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Market Structure and Price: An empirical analysis of Irish potato markets in Kenya

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Abstract

In many developing countries, Kenya included, food markets are characterised by information asymmetry, inadequate storage and transport infrastructure and weak physical and institutional market organisation. This study seeks to examine recent trends in domestic Irish potato prices in the production markets of Nakuru and Eldoret and the consumption markets of Nairobi and Mombasa, and investigate the relationship between market structure and price of Irish potato in the different markets. Monthly market data from January 1998 to May 2011 is used. The results show that there is a general rise in the price of potatoes. The farm-gate share of wholesale market prices for ware (fresh) potato increased in Nakuru and Eldoret to 52 percent in 2010 from 35 percent in 2009. These percentage shares suggest that there exist large marketing margins that are accrued by middlemen and brokers. Potato markets are oligopolistic in nature; a few market participants in the form of rural brokers, urban brokers and transporters have the market power. There are barriers to entry at the urban market centres where brokers provide the link between wholesalers and retailers. In many cases, brokers and transporters determine the market price for each potato consignment. The markets are integrated and price transmission does occur; however it is incomplete, the results showed that long run price transmission proportions range between 25 and 59 percent, implying that, the spatial arbitrage conditions are wanting in the markets that were examined. Proposed interventions include facilitation and up-scaling of market information sharing; investment in physical infrastructure (including storage and roads) to facilitate trade; and provision of incentives to encourage public-private partnerships in storage, distribution and marketing. From a policy perspective, efforts should be made to facilitate arbitrage through the improvement of storage and physical market infrastructure.

1. Linking price and structural analysis to commodity markets

Food markets serve both producers and consumers in the food chain. Missing markets and/or market failure disrupt the status quo, affecting trade opportunities for producers and food availability for consumers. The demand for agricultural products is significantly inelastic, so a small change in output in the short run will not translate to significant change in demand or price. In the long run, however, these changes will occur due to population growth, rapid economic growth and increase in household income. Food production being seasonal, supply can be distorted periodically due to the weather and other environmental factors. Conversely, consumption is continuous and predictable (Barrett and Mutambatsere 2005; Reardon and Timmer 2005). Agricultural produce has a low value-bulk ratio compared to manufactured goods, making it difficult and costly to store and transport. Most products in their raw form are considered perfect substitutes because produce is not priced based on spatial-geographical considerations (Goodwin 1994).

The food marketing system is a complex system of channels, actors and activities that facilitate the production, distribution and exchange of food commodities. The nature and form in which products are initially offered in the marketing system influences the organisation and operation of the whole system, subject to laws and regulations that govern the system (Kohls and Uhl 2002). Markets play a primary role in the interaction of the forces of demand and supply, such as through price adjustments across time and space, therefore reducing price variability. Inefficiencies in market functions are usually a result of high transaction costs, liquidity constraints, information asymmetry, lack of opportunities and infrastructure for arbitrage or inadequate physical infrastructure (Barrett and Li 2002). Consumption is continuous and predictable while food supply can be distorted by changes in weather patterns, making seasonal or spatial arbitrage critical. Demand for food is relatively inelastic to price and income changes up to a certain limit, and additional supply for present consumption is not needed once maximum utility is achieved. As much as consumption is continuous and relatively predictable, it is influenced by incomes, tastes and preference, and exhibits an elastic demand because of the possibility of substitution (Byerlee et al. 2006; Poulton et al. 2006).

Where markets are almost perfectly competitive, they make individual producers price takers. Competition harnesses rivalry and profit-seeking behaviour in the marketplace, which in turn encourages firms involved to seek innovations and new technologies, develop rules and regulations to govern the marketplace and to some extent regulate prices so as to minimise cost and maximise profits. Along the food marketing chain, especially for perishable commodities, the firms involved in value addition tend to exhibit oligopolistic and monopolistic types of competition, and thereby influence output prices, product and firm differentiation, market concentration, barriers to entry, location and information symmetry, creating imperfections in the food marketing system (Kohls and Uhl 2002; Kotler and Armstrong 1999). The difficulty lies in the complexity of creating a suitable meeting point between unattainable perfect competitive market conditions and the real world of imperfect competition in the food marketing system, characterised in most developing countries by poor communication, inadequate storage and transport infrastructure and poor organisation of markets both physically and institutionally (Barrett et al. 2005; Goodwin 1994).

1.1. Importance of price and structural analysis in commodity markets

Commodity prices vary within and across seasons. Some intra-seasonal variation is expected, given the seasonality of local supply and the cost of storage. The food chain is complex and has many actors whose involvement in the chain depends on the supply and demand for products that vary from season to season and from year to year. Food crops generally have inelastic demand; therefore, an increase in income growth and price change do not effect significant changes in the quantity of food demanded. On the other hand, productivity growth tends to result in decrease of producer prices disproportionate to increase in demand (Abbott et al. 2008).

Prices are determined jointly by consumer demand, farm supply and the food marketing system, a change in any one of which usually results in the adjustment of the other two (Barrett and Minten 2009). The product characteristics are critical, farm produce being largely in raw material form but consumed in a processed or semi-processed form. Produce is bulky and perishable in nature, requiring large storage capacities and, at the same time, quick handling and preservation. Farmers tend to dispose of their produce promptly upon harvest due to inadequate storage technology and facilities, or on account of financial limitations. Constraints that hamper the proper functioning of markets include lack of information and inadequate storage and other physical infrastructure (Trostle 2008; Conforti 2003; Kherallah et al. 2002).

The structure of the market is affected by the size and distribution of buyers and sellers and the existence or absence of barriers to entry and exit. This structure influences pricing and other output decisions. Examining price levels over time, therefore, offers a good understanding of the functioning of the market. The performance of a food marketing system is determined by the structural characteristics and behavioural characteristics of the market participants, which infer marketing efficiency (Goodwin 1994; Kotler and Armstrong 1999).

1.2. *Objectives of the study*

The following were the objectives of this study.

i. Examine recent trends of domestic prices of Irish potatoes in Kenyan production and consumption zones;

ii. Investigate the relationship, if any, between market structure and prices of Irish potatoes in the different key markets; and

iii. Highlight strategic policy interventions.

