The Effects of Government Maize Marketing and Trade Policies on Maize Market Prices in Kenya

By

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Abstract

The Government of Kenya pursues maize sector policy objectives via two main instruments—the National Cereals and Produce Board (NCPB) which procures and sells maize at administratively determined prices; and a variable tariff on maize imports. A private sector marketing channel competes with the NCPB and prices in the private sector are set primarily by supply and demand forces. This paper estimates the effects of NCPB activities, and the tariff rate, on the historical path of private sector maize market prices in Kenya. Results provide important insights into the historical effects of the NCPB, and will provide useful input into deliberations on the appropriate role for the NCPB, and tariff policy, in the future. It was not possible to use a fully structural econometric model to estimate the historical policy effects because of data limitations in Kenya, which are typical of many developing countries. Instead we use a vector autoregression model (VAR) and show how useful results can be obtained from a fairly parsimonious VAR that can be estimated with sparse data and imposes only minimal identification restrictions. Results show that NCPB activities have stabilized maize market prices in Kenya but also raised average price levels. Tariff effects are much smaller than those of the NCPB but the tariff also caused an increase in average Kenyan maize market price levels.

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EFFECTS OF GOVERNMENT MAIZE MARKETING AND TRADE POLICIES ON MAIZE MARKET PRICES IN KENYA

1. Introduction

Maize is the main staple food in Kenya and is an important source of calories to a large proportion of the population in both urban and rural areas. Maize consumption is estimated at 98 kilograms per person per year, which totals to roughly 30 to 34 million bags (2.7 to 3.1 million metric tons) per year. Maize is also important in Kenya's crop production, accounting for roughly 28 percent of gross farm output from the small-scale farming sector (Jayne et al., 2001).

Kenyan policy makers have been confronted by a classic "food price dilemma." On the one hand, there is pressure to ensure that maize producers receive adequate incentives to produce and sell their crop. Rural livelihoods in many areas depend on the viability of maize production as a commercial crop. On the other hand, the food security of a growing urban population, and of many rural households who are buyers of maize, depends on keeping maize prices low. For many years, policy makers have attempted to strike a balance between these two competing objectives—how to ensure adequate returns for domestic maize production while keeping costs as low as possible for consumers. Maize marketing and trade policy has been at the center of debates over this food price dilemma, including discussions over the appropriateness of trade barriers and the role of government in ensuring adequate returns to maize production. The government has pursued its maize pricing and income transfer policies via two main instruments—the National Cereals and Produce Board (NCPB) which procures and sells maize at administratively determined prices; and a variable tariff on maize imports. A private sector marketing channel competes with the NCPB and prices in the private sector are set primarily by supply and demand forces. The effects of the NCPB's marketing activities, and of the tariff, on the level and variability of maize market prices in the private sector channel are controversial and not well understood. Given the importance of maize in the Kenyan economy, detailed empirical research on the effects of NCPB activities and tariff levels will provide a better understanding of the past effects of these policies and also inform the debate about the appropriate role for tariffs and the NCPB in the future.

The objectives of this paper are to estimate the historical effects of NCPB maize trading activities and the maize import tariff on private sector wholesale maize price levels and variability. The analysis uses monthly data covering the period January 1989 through October 2004. It was not possible to use a fully structural econometric model to estimate the historical policy effects because of data limitations in Kenya, which are typical of many developing countries. Instead we use a vector autoregression model (VAR) and show how useful results can be obtained from a fairly parsimonious VAR that can be estimated with sparse data and imposes only minimal identification restrictions. We estimate the impacts of historical policies on wholesale prices in Kitale, a major surplus-producing area, and Nairobi, the major urban demand center in the country. Results indicate that NCPB activities had important effects on both maize price levels and variability, but the direction of the effect differed over different periods. During the 1993/94 drought period, for example, the NCPB reduced market prices substantially by selling maize at steep discounts to the market, implying a transfer of income from surplus-producing farmers to maize purchasing households. By contrast, since the 1995/96 season the NCPB has typically purchased maize at a premium to the market, thereby raising wholesale maize price levels in Kitale and Nairobi substantially, implying a transfer of income from maize purchasing rural and urban households to surplus-producing farmers. Over the entire sample period the NCPB's activities are estimated to have reduced both the standard deviation and coefficient of variation of prices, which is consistent with its stated mandate of stabilizing prices. However, data on NCPB costs are not available and so it was not possible to undertake a complete benefit cost analysis of the NCPB's activities.

Not surprisingly, the maize import tariff is estimated to have raised average domestic maize prices but to have contributed little in the way of increased price stability. Estimated tariff effects are relatively small, probably because of widespread maize smuggling across borders, informal arrangements at border crossings that appear to reduce effective tariff rates, and trade reversals in some years.

2. Maize Price Determination and Market Structure in Kenya

Kenya has had two parallel maize marketing channels since 1988 when the government partially liberalized maize markets by allowing private trade in maize within the country at prices determined by market forces. However, the official government marketing system was not dismantled and continues to operate in competition with private traders. A parastatal, the National Cereals and Produce Board (NCPB), purchases and sells maize at administratively determined prices. Throughout the 1980s and up to the mid-1990s the NCPB purchased between 3-6 million bags of maize per year. These amounts are roughly 50 to 70 percent of total domestic marketed maize, although accurate estimates of the total marketed maize surplus are difficult to obtain.

