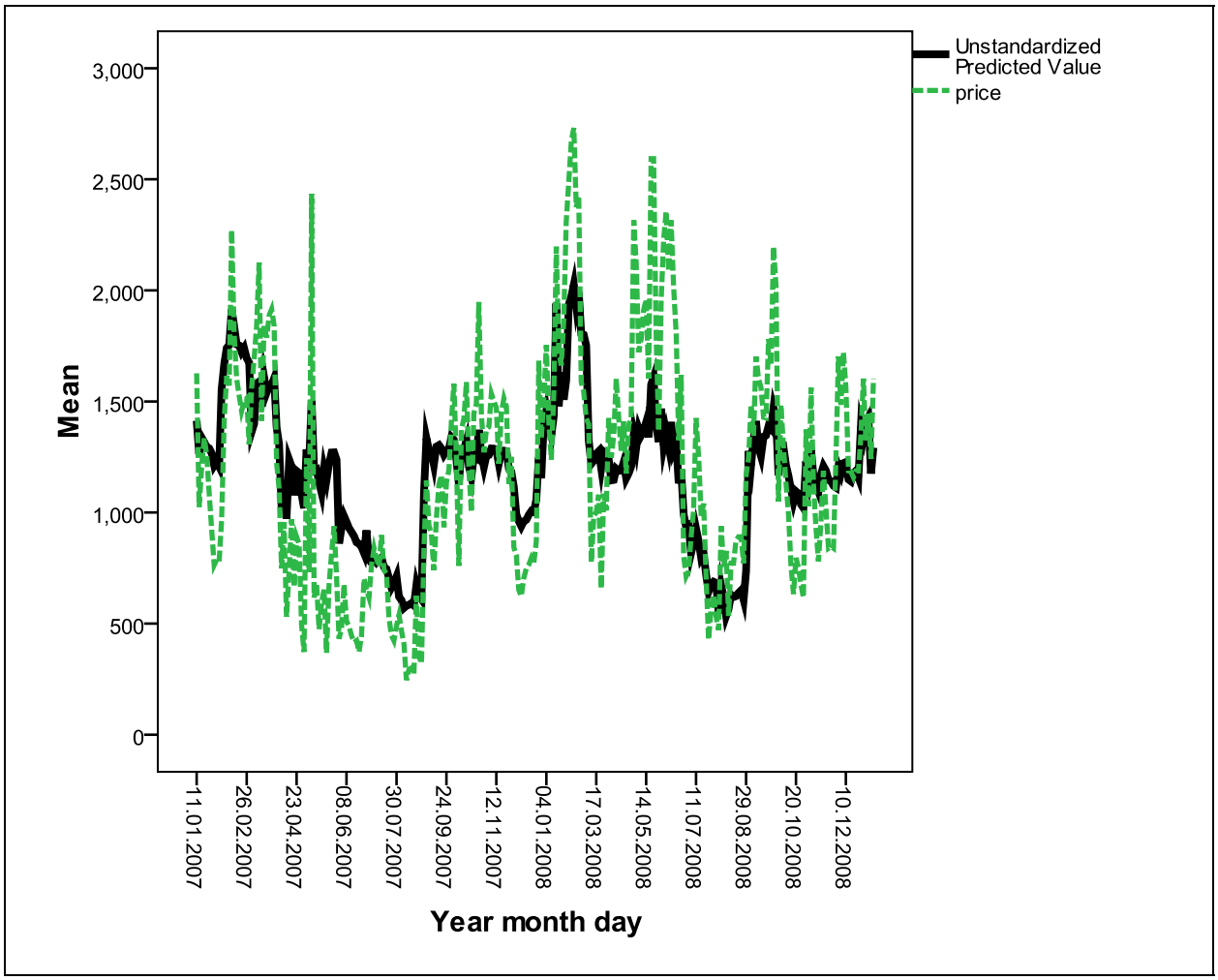
1. ***, ** and * denote significance at the 1%, 5% and 10% levels respectively
2. Variables without a standardized coefficient (Beta) were excluded from the model