1.3. *Organisation of the paper*

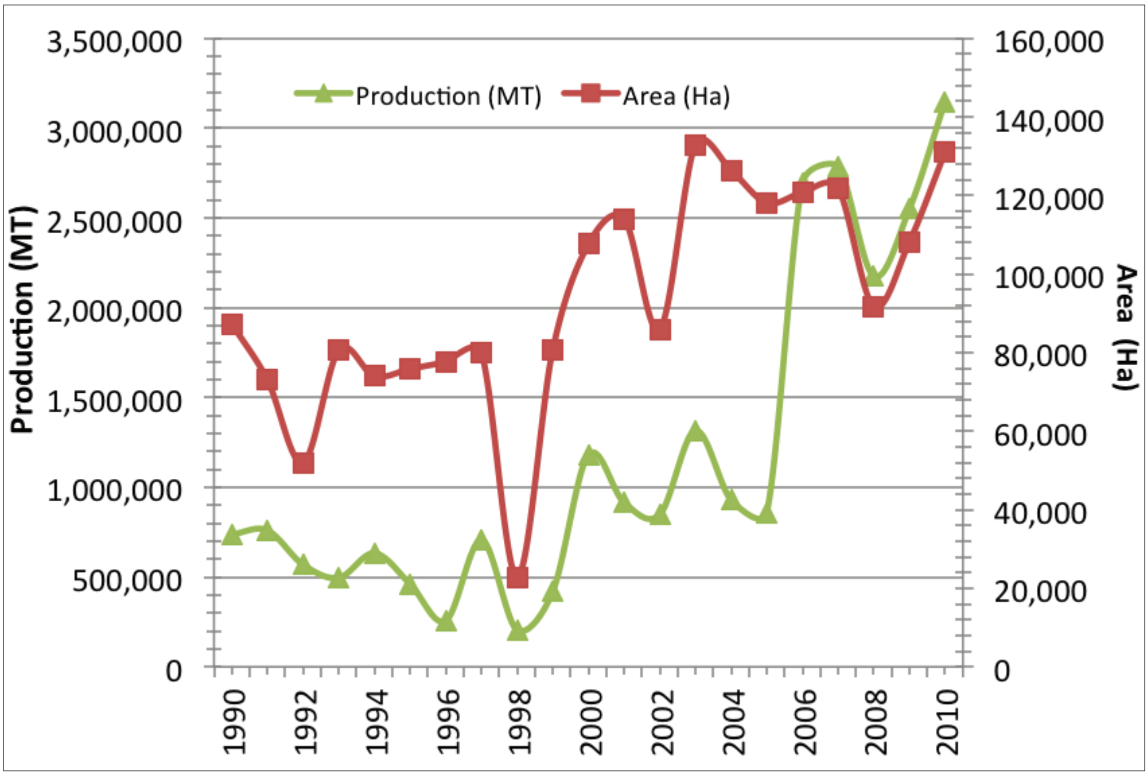
The paper is structured as follows. Section two presents an overview of potato production and marketing in Kenya. Section three covers conceptual issues on structure, conduct and performance, price transmission and market integration. Section four highlights the methodology used, and section five presents the results and discussion. Section six highlights the implications for policy.

2. Overview of potato production and marketing in Kenya

In Kenya, Irish potato ranks as the second most important food crop after maize. In 2010 annual production totalled 3.1m tonnes from 131,047ha of land (MoA 2011) (Figure 1). Potatoes are mainly grown under rain-fed conditions in the two main seasons of April–June and October–December (MoA 2011; Maingi 2010). Potato is both a staple food and a cash crop for many rural and urban families in Kenya and plays an important role in national food and nutrition security, poverty alleviation and income generation. The sub-sector employs over 2.5 million people along the value chain (Songa 2010; NPTF 2009).

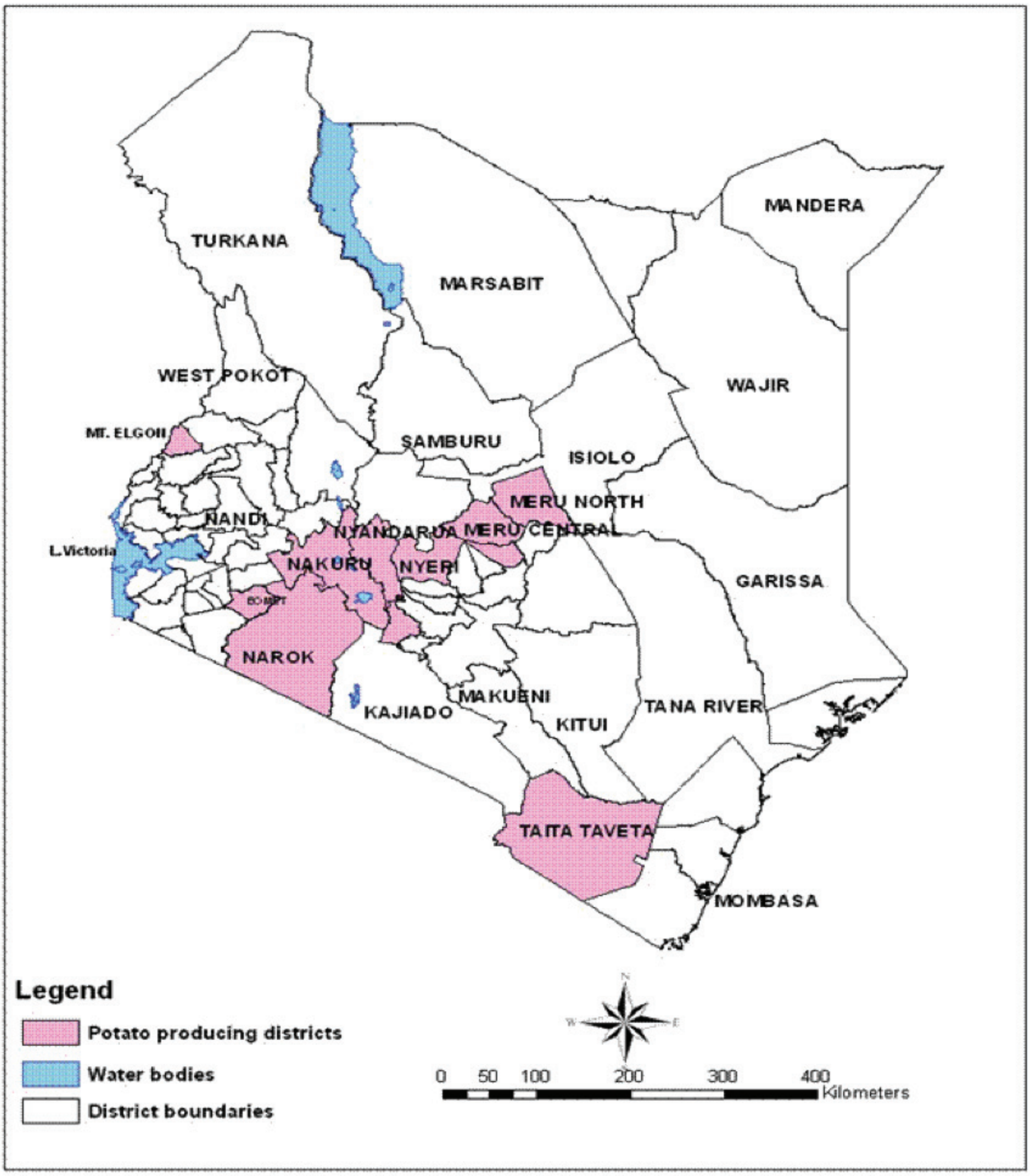
Potato production is concentrated in areas around Mt. Kenya (Meru Central, parts of Nyeri Laikipia and Nyandarua), Rift Valley (Mau, Bomet, Narok and parts of Nakuru district, Mt. Elgon, Keiyo and Marakwet districts) and Taita Taveta district (Kaguongo et al, 2008) (Figure 2).