Controls on maize transportation across district boundaries enabled the NCPB channel to continue to dominate maize marketing until the mid 1990s. However, after these controls were eliminated in 1995 the NCPB had to offer prices above market levels in order to acquire much maize. By the 1995/96 season, official NCPB buy prices were typically set higher than market prices during the post-harvest months when farmers in the maize breadbasket zones sell most of their maize (November to February, see Table 1). By absorbing surplus maize off the market, it is likely that the NCPB's operations affected parallel market prices. Moreover, fully one-third of the maize purchased by the NCPB since the 1995/96 season has not been sold domestically. In the 9 years since the 1995/96 season for which data has been obtained, the NCPB purchased cumulatively 14.8 million bags of maize but has sold only 9.7 million bags. Some of this maize appears to have been exported officially while some was sold to donors for drought relief operations in the pastoral areas of the country. By setting official prices higher than market levels and taking more maize off the domestic market than injecting into it through sales, the NCPB is likely to have put upward pressure on wholesale maize market prices.

Also starting in the 1995/96 marketing year, the government dramatically reduced the NCPB's operating budget, and it was forced to limit its purchases. NCPB maize purchases declined from over 5 million bags (450,000 metric tons) per year during the 1992/93 to 1994/95 period to roughly 1 million bags (90,000 metric tons) per year in the subsequent five years. Anecdotal evidence suggests that the NCPB shut down its buying functions in most parts of the country except for the Rift Valley areas (e.g., Trans Nzoia, Uasin Gishu, Lugari/Kakamega) where politically important constituents grew maize and relied on the NCPB for price supports.

Table 1. NCPB Purchase Price and Kitale Wholesale Price For the Post-Harvest Months Of November To February

	mean price (November to February)	
	NCPB Purchase price	Kitale wholesale price
	2004 Ksh per 90kg bag	
89/90	1325	1447
90/91	1245	1494
91/92	1298	1403
92/93	1332	2111
93/94	1885	1706
94/95	1689	997
95/96	1040	818
96/97	1882	1600
97/98	1823	1575
98/99	1504	1108
99/00	1623	1661
00/01	1520	1470
01/02	1200	703
02/03	1166	990
03/04	1205	1131

Note: shaded years signify drought years
Source: NCPB and Ministry of Agriculture Market Information Bureau data files.

The NCPB also set administered selling prices. Prior to 1989, industrial millers were legally bound to acquire maize only from the NCPB and were the NCPB's primary buyers. During the early 1990s, these restrictions were progressively lifted. The difference between the official NCPB selling and buying prices was typically insufficient to cover the NCPB's operating costs and deficits were incurred by the treasury.

Trade policy was another important aspect of maize price determination in Kenya during the sample period. The government imposed a tariff on maize imports, both at the port of Mombasa (to restrict imports from the world market) and at border crossings along the Uganda and Tanzanian borders, to support domestic maize prices. Evidence indicates that the costs of maize production in eastern Uganda is typically lower than in most areas of Kenya (Nyoro, Kirimi, and Jayne, 2004), and so imports from Uganda would have been much higher in the absence of the tariff. However, since the border is relatively porous, illegal cross border trade occurred throughout the sample period, and it is alleged that the NCPB support price policy encouraged maize imports from Uganda at the same time that official trade policy attempted to suppress it. Illegal cross-border trade appears to have been impeded somewhat by transaction costs, including bribery payments to police, extra handling charges associated with offloading maize at the border, smuggling it across the border, and on-loading maize into trucks on the Kenya side of the border.

A rapid appraisal study undertaken in October 2004 indicates quite different approaches taken by traders and border police in implementing the maize tariff. One common procedure, uncovered in a focus group discussion of traders, is for the police to report one-quarter of the number of bags that the trader seeks to import into Kenya across the official border, levy the full tariff charge on this partial load, and obtain an informal payment from the trader amounting to the levy charge on another 25 percent of the load. The remaining 50 percent of the traders' maize goes across unrecorded. In this way, the trader effectively pays a tariff on maize imported into Kenya equal to 50 percent of the official tariff rate (with only half of this, i.e., 25%, going into the government coffers). Awuor (2003) reports similar partial payments at Uganda-Kenya border crossings. Such anecdotal evidence indicates that the tariff was unlikely to have influenced Kenyan prices by as much as the nominal tariff might seem to indicate.

For a brief period from July 1992 to June 1995, the Kenyan government eliminated the maize import tariff. It is unknown what effect this had on informal imports from Uganda and Tanzania as such information is unrecorded.

The official import tariff may be thought to have an influence on the incentives for private traders to import maize from international sources through the port of Mombasa. However, financial cost accounting analysis indicates that, even under a zero tariff regime, internationally sourced maize can only rarely be competitive in Nairobi and parts west from there. The port costs and upland transport costs add at least $50 per ton to the cost of internationally sourced maize, which provides a form of protection to domestic production in the central and western parts of the country where most of the population resides. Therefore, we would expect the maize import tariff to affect maize prices primarily through its impact on informal trade flows between Uganda, Tanzania and Kenya rather than on international imports through Mombasa.

In summary, we hypothesize that government policy may have affected wholesale maize market prices in Kenya both through the tariff and through NCPB marketing activities.