Figure A1. Mean Standardized Price Residuals by Crop



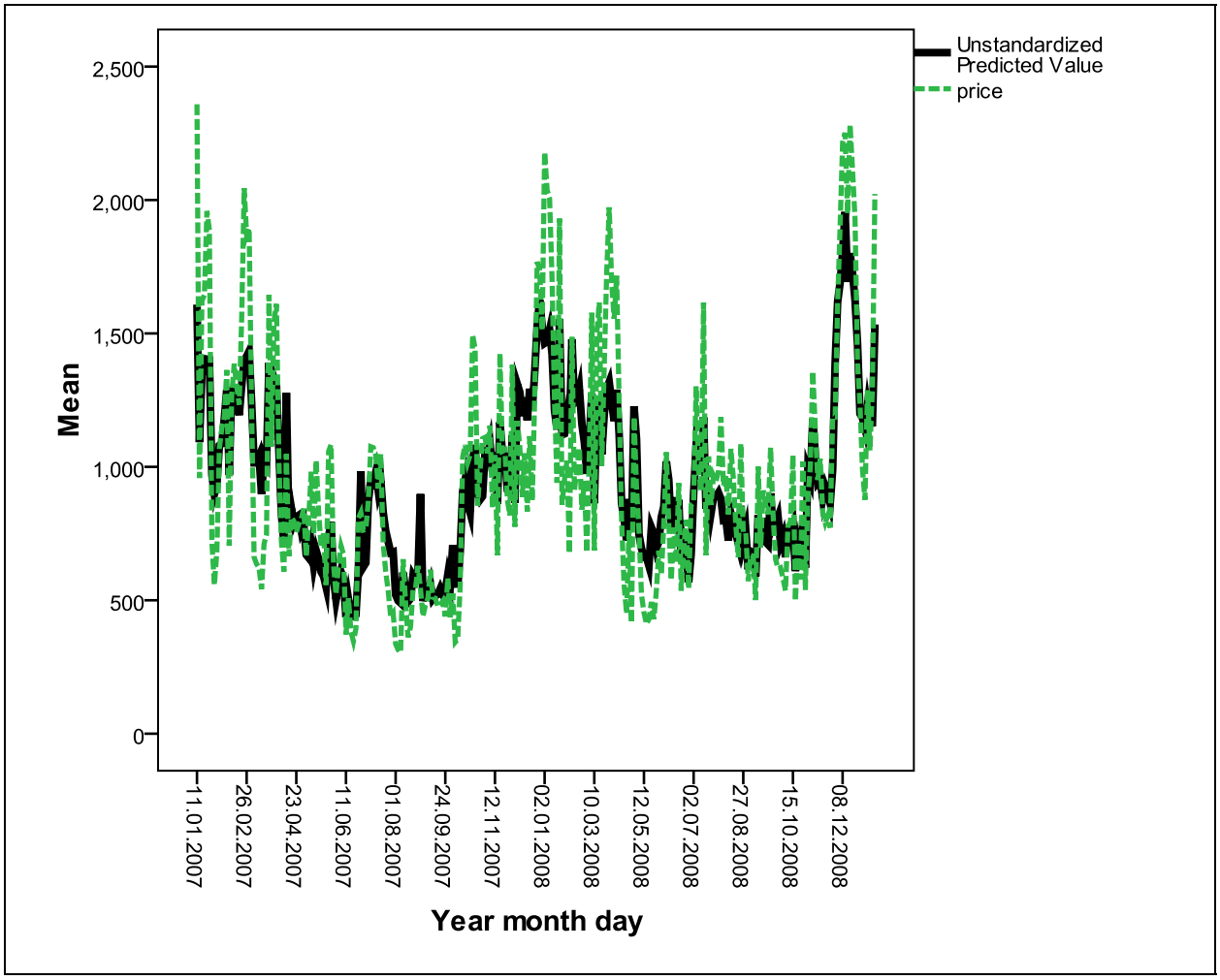
Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Figure A2. Price and Unstandardized Predicted Value of Tomato by Date