Figure 1. Potato area and production, 1990–2010



Source: MoA 2011

Figure 2. Map of Kenya showing main potato producing counties



In the last five years there have been collaborative efforts by the government, the private sector and donors to combat the challenges affecting potato production, such as inadequate certified and clean seed supply, pests and diseases – particularly bacterial wilt and potato blight – and inadequate and improper use of inputs and crop husbandry (Mutunga 2010; Kaguongo et al. 2008). As a result productivity had risen to 24t/ha by 2010, compared to 7t/ha in 2005 and 8t/ha in 1990 (MoA 2011).

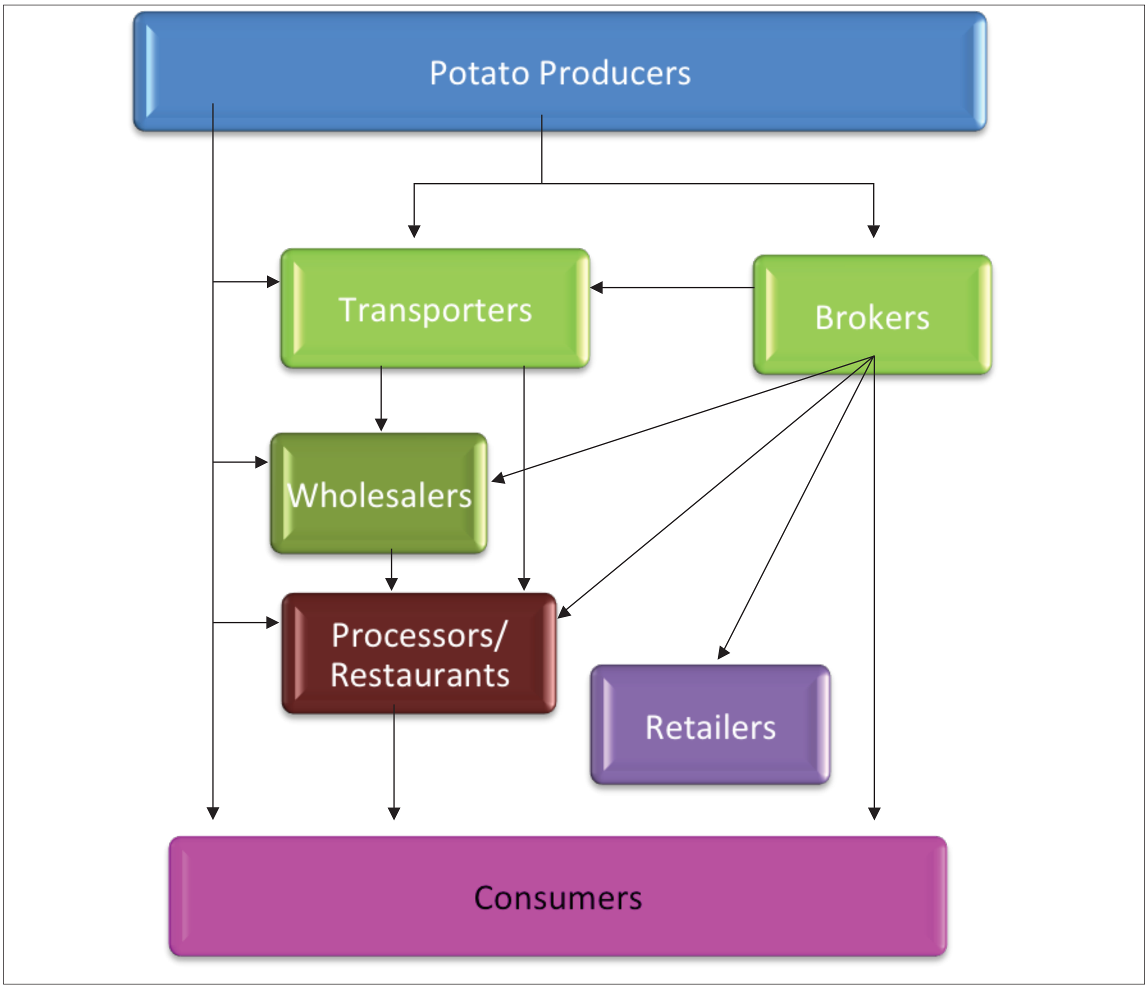
Per capita consumption of potatoes is estimated at 25kg annually (NPTF 2009) compared to an annual per capita supply of 21kg (FAOSTAT 2010). The demand for potatoes has been largely driven by urbanisation, which led to an evolving food demand that has opened new markets for convenience, fast food and prestige food products (UNCTAD 2010).

Marketing of potatoes, like that of any other perishable bulky vegetable, is faced with several challenges. The supply of produce to the market is highly correlated to the weather patterns since the crop is mainly rainfed; thus, there is usually a glut during the harvesting period, and farmers are willing to sell their produce then because they lack storage technology and infrastructure (Tesfaye 2010; Maingi 2010).

The marketing chain of potatoes has several actors who unnecessarily increase the transaction costs of ware (fresh) potato along the chain without adding value to the product due to their cartel-like behaviour. Poor road infrastructure introduces additional transaction costs (Mutunga 2010; Tesfaye 2010) (Figure 3).

Potato producers have several marketing channels at their disposal and, depending on their hectarage, larger-scale producers and farmer groups often have contractual

Figure 3. Marketing channels for ware potatoes



Source: NPTF 2009

agreements with processors. Brokers mainly play the role of assembly, while the consumers have access to both ware potatoes and processed potato products such as crisp, chips and frozen chips. Consumer preferences are evident in the different segments of the marketing chain: processors, restaurants and fast food outlets prefer the white skinned varieties, while the red skinned varieties are preferred for domestic consumption, i.e. boiling, mashing etc. (Mutunga 2010; Tesfaye 2010; Maingi 2010).

Important recent policy changes in the sub-sector include:

- A reduction in the number of new potato varieties released under the national breeding programme. Current efforts are being made to import germplasm from the Netherlands to meet this deficit.

- Standardisation of the potato marketing bags. If adopted, this would ensure less wastage due to poor packaging and reduced exploitation of the producers, thus increasing incomes.