3. Methodology

Estimating the effects of government policy on maize prices in Kenya over a historical sample period is a very difficult task. Data are limited, the objectives of government policy have undoubtedly changed over time, and using a traditional structural econometric model to identify policy effects would be sensitive to the Lucas critique that behavioral relationships underlying the model may have been different under alternative policy scenarios (Lucas, 1976). Indeed, a traditional structural econometric approach is not feasible for tackling this problem in the current context because prices are the only reliable market data available for maize (e.g., reliable data on consumption, informal trade, and storage are not collected in Kenya).

Faced with these data problems, and the possibility that structural behavioral relationships may have been different under alternative policy scenarios, we take a vector autoregression (VAR) approach (Sims, 1980, Fackler, 1988, Myers, Piggott, and Tomek, 1990). VAR models have proven to be very useful for estimating policy effects in the presence of limited data and/or uncertainty about the correct structural model that is generating observed data. The approach has been applied mainly to macroeconomic models and macroeconomic policy but has also been applied successfully to study the effects of commodity marketing policy (e.g. Myers, Piggott, and Tomek, 1990). The advantage of the VAR approach is that it treats policy decisions as endogenous and separates policy changes into an endogenous component that reacts to changes in the economic environment and an exogenous component that represents innovations in the policy stance. By endogenizing policy variables the VAR approach helps to overcome the Lucas critique and also provides a means of estimating the effects of policy changes under minimal identifying assumptions about the structure of either markets or the underlying policy environment. Of course, these advantages come at a cost because while the net effect of policy changes on key variables of interest may be obtained, the structural economic mechanisms through which these policies manifest themselves is not always evident. Furthermore, VAR models generally require long data series and results can sometimes be quite sensitive to alternative identification restrictions.

To outline the VAR approach, suppose we observe a vector of market variables $\boldsymbol{y_t}$ that we want to simulate under alternative policy scenarios. We also observe a vector of policy variables $\boldsymbol{p_t}$ that the government uses to attempt to influence the market variables $\boldsymbol{y_t}$. A general dynamic model of the relationship between the market variables and the policy variables can be written as:

$$\text{(1)} \qquad \boldsymbol{By_t = \sum_{i=1}^{k} B_i y_{t-i} + \sum_{i=0}^{k} C_i p_{t-i} + A^y u_t^y}$$

$$\text{(2)} \qquad \boldsymbol{Dp_t = \sum_{i=0}^{k} G_i y_{t-i} + \sum_{i=1}^{k} D_i p_{t-i} + A^p u_t^p}$$

where the $\boldsymbol{B}$, $\boldsymbol{B_i}$, $\boldsymbol{C_i}$, $\boldsymbol{A^y}$ and $\boldsymbol{D}$, $\boldsymbol{D_i}$, $\boldsymbol{G_i}$, $\boldsymbol{A^p}$ are matrices of unknown parameters, k is the maximum number of lags allowed in any equation, and $\boldsymbol{u_t^y}$ and $\boldsymbol{u_t^p}$ are vectors of mutually uncorrelated "structural" innovations representing random shocks to the fundamental supply, demand, and policy process that are generating data for $\boldsymbol{y_t}$ and $\boldsymbol{p_t}$.[1]

[1] The assumption that each structural error vector contains mutually uncorrelated errors is not restrictive because the $\boldsymbol{A^y}$ and $\boldsymbol{A^p}$ matrices allow each shock to enter every equation in the block. The assumption that $\boldsymbol{u_t^p}$ is also uncorrelated with $\boldsymbol{u_t^y}$ is also not restrictive because independence from current market conditions is part of the definition of an exogenous policy shock (see Bernanke and Mihov, 1998).

To this point the model is very general because the dynamics between the market variables and the policy variables are left unrestricted and the parameter matrices allow a wide range of contemporaneous interactions between all of the variables in the system. We could also add deterministic intercept, trend and/or seasonality variables to each of the equations in the system (or alternatively think of all variables as being expressed in terms of deviations from their mean, trend, and/or seasonal components) without changing any of the results or discussion that follows.

Proponents of a more traditional structural simultaneous equations approach to econometrics often argue that the system (1)-(2) is misspecified because $\boldsymbol{y_t}$ generally does not include all of the relevant variables that might be influencing the supply and demand for commodities. It should be kept in mind, however, that the goal here is not necessarily to estimate structural supply and demand curves but only to determine the impacts of policy variables on equilibrium values of a subset of market variables (in our case maize prices). The VAR allows this goal to be obtained without imposing a large set of overidentifying supply and demand restrictions. The VAR system is simply an alternative representation of the historical correlations imbedded in a more complete structural simultaneous equations model, and in this sense is not "misspecified" (though there is clearly a loss of information from not including all of the relevant supply and demand shift variables in the model).

If we could estimate the system (1)-(2) it would then be straightforward to obtain policy effects and simulate the effects of alternative policy paths. Unfortunately, however, the system is not yet econometrically identified. This is easy to see because the reduced form of the model has an error covariance matrix with $(N^2 + N)/2$ unique parameters (where N is the total number of variables in $\boldsymbol{y_t}$ and $\boldsymbol{p_t}$), which is not nearly enough to identify all of the contemporaneous parameters $\boldsymbol{B}$, $\boldsymbol{C_0}$, $\boldsymbol{D}$, $\boldsymbol{G_0}$, $\boldsymbol{A^y}$, and $\boldsymbol{A^p}$ in the system (see Sims, 1980 and Fackler, 1988).[2] In order to proceed we need a set of identification restrictions. These identification restrictions are often critical because results can be sensitive to alternative identification schemes, and identifications used in

[2] Remember that the dynamics of the system are completely unrestricted so they will not provide identifying information.

practice are typically just-identifying so there are no over-identifying restrictions to test econometrically.