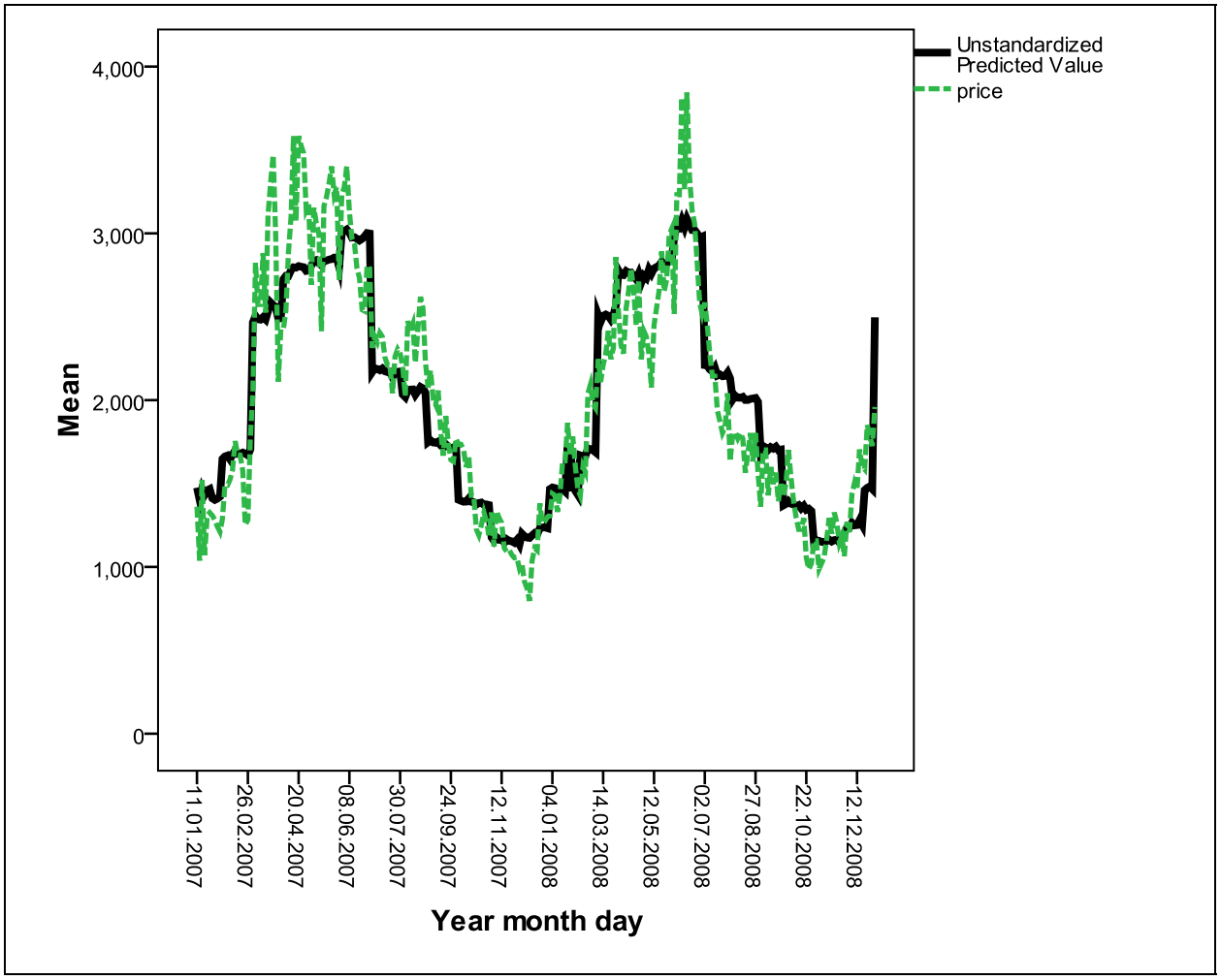
Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Figure A3. Price and Unstandardized Predicted Value of Rape by Date



Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Figure A4. Price and Unstandardized Predicted Value of Onion by Date



Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

APPENDIX B. REGRESSION RESULTS ON RETAIL PRICE BEHAVIOR

Table B1. Regression Models for Tomato Weekly Prices in Four Different Retail Channels

Regression model parameters	Regression model values by retail channel			
	Chilenje Market	Melisa Supermarket	Shoprite Checkers	Spar Supermarket
No. of observations	115	104	103	103
F	F(15, 101) | 76146	F(15, 89) | 26952	F(15, 88) | 4357	F(15, 88) | 0
Probability>F	0.0000	0.0000	0.0000	0.0000
R-squared	0.8661	0.9658	0.9251	0.7451
Root MSE	0.0942	0.0656	0.0967	0.0858
	←----------Coefficients ----------→			
Log(Soweto price)	0.382***	-0.004	0.008	0.000
Week	0.001	0.004***	0.008***	-0.001
Ln(time)	0.034	-0.016	-0.089	0.052
January	-0.045	0.108	0.287***	0.025
February	0.114***	0.147	0.114	0.046
March	0.111***	0.140*	0.119	0.032
April	-0.001	0.132*	0.106	0.019
May	0.050	0.078	-006	0.157
June	0.034	0.088	-0.049	0.009
July	-0.035	0.053	-0.094	-0.009
August	-0.050	-0.008	-0.125	0.003
September	-0.067	0.022	0.058	-0.000
October	-	0.062	0.070	-0.000
November	0.040	-	-	-
December	0.023	0.047	-0.028	0.044
Constant	5.265***	8.028***	7.964***	0.895***
rho	0.009	0.655	0.852	-0.145
DW (original)	1.987	1.020	0.536	2.155
DW (transformed)	2.011	2.090	2.03	1.884