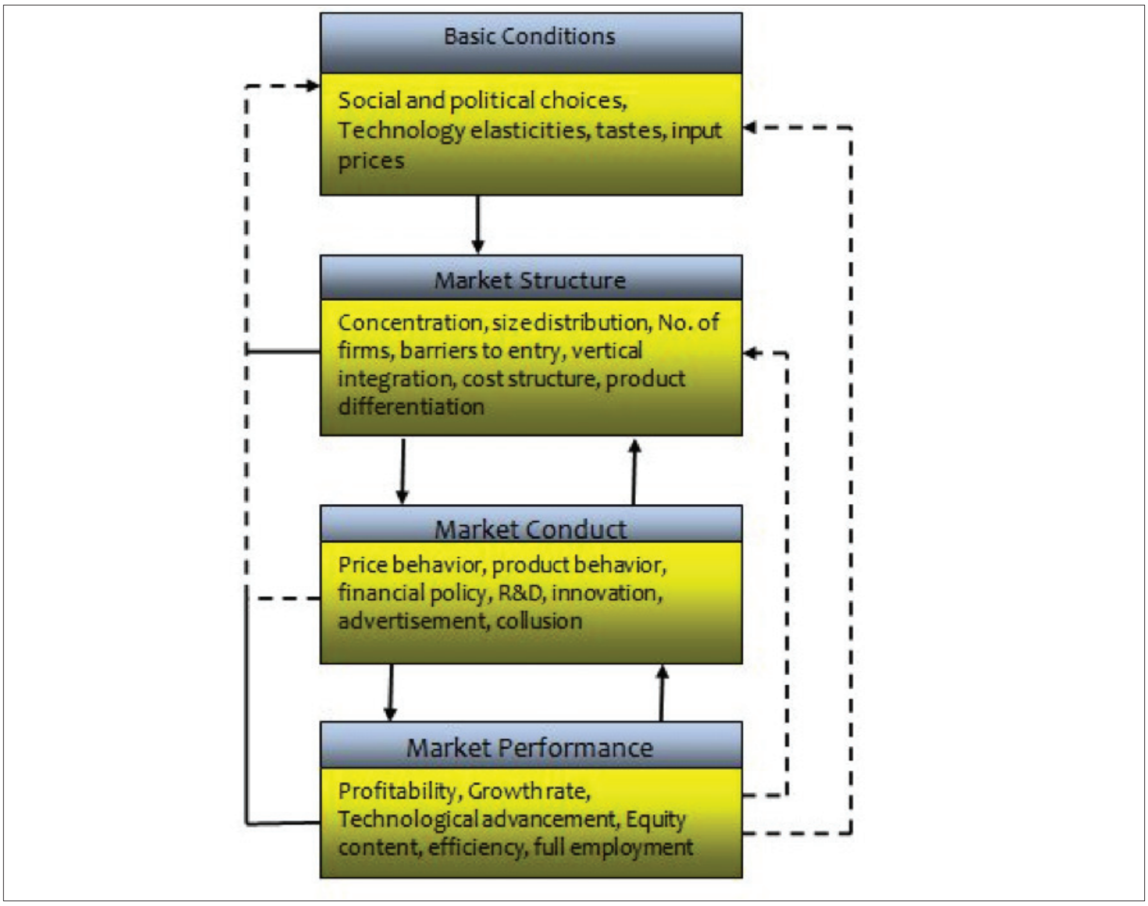
3. Literature review

3.1. Market Structure Conduct and Performance framework

The Structure Conduct and Performance (SCP) framework explains market behaviour and its differences between markets. The model hypothesises that market structure determines market conduct, which in turn determines the performance of the market.

Market structure explains the concentration, i.e. the number and distribution, of sellers and buyers within the marketplace. Measures of market concentration include buyer concentration ratios and seller concentration ratios. The Herfindahl index is used to determine and compare concentration within industries. Barriers to entry limit the number of firms in the business. These barriers include copyrights, patents, control of ownership of key inputs, economies of scale, differentiated product differentiation, high capital outlay, managerial know-how, market information, legal requirements and established brand names. Product or service differentiation exists when

Figure 4. Structure Conduct and Performance model



Source: Kotler and Armstrong 1999

products sold within the same market are not regarded by buyers as perfect substitutes. Market conduct explains the existing market structure and includes price determination behaviour, product behaviour, research and development, innovation, advertising, sales promotion policies, financial policy and collusion. Market performance considers the price relative to the average cost of production (Kohl and Uhl 2002; Kotler and Armstrong 1999; Goodwin 1994).

There are two hypotheses in the SCP framework. One is the structure performance hypothesis, which proposes that the degree of market concentration is inversely related to the degree of competition. The second is the efficient structure hypothesis, which proposes that the performance of the firm is positively related to its efficiency. This study tests the efficient structure hypothesis by measuring market performance through the use of spatial price relationships that have been used as an indicator of market performance (Kari et al. 2002; Faminow and Benson 1990).

3.2. Price analysis

Price movements over time reflect the upward or downward drift in real prices, which can either be as a result of supply or demand. The time variable in trend analysis enables measurement of the effects of the variables that influence the prices of agricultural products. The Cobweb theorem explains cycles in agricultural prices and production. The model is based on the following assumptions:

i. Price is determined in an atomistically competitive market environment in which no seller has a market share large enough to enable him to influence the price;

ii. Current prices are determined largely by currently available supplies that are subject to little or no modification in the immediate period;

iii. Producers plan production for the next period primarily on the basis of recently observed prices;

iv. There is a lag of a least one production period between the time of a decision to produce and actual availability of that production;

v. Planned production is ultimately realised as actual production; and

vi. Demand and supply relationships remain constant.

A typical cycle in agricultural production is continuous rather than divergent, implying that agricultural supply functions are of an 'inverted S' type rather than a straight line. Theoretically, cycles in price and production are inversely related, as which high prices encourage new producers to begin production and exiting producers to expand output (Goodwin 1994). The length of the agricultural price cycle (peak to peak) depends on the biological lags involved in producing the commodity (Figure 5).

3.3. *Linking market structure and price*

This study holds that by measuring market integration and price transmission between markets, useful conclusions can be drawn about the link between the market structure and the price of commodities.

Price transmission provides insights into how price changes in one market are transmitted to another, thus reflecting the extent of market integration and, to some extent, how the markets function. Price transmission estimates the responsiveness of prices between markets, usually defined as the percentage change in the price in one market given a one percent change in the price in another market (Meyer and von Cramon-Taubadel 2004; Kohls and Uhl 2002; Peltzman 2000). The assumptions are that the products are homogeneous (perfect substitutes), meaning there is no variation in quality; traders are numerous such that none has any overbearing market power; traders have complete information; trading occurs instantly; and there are no policy barriers to trade. However, transaction costs (including transportation costs) are a major factor in trade, particularly for staple food crops. A low value-to-bulk ratio will result in higher transportation costs relative to the value of the product, as is the case in potatoes.

Price transmission is said to be perfect, and the markets said to be integrated, when price change in one market is rapidly reflected in an equivalent change in the other markets. Spatial arbitrage would ensure that prices of a commodity will differ by an amount that is almost equal to transfer costs. If the difference between price in market A (P^a_A) and price in market B (P^a_B) is greater than the cost of transportation, tax, risk and profits between the two markets, then trade is profitable.