Bernanke and Mihov (1998) suggest that a natural identification restriction to use in this context is to set $\boldsymbol{C_0} = 0$, which excludes policy shocks from influencing market variables within the current period. This implies that while fundamental market (supply and demand) shocks may have an immediate impact on market variables, changes in policy take time to filter through the marketing system and have an effect on market price levels.

Bernanke and Blinder (1992) have shown that if $\boldsymbol{C_0} = 0$ then the effect of a policy shock on market variables is independent of the $\boldsymbol{B}$ and $\boldsymbol{A^y}$ parameter matrices. Put another way, the effect of a policy shock on market variables is not sensitive to alternative (just-identified) identification schemes on the $\boldsymbol{y_t}$ block of the model (1). This is a useful result because it means that estimates of policy effects on market variables will be robust to any alternative (just-identified) identification scheme that might be used for the market variables block of the model.

However, policy effects will still be sensitive to the restrictions used to identify $\boldsymbol{D}$, $\boldsymbol{G_0}$, and $\boldsymbol{A^p}$ in the policy block. The most common identification scheme used in VAR models is the Choleski factorization which imposes a recursive ordering among variables with innovations to any variable having a contemporaneous effect on itself and variables ordered lower in the block, but not on variables ordered higher in the block (Sims, 1980).[3] In our context this would imply $\boldsymbol{A^p}$ is restricted to be diagonal and $\boldsymbol{D}$ to be lower triangular with ones on the diagonal (with $\boldsymbol{G_0}$ left unrestricted). Alternative orderings for the policy variables then imply alternative identifications. Alternatives to the Choleski factorization have also been used when appropriate (e.g. Blanchard and Quah, 1989). Whatever identification scheme is implemented it should be based on sound economic logic and be consistent with institutional characteristics of the policy processes being modeled.

[3] It is important to note that this restriction only applies to contemporaneous interactions between the variables. Dynamic interactions in the model remain unrestricted.

Once an identification scheme has been chosen the model can be estimated in two steps. First, estimate the reduced form of the system using ordinary least squares applied to each equation. Second take the reduced form least squares residual covariance matrix and solve for the unknown contemporaneous structural parameters (in the case of just-identified systems) or use maximum likelihood to estimate these parameters (in the case of over-identified systems). These estimation procedures are explained in detail elsewhere (e.g. Fackler, 1988; Myers, Piggott and Tomek, 1990).

Having estimated the model then impulse response analysis can be used to trace out the dynamic response of all variables in the system to a typical innovation in a particular policy variable (see Hamilton, 1994). Furthermore, if we set all structural innovations except the policy innovations to their historical values, and then control the sequence of policy innovations in order to generate specific historical paths for the policy variables, we can simulate what the effects of alternative policies would have been over the sample period of the data. This can be quite useful for evaluating counterfactual price paths under alternative policy scenarios.

4. Application to Kenyan Maize Prices

The first step in applying the VAR methodology to estimate policy effects on Kenyan maize prices is to choose the variables to include in the $\boldsymbol{y_t}$ and $\boldsymbol{p_t}$ vectors. Two regional wholesale prices in Kenya are included in the $\boldsymbol{y_t}$ vector—the wholesale price in the maize breadbasket district of Kitale and the wholesale price in the main consumption region of Nairobi. Prices for other regions could also have been included but it was found that adding other regions increased the dimensionality of the model without significantly changing the estimated policy effects on the Kitale and Nairobi prices. Including the two regional markets in Kitale and Nairobi allows an evaluation of how policy affects prices in a major production area versus a major consumption area while still maintaining a tractable model specification.

In most years there is potential for significant cross-border maize trade between Kenya, Uganda, and Tanzania, usually in the form of imports into Kenya but occasionally in the form of exports to Uganda and/or Tanzania. Mbale is a major market in Eastern

Uganda that serves the border region and, because of cross-border trade, interactions are expected between Mbale and Kenyan prices. Hence, wholesale price in Mbale is also included in the $\boldsymbol{y_t}$ vector. Including prices from Tanzania might also be appropriate but monthly wholesale price series for Tanzanian markets are not available and so could not be included in the analysis. Kenya also occasionally imports maize from South Africa or related world markets and so South African prices are also candidates for inclusion in the $\boldsymbol{y_t}$ vector. As discussed above, however, internationally sourced maize can only rarely be competitive in Kenya and so South African prices are unlikely to have a major influence on Kenyan prices in normal years. Furthermore, estimated policy effects on Kenyan maize prices were very similar irrespective of whether or not the South African price was included in $\boldsymbol{y_t}$ (see the Appendix). Hence, South African prices were not included in the final model specification.

Including other market variables such as trade flows, consumption amounts, storage levels, etc. might provide additional information but monthly data on these variables for maize in Kenya are not available. Hence, the $\boldsymbol{y_t}$ vector in the final model specification includes three variables—Kitale price, Nairobi price, and Mbale price.