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Notes:

1. Dependent variable: log (outlet weekly price)
2. ***, ** and * denote significance at the 1%, 5% and 10% levels respectively
3. Variables without a coefficient were excluded from the model

Table B2. Regression Models for Rape Weekly Prices in Four Different Retail Channels

Regression model parameters	Regression model values by retail channel			
	Chilenje Market	Melisa Supermarket	Shoprite Checkers	Spar Supermarket
No. of observations	117	96	43	86
F	F(15, 102) | 0	F(15, 81) | 16842	F(12, 28) | 0	F(15, 71) | 40746
Probability>F	0.0000	0.0000	0.0000	0.0000
R-squared	0.8045	0.8461	0.9234	0.8379
Root MSE	0.0762	0.1252	0.1179	0.1009
	←---------- Coefficients ----------→			
Log(Soweto price)	0.166***	0.018	0.045	0.062
Week	0.001*	0.004***	-0.008***	-0.000
Ln(time)	-0.010	-0.046	0.653***	0.110***
January	0.051	0.246**	1.600***	0.198***
February	0.049	0.334***	1.513***	0.226***
March	0.055*	0.145	-0.094	0.156*
April	0.075	0.035	0.514***	0.207***
May	0.019	0.020	-	0.073
June	-0.060**	-0.068	0.147	0.009
July	-	-	0.039	0.172***
August	-0.051**	-0.020	-0.228**	0.144**
September	-0.086***	-0.165**	-	0.037
October	-0.045*	-0.029	0.033	0.041
November	-0.026	0.096	0.015	-
December	0.026	0.053	0.038	-0.027
Constant	6.970***	7.605***	6.330***	7.324***
rho	0.134	0.383	-0.124	0.301
DW (original)	1.737	1.311	2.160	1.452
DW (transformed)	1.911	2.011	1.998	1.986

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Notes:

1. Dependent variable: log (outlet weekly price)
2. ***, ** and * denote significance at the 1%, 5% and 10% levels respectively
3. Variables without a coefficient were excluded from the model

Table B3. Regression Models for Onion Weekly Prices in Four Different Retail Channels

Regression model parameters	Regression model values by retail channel			
	Chilenje Market	Melisa Supermarket	Shoprite Checkers	Spar Supermarket
No. of observations	115	100	102	102
F	F(15, 100) | 16159	F(15, 85) | 16619	F(15, 87) | 5381	F(15, 87) | 56657
Probability>F	0.0000	0.0000	0.0000	0.0000
R-squared	0.9290	0.9070	0.9377	0.8877
Root MSE	0.0916	0.1110	0.08567	0.1132
	←---------- Coefficients ----------→			
Log(Soweto price)	0.487***	0.383***	0.151*	0.128
Week	0.001	-0.001	-0.001	-0.011***
Ln(time)	0.039	-0.071*	0.016	0.302***
January	0.042	-0.254**	0.062	0.087
February	0.206***	-0.219*	0.020	-0.025
March	0.077	-0.313**	0.009	-0.125
April	0.147	-0.216*	-	-0.112*
May	0.132	-0.183	0.141**	-
June	0.173	-0.076	0.200***	-0.020
July	0.027	0.020	0.233***	-0.068
August	-0.175**	-0.012	0.239***	-0.136**
September	-0.108*	-0.012	0.240***	-0.012
October	-0.091*	-0.070	0.071	0.027
November	-	-	0.008	0.055
December	0.009	-0.043	0.003	0.078
Constant	4.527***	5.900***	7.063***	6.991***
rho	0.608	0.511	0.842	0.523
DW (original)	1.010	1.174	0.700	1.042
DW (transformed)	2.108	2.008	2.310	2.202

Source: FSRP Vegetable Market Volumes and Prices Monitoring Data January 2007 to January 2009.

Notes:

1. Dependent variable: log (outlet weekly price)
2. ***, ** and * denote significance at the 1%, 5% and 10% levels respectively
3. Variables without a coefficient were excluded from the model