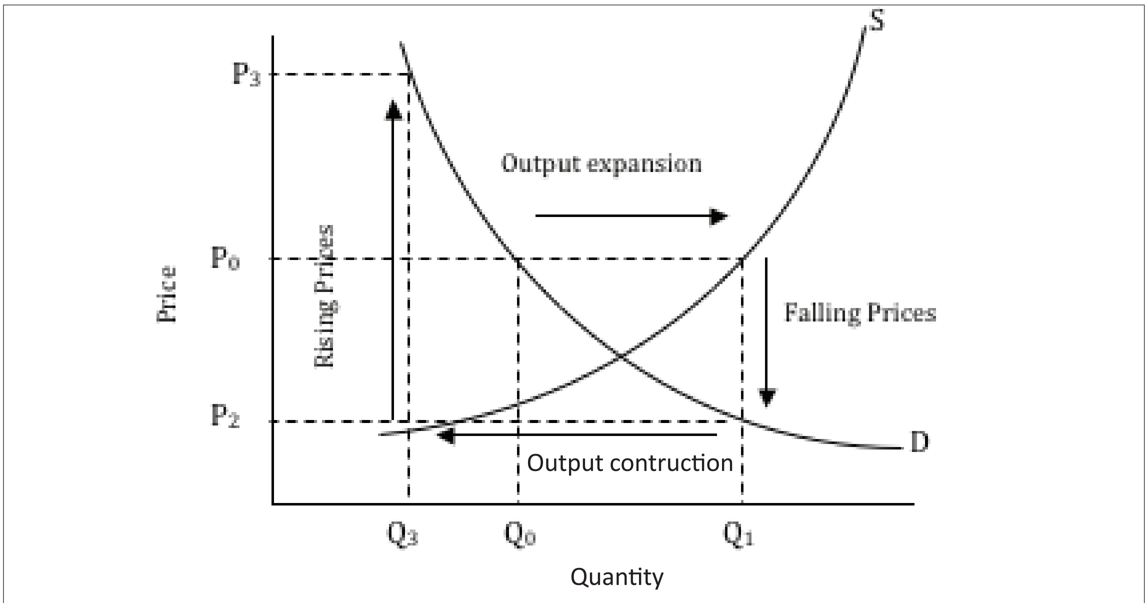
If $$P^a_B - P^a_A > c, \quad [1]$$

then it will be profitable to move the commodity from market A to market B. Trade will reduce the supply and raise the price in the exporting market (market A) and increase the supply and reduce the price in the importing market (market B), thus causing the prices in the two markets (P_A and P_B) to move toward each other. Spatial equilibrium is reached when

$$P_B - P_A = c, \quad [2]$$

Implying that traders would choose to be indifferent to trading and not trading. On the other hand, if the difference between the price in market A and in market B is less than the full cost of transportation tax and risk, then it is not profitable to trade between the two regions.

Figure 5. Agricultural price and output cycles: the cobweb diagram



Source: Kohls and Uhl 2002; Doll and Orazem 1996; Goodwin 1994

If the direction of trade between the two markets frequently changes, price transmission will be imperfect. Trade reversals are not uncommon in agricultural markets because the supply of most crops is seasonal, so a region may export a crop during its harvest season and import it during the off-season (Stephen et al. 2012; Minot 2011; Moser et al. 2009; Negassa et al. 2007).

The common tests for co-movement of price include cointegration and the error correction models (Jayne et al. 2010; Barrett and Li 2002). The study relies heavily on the notion that spatial arbitrage causes the difference between two prices in market A and market B to be equivalent to the transfer costs between the markets, implying that market integration can be evaluated by means of cointegration. One main criticism of the cointegration test is that it ignores transaction costs and assumes a linear relationship between the market prices; this is not a sufficient condition for market integration implied by the spatial arbitrage conditions. Indeed, the main cause of the price difference between surplus and deficit areas is transaction costs, unsynchronised price cycles and intermittent trade patterns that reduce market integration (Jayne et al. 2010; Baulch 1997; Barrett 1996; Faminow et al. 1990).

Cointegration and the error correction model, however, provide a tool that can yield information on the speed and completeness of price transmission, and the asymmetry of the relationships between prices. Cointegration focuses on the long-run relationships between bivariate or multivariate price series. Given prices for two (or more) spatial markets, the long-run price relationship can be obtained by running the following regression:

$$P_t^i = \alpha + \beta\, p_t^j + \varepsilon_t \qquad [3]$$

Where ε_t is the error term. This tests whether $\beta = 1$ in equation (3) is the test of the law of one price, implying that price changes in one market will be transmitted to other markets. If the price series is stationary, i.e. integrated in the same order, then equation (3) can be used to test for cointegration using the Johansen vector autoregression method (Barrett and Li 2002; Asche et al. 1999). However, if the price series is non-stationary then the parameters are not valid, since they are likely to be spurious. The Granger representation theorem (Engle and Granger 1987) will therefore apply. It holds that if two time series variables are cointegrated, their relationship can be explained by an error correction model; thus, if prices for two spatial separate markets are cointegrated, then a vector error correction model can be applied. The model takes the following general form:

$$\Delta P_t = \propto + \Pi\, P_{t-1} + \Sigma_k^q\, \Gamma_K \Delta P_{t-k} + \varepsilon_t \qquad [4]$$

Where P_t is an n x 1 vector of n price variables;

Δ is the difference operator, so Δ**pt**= $\mathbf{p_t} - \mathbf{p_{t-1}}$;

$\boldsymbol{\varepsilon_t}$ is an n x 1 vector of error terms;

α is an n x 1 vector of estimated parameters that describe the trend component;

Π is an n x n matrix of estimated parameters that describe the long-term relationship and the error correction adjustment; and

Γk is a set of n x n matrices of estimated parameters that describe the short-run relationship between prices, one for each of q lags included in the model.

4. Material and methods

4.1. *Estimating market performance*

Market performance was estimated using farm-retail share and farm-retail margin, calculated as follows:

$$\text{FRS} = \frac{P_f}{P_r} * 100 \qquad [5]$$

$$\text{FRS} = \frac{P_f - P_r}{P_r} * 100 \qquad [6]$$

Where FRS is the farm-retail price share, FRM is the farm-retail margin, Pf is the farm-gate price and Pr is the retail price.

4.2. *Estimating trends*

A descriptive analysis of the price trends from January 1998 to May 2011 uses 197 monthly observations per commodity (white and red Irish potato) in four spatial wholesale markets (Nairobi, Mombasa, Nakuru and Eldoret). The seasonal index was computed using the ratio–to-moving average:

$$SF_t = P_t / CMA_t \qquad [7]$$

Where SF_t is the seasonal factor, P_t is the price and CMA_t is the centred moving average.