For the $\boldsymbol{p_t}$ vector we want variables that represent the operation of Kenyan maize price policy. The NCPB manages domestic maize prices by buying maize in surplus producing regions at an administratively determined purchase price, transporting it to major consumption regions, and selling it at an administratively determined sell price. Hence, the NCPB influences prices in three main ways—by changing the size of the buy price premium (the difference between the NCPB buy price and the market price in surplus producing regions); by changing the size of the sell price premium (the difference between the NCPB sell price and the market price in consuming regions); and by potentially rationing how much maize they will buy or sell at their administratively determined prices (i.e. by choosing the amount of net purchases to make during any particular period). Hence, we initially included three variables in the $\boldsymbol{p_t}$ vector: (a) the buy price premium (measured as the difference between the administered NCPB purchase price and the wholesale market price in the major production area of Kitale); (b) the sell price premium (measured as the difference between the administered NCPB sell price and the wholesale market price in the major consumption region of Nairobi); and (c) net NCPB purchases of maize (measured as the difference between the amount of maize purchased by the NCPB and the amount of maize sold).

Notice that all three of these policy variables can be positive, zero, or negative and if all three of them were set to zero then the market would be operating without NCPB influence. Furthermore, positive values for the buy price premium indicate the NCPB is subsidizing producers (setting buy prices above the producer market price) while negative values of the sell price premium indicate subsidization of consumers (setting sell prices below the market price). Positive net NCPB purchases would indicate they are adding to their stocks while negative net purchases would indicate they are running down stocks.

It was found that estimated NCPB effects on maize market prices were very similar irrespective of whether the third policy variable (net NCPB purchases) was included or not (see the Appendix). This suggests that the NCPB does not engage in significant quantity rationing and generally stands ready to take and make all deliveries at their administratively determined buy and sell prices. Hence, the main policy instruments influencing price levels are the buy and sell price premiums built into the NCPB administered buy and sell prices. For this reason the final model specification only includes the buy price premium and the sell price premium in the policy vector $\boldsymbol{p_t}$.

The other variable that we might want to include in the policy vector would be a measure of the formal tariff rate the government imposes on maize imports. However, the tariff is an administratively determined rate that is changed very infrequently and therefore not well suited to being modeled in a linear VAR framework. Furthermore, the tariff rate is already included implicitly in the model because the Ugandan maize price data are converted to Kenyan Shillings and adjusted by the historical tariff rate in order to make the Ugandan prices directly comparable to Kenyan prices. This suggests that the effects of the tariff can be simulated by extracting the tariff effect from the Ugandan prices, and then recursively computing the resulting dynamic price path of the Kenyan maize price variables in $\boldsymbol{y_t}$. This will be explained in more detail below.

For identification we follow Bernanke and Blinder (1992) and Bernanke and Mihov (1998) and begin by setting $\boldsymbol{C_0} = 0$. As indicated above, this assumes market variables respond to policy changes with a lag but there is no contemporaneous response. This may seem like a very strong restriction because it implies that maize sellers and buyers respond to a change in the NCPB buy and sell price premiums, but that it takes a full period (in our case a month) before they become fully aware of the change and start altering their behavior. However, there are a number of frictions that might preclude immediate adjustment to buy and sell price premium changes. First, in developing countries like Kenya access to market information tends to be sporadic and incomplete. Hence, it may take some time before buyers and sellers even become aware that the premiums have changed. Second, even when market participants become aware of the premium changes it may be costly and time consuming to alter their marketing channel because of adjustment costs and inertia. Therefore, the assumption that there is a least a one month delay in any market response to changes in NCPB buy and sell price premiums seems like a reasonable restriction in this context. Furthermore, the only real alternative to setting $\boldsymbol{C_0} = 0$ is to set $\boldsymbol{G_0} = 0$, which implies that policy variables do not respond contemporaneously to changes in market prices. This seems like an even more untenable assumption because it implies that the NCPB is not monitoring closely what is going on in the markets. We estimated the model under the $\boldsymbol{G_0} = 0$ restriction and found that impulse responses were illogical and inconsistent. Hence, $\boldsymbol{C_0} = 0$ appears to be the most appropriate identification restriction in this application.

Given that $\boldsymbol{C_0} = 0$ is imposed there is no need for any identification restrictions on the market variables block (i.e. no need to restrict $\boldsymbol{B}$ or $\boldsymbol{A^y}$) because, as explained above, the effects of policy changes on market variables will then be independent of alternative identifications. For the policy block we use a simple Choleski factorization with the buy price premium ordered first and the sell price premium ordered second. This implies the NCPB determines its buy price premium first and evaluates how much maize is being delivered, then it sets the sell price premium based on the level of the buy price premium. This seems logical and the results are very similar using the reverse order.[4]

[4] Also note that this recursive ordering only influences the impulse response analysis and has no effect on the simulated path of counterfactual prices in the absence of the NCPB (because in this case both of the NCPB policy variables become zero in every period irrespective of the recursive ordering).

5. Data and Preliminary Results

Data

The study uses monthly data from January 1989 through October 2004. Wholesale maize prices for Kitale and Nairobi were obtained from the Ministry of Agriculture's Market Information Bureau. Wholesale maize prices for Mbale in eastern Uganda were obtained from the Ministry of Agriculture in Uganda. All prices are expressed in Kenyan Shillings per 90kg bag. Ugandan prices were converted to Kenyan shillings using the official exchange rate and then adjusted upward by the official tariff rate in order to make then directly comparable to Kenyan prices. Official maize import tariffs were available on a monthly basis from the Ministry of Industry and Trade. All prices are nominal because the goal is to estimate policy effects on the historical path of nominal prices. It is possible that interactions between maize prices and the general price level have an influence on the effects of NCPB policy on nominal maize prices (i.e. that a measure of the general price level should be included in the model). However, estimated policy effects on nominal Kenyan maize prices were very similar irrespective of whether or not the consumer price index was included (see the Appendix). A small number of missing price observations were imputed using linear forecast equations based on inter-regional price relationships.

Diagnostic tests

Preliminary investigations of the data focused on testing for seasonality and unit roots in each variable. Correlograms for both the price and policy variables displayed no strong evidence of seasonality and results provided later confirm that residuals from the VAR regressions without seasonal variables show no significant evidence of autocorrelation. This lack of strong seasonality in prices might initially seem surprising but Kenya has two cropping seasons and the activities of the NCPB are designed, in part, to reduce seasonal price variations. Hence, it is reasonable that historical monthly maize prices in Kenya do not display strong seasonality.

Next, augmented Dickey–Fuller regressions were run for each price and policy variable to test for unit roots. One lagged dependent variable was sufficient to eliminate autocorrelation in the residuals in all of the Dickey-Fuller regressions, and a constant and time trend were also included to account for any systematic deterministic components. Phillips-Perron unit roots tests were also applied as a consistency check.[5] A constant and a time trend were also allowed for in the Phillips-Perron tests, and the number of Newey-West lags was set to 4. Results from both the augmented Dickey-Fuller and Phillips Perron tests are shown in Table 2. Results support stationarity in all variables, except perhaps the Nairobi maize price which has p-values of 0.083 under Dickey-Fuller and 0.154 under Phillips-Perron. Even in this case, however, a unit root can be rejected using a 10% significance level under Dickey-Fuller (see Table 4). Furthermore, these unit root tests are known to have low power against the alternative hypothesis of stationarity, and it seems highly unlikely that the Nairobi maize price would have a unit root while the Kitale and Uganda prices do not. Finally,there is little to be gained in the VAR framework by imposing unit root and cointegration restrictions even if they are valid (except, of course, some gain in estimation efficiency).[6] Given the general support for stationarity in the Kenyan maize price and policy variables, and the fact that estimation will still be consistent even if unit roots exist, we estimate the VAR without imposing any unit root or cointegration restrictions.

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[5] Phillips-Perron tests are more robust to serial correlation and time-dependent heteroscedasticity than the augmented Dickey-Fuller test (Davidson and MacKinnon, 1993)

[6] The reason is that least squares estimation of the VAR parameters remains consistent, even in the presence of unit roots and cointegration (Davidson and MacKinnon, 1993). It is only distribution theory (and therefore hypothesis testing) that is altered drastically. But the VAR analyses of impulse response functions and policy simulation do not require formal hypothesis testing.

Table 2. Unit Root Test Results

Test	Uganda Price	Kitale Price	Nairobi Price	NCPB Buy Price Premium	NCPB Sell Price Premium
Dickey-Fuller	-4.126 (0.006)	-3.294 (0.067)	-3.206 (0.083)	-4.344 (0.003)	-4.183 (0.005)
Phillips-Perron	-3.665 (0.025)	-3.480 (0.042)	-2.926 (0.154)	-4.730 (0.001)	-3.999 (0.009)

Notes: Dickey-Fuller and Phillips-Perron values are *Z(t)* statistics with MacKinnon approximate *p*-values for testing the null hypothesis of a unit root given in brackets under the statistic. The number of lags included in the augmented Dickey-Fuller tests was 1 and the number of Newey-West lags used in the Phillips-Perron test was 4. Both models include a constant term and a time trend to account for deterministic components.

6. Results

VAR estimation results

Given the preceding preliminary results, the VAR was specified in levels of the variables with no seasonality or trend terms.[7] Standard VAR order selection criteria such as the Akaike information criterion and Schwartz Bayesian criterion (see Enders, 1995) all suggested a first-order model. However, these criteria are known to underestimate lag-length in some circumstances and likelihood ratio statistics suggested higher-order lags were needed. Hence, we tested the residuals for autocorrelation using Ljung-Box Q statistics and found that both first- and second-order models had statistically significant autocorrelation in at least one set of residuals. We therefore expanded the model to third-order lag and residuals from this model are well behaved in all cases.

Estimation results for the third-order VAR are provided in Table 3. As is normally the case in VAR models, there are many parameter estimates that are not

[7] There was no strong preliminary evidence of seasonality, and it has become standard practice in estimating VARS not to include trends so that the dynamic interrelationships among the variables can be estimated without imposing strong identification restrictions. Furthermore, tests for the existence of trends and autocorrelated residuals (reported below) suggest that seasonality and trend variables are not required in this application.