4.3. *Measurement of market integration and price transmission*

The study used the vector error correction model (VECM) to examine the relationship between the commodity prices and the markets (Minot 2011; Van Campenhout 2007).The logarithmic transformation of average monthly prices is used. The following conditions were met:

i. Each variable is non-stationary and integrated to degree 1, written as I(1). This means that the variable follows a random walk, but the first difference (X_t - X_{t-1}) is stationary, written as I(0).

ii. The variables are cointegrated, meaning that there is a linear combination of the variables that is stationary. We are analysing two prices at a time, so that the cointegrating equation would take the form of:

$$P_1 = \alpha + \beta P_2 + \varepsilon \quad \text{or} \quad P_1 = \alpha - \beta P_2 = \varepsilon \qquad [8]$$

Where ε is stationary.

The analysis consists of three steps:

i. Test the price variables individually to see if they are I(1). This is done with the augmented Dickey-Fuller test and the Phillips-Perron test.

ii. Use the Johansen test to determine whether the two series are cointegrated, meaning that each variable is I(1) and a linear combination of the two variables is I(0). In terms of our analysis, this tests whether there is a long-run relationship between the prices in the spatial markets.

iii. If the Johansen test indicates that there is a long-run relationship between the two variables, then we estimate the VECM. The model takes the following general form:

$$\Delta P_t = \propto + \Pi P_{t-1} + \Sigma_{k-1}^{q} \Gamma_K \Delta P_{t-k} + \varepsilon_t \qquad [9]$$

Where $\mathbf{P_t}$ is an n x 1 vector of n price variables;

Δ is the difference operator, so $\Delta PT = P_t - P_{t-1}$;

$\boldsymbol{\varepsilon_t}$ is an n x 1 vector of error terms;

α is an n x 1 vector of estimated parameters that describe the trend component;

Π is an n x n matrix of estimated parameters that describe the long-term relationship and the error correction adjustment; and

Γk is a set of n x n matrices of estimated parameters that describe the short-run relationship between prices, one for each of q lags included in the model.

The VECM tests for the effect of each variable on each other variable. In the context of this study, the two-variable VECM tests the effect of the different commodity prices in the different markets. In addition, tests indicate that one lagged term is generally sufficient; therefore, the interest is in one portion of the VECM. This portion can be simplified as follows:

$$\Delta P_t^a = \propto + \theta\,(P_{t-1}^a - \beta P_{t-1}^b) + \delta \Delta P_{t-1}^b + \rho \Delta P_{t-1}^a + \varepsilon_t \qquad [10]$$

Where P_t^a is the log of market A price;

P_t^b is the log of market B price of the same commodity;

Δ is the difference operator, so $\Delta P_t = P_t - P_{t-1}$;

α, θ, β, δ and ρ are estimated parameters; and

ε_t is the error term.

4.4. *Data and data sources*

The study uses secondary data from market surveys carried out in 2009 (Kaguongo et al.) and 2010 (Abong' et al.) to establish the market performance of the four wholesale markets, namely two consumption markets, Nairobi and Mombasa, and two production markets, Nakuru and Eldoret. Following this, an analysis of monthly price series for the four wholesale markets covering the period between January 1998 and May 2011 was done with data available from the Ministry of Agriculture.

5. Results and discussion

5.1. *Market structure and conduct*

For most agricultural products there is no direct relationship between the basic producers and the ultimate consumers of these goods, and therefore farmers tend to be price takers; they have no power to negotiate prices because of the structure of the markets. This is evident in the case of grains, oil seeds and most livestock products. For fruits and vegetables, grading, sorting, transportation etc. differentiate the final product. The competitive conditions for producers and consumers are therefore treated differently (Goodwin 1994).

For potato producers, the market is oligopolistic in nature – i.e. there are few market participants in the form of rural brokers and transporters – while for consumers, it is to some extent polyopsonist – i.e. there are many sellers available at retail level, but a limited number at wholesale level. The marketing structure has a number of intermediaries. There are no barriers to entry at the farm gate level or assembly point. There are rural brokers who are useful for the assembly of potatoes from farms, and they work hand in hand with transporters, who in turn work with urban brokers. There are barriers to entry at the urban market centres, where cartels of brokers provide the link between wholesalers and retailers. In many cases, brokers and transporters determine the market price for each potato consignment delivered, accounting for the purchase price, cost of assembly and transportation costs, and thus to some extent hold the market power (Abong' 2010; Mutunga 2010; Wang'ombe 2008).

Table 1: Market performance for Nakuru and Eldoret markets				
Description	**Nakuru**		**Eldoret**	
	2009	**2010**	**2009**	**2010**
	Ksh/kg			
Farm gate (Survey data)	7.6	10.3	8.0	9.4
Wholesale (MoA)	21.4	19.7	17.8	16.0
	Percentage Share			
Farm wholesale share	35.5	52.2	45.0	59.0
Farm wholesale margin	64.5	47.8	55.0	41.0

5.2. Market performance

Market performance is measured for the two producing areas of Nakuru and Eldoret. Table 1 shows that the farm-gate share of wholesale market prices for ware potato has increased between 2009 and 2010 from 35 percent to 52 percent. This increase can be explained in part by the efforts made by the National Potato Association, Ministry of Agriculture and KENFAP together with other stakeholders to promote potato growing and marketing in the country (NPTF 2009). In addition, the percentage shares suggest that there exist large marketing margins that are accrued by the middlemen and brokers who are active in this marketing chain (see Figure 3).

5.3. Price trends for Irish potato

One hundred and sixty one observations were made for each market studied. Figure 6 shows the wholesale market prices in the production zones of Nakuru and Eldoret and consumption markets of Nairobi and Mombasa between January 1998 and May 2011. In general, it is evident that the trends in the real wholesale prices have remained more or less the same over the study period. The average monthly price is highest in Mombasa (Ksh 3,336), and ranges between Ksh 2,400 and Ksh 1,600 in Nairobi, Nakuru and Eldoret. Red potatoes show a high spike in price in February 2005; this is not evident for white potatoes, and can be attributed to low supply due to drought, especially in the upper eastern areas of Kenya where red potato is mainly grown.

Table 2 shows the seasonal calendar for potato. The price of potato is highest in April for all the markets and equally in May for Eldoret. There is sufficient supply of potatoes across all the markets in the month of August, reflected in lower prices on average. The seasonality index did not show variation across varieties, as shown in Figure 6 above.

5.4. Market integration and price transmission

Price transmission shows the co-movement of prices in the different markets, an indication of efficient and competitive markets. The first step in the analysis is to test for the presence of unit roots using the augmented Dickey-Fuller unit root test (1979). The series is differenced once to make the data stationary and the unit root shows that null hypothesis can be rejected at 5 percent for all the price series, and the series is integrated of order one I(1) (Table 5 appended). After this, Granger causality was tested, and the results showed that the Mombasa potato price displays Granger causality on Eldoret potato prices.

Table 2: Seasonality of Irish potato markets		
Market	**Seasonal index (calendar year)**	
	High Season	**Low Season**
Nairobi	April	August
Mombasa	April	August
Nakuru	April	August
Eldoret	April, May	July, August

Figure 6a. Average monthly wholesale prices for red Irish potato in Nairobi, Mombasa, Nakuru and Eldoret markets

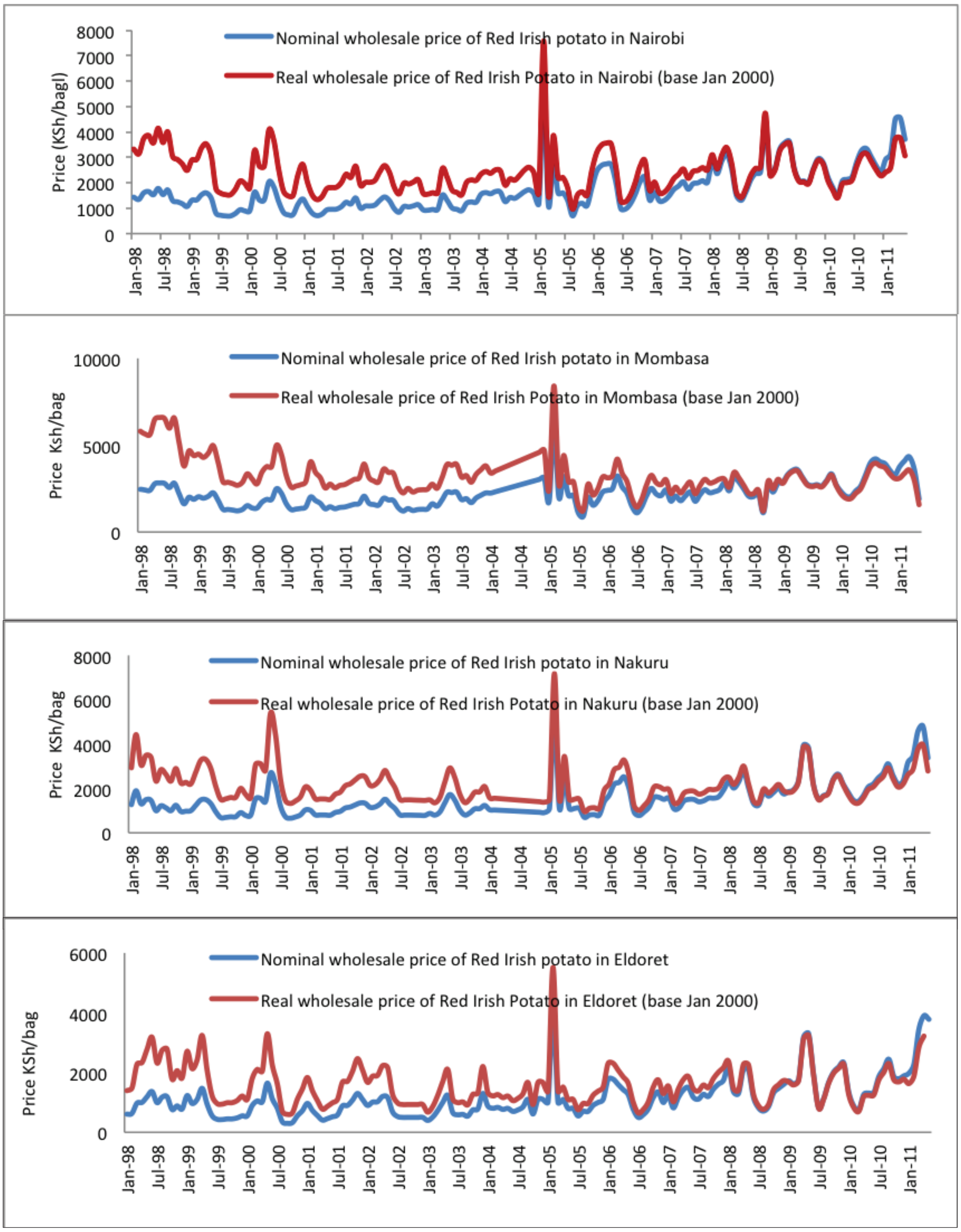
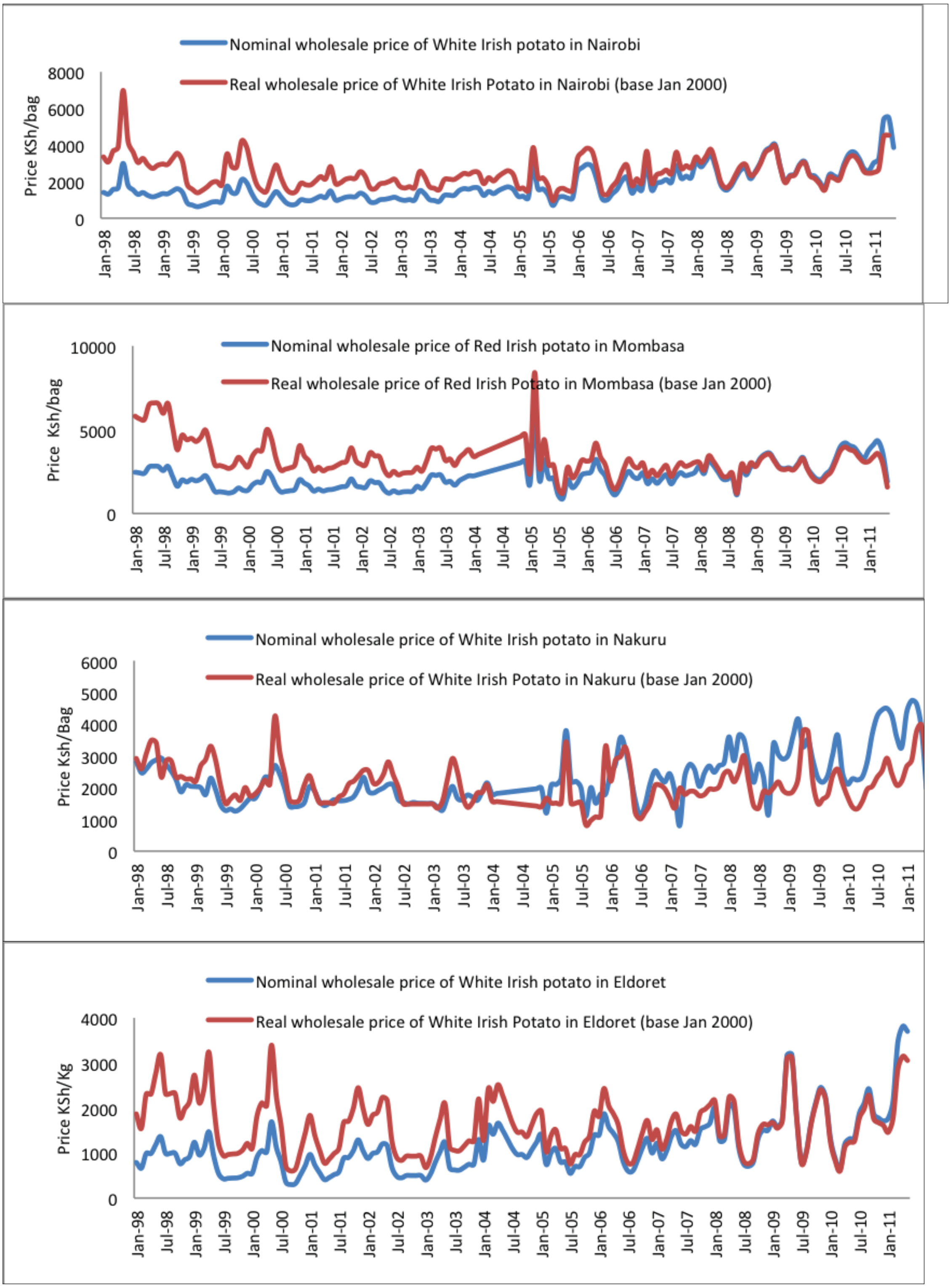