Table 3. VAR Estimation Results

Coefficient	Uganda Price Equation	Kitale Price Equation	Nairobi Price Equation	Buy Price Premium Equation	Sell Price Premium Equation
Constant	46.75	19.83	43.26	-34.64	-15.39
	(0.81)	(0.63)	(1.82)	(-1.03)	(-0.56)
Uganda Price-Lag 1	0.98	0.02	0.02	-0.02	-0.02
	(13.37)	(0.43)	(0.55)	(-0.52)	(-0.64)
Uganda Price-Lag 2	-0.14	0.02	-0.00	-0.00	-0.00
	(-1.42)	(0.37)	(-0.12)	(-0.01)	(-0.10)
Uganda Price-Lag 3	0.04	-0.03	-0.01	0.03	0.02
	(0.60)	(-0.86)	(-0.40)	(0.62)	(0.45)
Kitale Price-Lag 1	-0.10	1.07	0.36	-0.15	-0.22
	(-0.31)	(5.99)	(2.68)	(-0.78)	(-1.43)
Kitale Price-Lag 2	-0.01	-0.25	-0.19	-0.08	0.16
	(-0.02)	(-1.09)	(-1.09)	(0.33)	(0.81)
Kitale Price-Lag 3	0.06	-0.06	0.03	0.11	-0.10
	(0.19)	(-0.34)	(0.25)	(0.59)	(-0.66)
Nairobi Price-Lag 1	0.34	0.19	1.09	-0.03	-0.21
	(0.92)	(0.93)	(7.24)	(-0.15)	(-1.24)
Nairobi Price-Lag 2	-0.14	-0.00	-0.27	0.08	-0.31
	(-0.28)	(-0.00)	(-1.34)	(0.27)	(1.34)
Nairobi Price-Lag 3	-0.07	-0.01	-0.03	-0.04	0.07
	(-0.19)	(-0.05)	(-0.19)	(-0.21)	(0.43)
Buy Premium-Lag 1	-0.16	0.26	0.27	-0.68	-0.13
	(-0.56)	(1.69)	(2.32)	(4.19)	(-0.98)
Buy Premium-Lag 2	0.05	-0.37	-0.24	0.27	0.22
	(0.13)	(-1.83)	(-1.55)	(1.24)	(1.25)
Buy Premium-Lag 3	0.09	0.24	0.02	-0.24	-0.08
	(0.32)	(1.56)	(0.21)	(-1.49)	(-0.64)
Sell Premium-Lag 1	0.44	-0.04	0.11	0.03	0.73
	(1.54)	(-0.25)	(0.94)	(0.21)	(5.49)
Sell Premium-Lag 2	-0.23	0.06	-0.03	-0.29	0.05
	(-0.64)	(0.28)	(-0.22)	(-0.13)	(0.27)
Sell Premium-Lag 3	-0.13	-0.09	0.01	0.11	0.02
	(-0.47)	(-0.62)	(0.09)	(0.72)	(0.19)
R-Square	0.878	0.897	0.943	0.722	0.775

Note: Numbers in parentheses under the coefficient estimates are associated t-statistics.

individually statistically significant. However, likelihood ratio tests and tests for residual autocorrelation suggest a third order model is appropriate, and the usual approach is to allow the dynamic interrelationships among variables to be estimated without further exclusion restrictions based on individual t-statistics. Coefficients of determination shown at the bottom of the table indicate each equation has strong in-sample explanatory power.

Model evaluation tests were conducted on the estimated VAR and results are provided in Table 4. Ljung-Box Q tests support residuals from each equation having the white noise property. The same test applied to the squared residuals supports no autoregressive conditional heteroscedasticity (ARCH) in any residual series, except for the Kitale price equation which does show evidence of ARCH effects. ARCH effects are not modeled explicitly because they only appear in one equation and because parameter estimates remain consistent in the presence of conditional heteroscedasticity (Enders, 1995). Hence, we should still get consistent estimates of policy effects on the levels of historical prices, which is the primary focus of this research. We also tested for a linear trend term in each equation and this term was statistically insignificant at conventional significance levels in all equations except the Nairobi price equation. Trend terms were not modeled explicitly because they are only statistically significant in one equation and because it is generally recommended not to include trend terms in VARs so that the dynamic interrelationships between variables remains as unrestricted as possible (Enders, 1995).

Data for the model cover a fairly extended period from January of 1989 through October of 2004. During this time there were two major shocks that may have caused structural change in the VAR—the severe drought of 1992-1994 (which was also associated with a temporary removal of the import tariff) and the removal of interregional trade restrictions and other market liberalization implemented in the middle of 1995. This suggests investigating structural change in the model by breaking the full sample into three periods—the "pre-liberalization period" from January 1989 through May 1992; the "drought period" from June 1992 through June 1995; and the "post-liberalization period" from July 1995 through October of 2004. Dummy variables were constructed and used to test for structural change in the VAR over these three periods. Tests for the null hypothesis of no intercept changes over the three periods are reported in Table 4 and support the null hypothesis of no structural change. Further tests (not reported) on slope coefficients from the VAR also do not find significant evidence of structural change. Therefore, the VAR was assumed to be stable over the sample period for further analysis.