Figure 6b. Average monthly wholesale prices for white Irish potato in Nairobi, Mombasa, Nakuru and Eldoret markets



Data source: MoA 2011

Table 3: Transmission of Eldoret potato prices to the Nakuru, Nairobi and Mombasa markets					
Location	Unit root	Long run relationship	Error Correction Model		
	ADF test	Johansen Test	Speed of adjustment	Short run adjustment	Long run adjustment
Nakuru	Yes	Yes	-0.66	0.09*	0.37
Nairobi	Yes	Yes	0.18	0.20	0.25*
Mombasa	Yes	Yes	-0.43	0.14*	0.28*

*Significant at 5%

Thirdly, cointegration was carried out to determine the long run relationships between the markets. Both the trace test and maximum eigen value indicated that there were four cointegrating vectors for the markets Eldoret, Nakuru, Mombasa and Nairobi (Table 6 appended). Taking into account that Nakuru and Eldoret are producing markets, the model was run as equation (9) with the markets as exogenous variables.

Table 3 shows that Eldoret market prices are reflected in Mombasa with a speed of adjustment of (-0.43) and a long run adjustment proportion of 28 percent. Mombasa and Nairobi long run adjustment proportions are significant, suggesting strong relationships between the Eldoret market and these two markets. In the short run Eldoret market prices reflect a 9 percent adjustment proportion to the Nakuru market.

Table 4 shows that Nakuru market prices are reflected in Mombasa with a speed of adjustment of (-0.42) and a long run adjustment proportion of 44 percent. Mombasa and Nairobi long run adjustment proportions are significant, suggesting strong relationships between the Nakuru market and these two markets. The negative sign on the short run adjustment proportion implies that the prices are diverging.

5.5. *Synthesis of the results*

The results show that the potato markets in the country are not functioning properly, mainly due to their structure. As mentioned earlier, the market is oligopolistic in nature, i.e. there are few market participants in the form of rural brokers, urban brokers and transporters who have the market power. There are barriers to entry at the urban market centres where the brokers provide the link between wholesalers and retailers. In many cases the brokers and transporters determine the market price for each potato consignment delivered after accounting for their assembly and transportation costs. The potato markets investigated were integrated and price transmission does occur in the long run.

The trend results show that there is a general rise in the price of potatoes. The farm-gate share, of wholesale market prices for ware(fesh) potato have, increased between 2009 and 2010. In addition, the percentage shares suggest that there exist large marketing margins that are accrued by middlemen and brokers. There are several possible explanations for this scenario (Barrett and Mutambatsere 2005; Goodwin and Schroeder 1990):

i. There is information asymmetry between producing and consuming markets. The is poor road networks between the producing and the consumption areas, resulting in high transportation costs.

ii. Price transmission is usually incomplete in the short run, but complete in the long run, due to spatial arbitrage. The markets studied show that long run price transmission proportions range between 25 and 59 percent, implying that, firstly, the markets in question have inadequate or no storage infrastructure and, secondly, transporters, middlemen and/or wholesalers have market power in the food marketing chain and therefore increase the transaction costs in an effort to maximise profit. Therefore, price transmission does not fully occur.

Table 4: Transmission of Nakuru potato prices to the Eldoret, Nairobi and Mombasa markets					
Location	Unit root	Long run relationship	Error Correction Model		
	ADF test	Johansen Test	Speed of adjustment	Short run adjustment	Long run adjustment
Eldoret	Yes	Yes	-0.19	-0.13	0.59
Nairobi	Yes	Yes	-0.02	-0.15	0.43*
Mombasa	Yes	Yes	-0.42	-0.15	0.44*

*Significant at 5%

6. Implications for policy

The implications for policy are that efforts should be made to facilitate arbitrage through the development of storage and physical infrastructure. Lack of proper storage at farm level necessitates that farmers sell in order to avoid losses, and this tends to accelerate intra-seasonal price instability. At the market centres the focus should be on initiatives such as building the capacities of local councils and local communities to sustainably manage their marketing infrastructure, and building and/or rehabilitating identified marketing infrastructure.

There is need to improve the efficiency of food markets through improvement of infrastructure including storage, transportation, information and communication technology (ICT) and market information at national and local levels, in addition to empowering the producers, facilitating market linkages and expanding/developing agricultural market information systems.

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Appendix

Table 5: Augmented Dickey-Fuller (ADF) unit root test	
Variable	Test statistics
Eldoret Irish Potato	-9.932799 I(1)
Nakuru Irish Potato	-11.07773 I(1)
Mombasa Irish Potato	-9.058550 I(1)
Nairobi Irish Potato	-10.97177 I(1)

The figures in parentheses are the order of integration. The Mackinnon critical values for the augmented Fuller test at 5% significance are -3.46 and -2.98 for first difference.

Table 6: Cointegration test – Irish potato (DLELDAPO DLNKUAPO DLMBAWPO DLNRBWPO)

Hypothesised No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.**
None *	272.6598	47.85613	0.0001
At most 1 *	177.2393	29.79707	0.0001
At most 2 *	102.2419	15.49471	0.0001
At most 3 *	38.49800	3.841466	0.0000
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level.			

* denotes rejection of the hypothesis at the 0.05 level.

Hypothesised No. of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	95.42045	27.58434	0.0000
At most 1 *	74.99736	21.13162	0.0000
At most 2 *	63.74395	14.26460	0.0000
At most 3 *	38.49800	3.841466	0.0000
Max-eigen value test indicates 4 cointegrating eqn(s) at the 0.05 level.			

* denotes rejection of the hypothesis at the 0.05 level.

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