Table 4. VAR Model Evaluation Results

Test	Uganda Price Equation	Kitale Price Equation	Nairobi Price Equation	Buy Price Premium Equation	Sell Price Premium Equation
Evaluation of Residuals					
- AR(1)	0.045	0.288	0.005	0.105	0.007
	(0.831)	(0.591)	(0.945)	(0.746)	(0.935)
- AR(6)	4.7115	6.225	7.172	4.405	2.010
	(0.581)	(0.399)	(0.305)	(0.622)	(0.919)
- AR(12)	8.731	16.343	10.529	11.243	7.276
	(0.726)	(0.176)	(0.570)	(0.508)	(0.839)
- ARCH(1)	2.419	5.411	1.185	3.069	2.708
	(0.120)	(0.020)	(0.276)	(0.080)	(0.100)
- ARCH(6)	2.752	19.020	5.924	6.552	4.278
	(0.839)	(0.004)	(0.432)	(0.364)	(0.639)
- ARCH(12)	2.971	28.455	7.407	12.616	7.275
	(0.996)	(0.005)	(0.830)	(0.398)	(0.839)
Deterministic Trend	0.225 (0.704)	0.064 (0.842)	0.521 (0.030)	0.090 (0.792)	-0.303 (0.276)
Structural Change	1.12 (0.571)	0.99 (0.610)	4.43 (0.109)	0.07 (0.966)	5.12 (0.077)
Import Variables	0.15 (0.985)	1.56 (0.670)	2.45 (0.484)	1.57 (0.666)	1.35 (0.717)

Notes: The AR (ARCH) residual tests are Ljung-Box Q tests for the relevant order autocorrelation in the residuals (squared residuals) of the series. The deterministic trend statistic is a t-value for testing the null hypothesis of no linear trend in each equation, with *p*-value in parentheses under the statistic. The structural change statistic is Chi-square with two degrees of freedom and tests the null hypothesis on no intercept shifts during different policy regimes, again with *p*-value in parentheses under the statistic. The import variables statistic is Chi-square with three degrees of freedom and tests the null hypothesis of no import effects in the VAR, again with *p*-value in parentheses under the statistic.

It is also possible that imports have a significant effect on the dynamic interrelationships between price and policy variables in the VAR. To test this we obtained monthly data on private sector, NCPB, and food aid imports. These three import variables were then included as exogenous variables in the VAR and tests for whether they have additional explanatory power once all the price and policy variable lags had been included in the model were conducted. Results provided in Table 4 support the null hypothesis that the import variables have no additional explanatory power. Therefore, imports were not included as exogenous variables in the VAR.[8]

Impulse response results

The economics underlying dynamic interrelationships between Kenyan maize price and policy variables is that buyers and sellers of maize have two alternative marketing channels to choose from—they can sell to or buy from the NCPB at administratively determined NCPB prices, or they can sell or buy through the private sector wholesale market channel at prices set by forces of supply and demand. Clearly, relative prices in the two channels will be a major determinant of volume moving along each channel, and changing volumes in the market channel should influence market prices. For example, if the NCPB raises its buy price above the market price in Kitale then we might expect more supply entering the NCPB channel and less supply entering the market channel. And as supply contracts in the marketing channel this should put upward pressure on market prices in Kitale. Similarly, if the NCPB raises its sell price above the market price in Nairobi then we might expect less demand for NCPB maize and more demand for market sourced maize. And this increase in market demand should put upward pressure on market prices in Nairobi. Hence, by altering buy and sell price premiums relative to market prices the NCPB alters volumes moving through the two marketing channels and influences the level of market prices.

[8] Of course, this does not necessarily mean that imports do not affect prices, only that imports do not inform the dynamic interrelationships between domestic prices and NCPB price premiums, once lags of the price and policy variables have been accounted for. Put differently, exclusion of the import variables implies that when the effects of NCPB activities on prices are evaluated it is being assumed that imports will continue to play the same *role* they have played historically in influencing market price levels (though not necessarily that imports would remain at their historical *levels* .

Nevertheless, volumes moving through the different marketing channels are not expected to depend solely on the price premiums, nor would we expect all of the adjustment to changes in price premiums to occur instantaneously. There are many reasons besides price alone why sellers and buyers might choose a particular marketing channel. Location is likely to be important as this could cause one of the channels to be much more convenient (and therefore less costly to supply to) than the other. There might also be benefits to having an experienced relationship with buyers or sellers in a particular channel, or future costs might be incurred if the channel is switched (e.g. you might be excluded from participating later when the price differentials return to being favorable). In these situations the price differential has to rise to a threshold level before it becomes economical to switch. Buyers and sellers might also incur adjustment costs in the form of information gathering, learning, investment in new equipment and experiences, etc. when changing their marketing channel. For these reasons we would expect a dynamic aggregate response to changing price premiums rather than a one-time instantaneous adjustment.

The dynamic response of market prices to changes in NCPB buy and sell price premiums can be investigated using impulse response analysis. Impulse response analysis uses the moving average representation of the VAR to trace out the dynamic effect of shocks to the system on each of the variables in the system. Here we are interested in the dynamic response of market prices to shocks to the NCPB buy and sell price premiums. Based on the economic reasoning above we would expect positive shocks to the premiums to have positive effects on market prices, with the effect being spread over time as a result of adjustment costs from moving between marketing channels.

The response of Kitale and Nairobi maize prices to a one-time random shock in NCPB buy and sell price premiums (assuming both the premiums and the prices then continue to respond according to their historical patterns embodied in the VAR equations, but with no additional shocks) are shown in Figure 1. As expected, a positive shock to the buy price premium increases Kitale market prices, with the effect starting out small, getting gradually stronger over a seven month period, and then diminishing (but still positive) after that (see the top panel of Figure 1). The effect is very persistent and

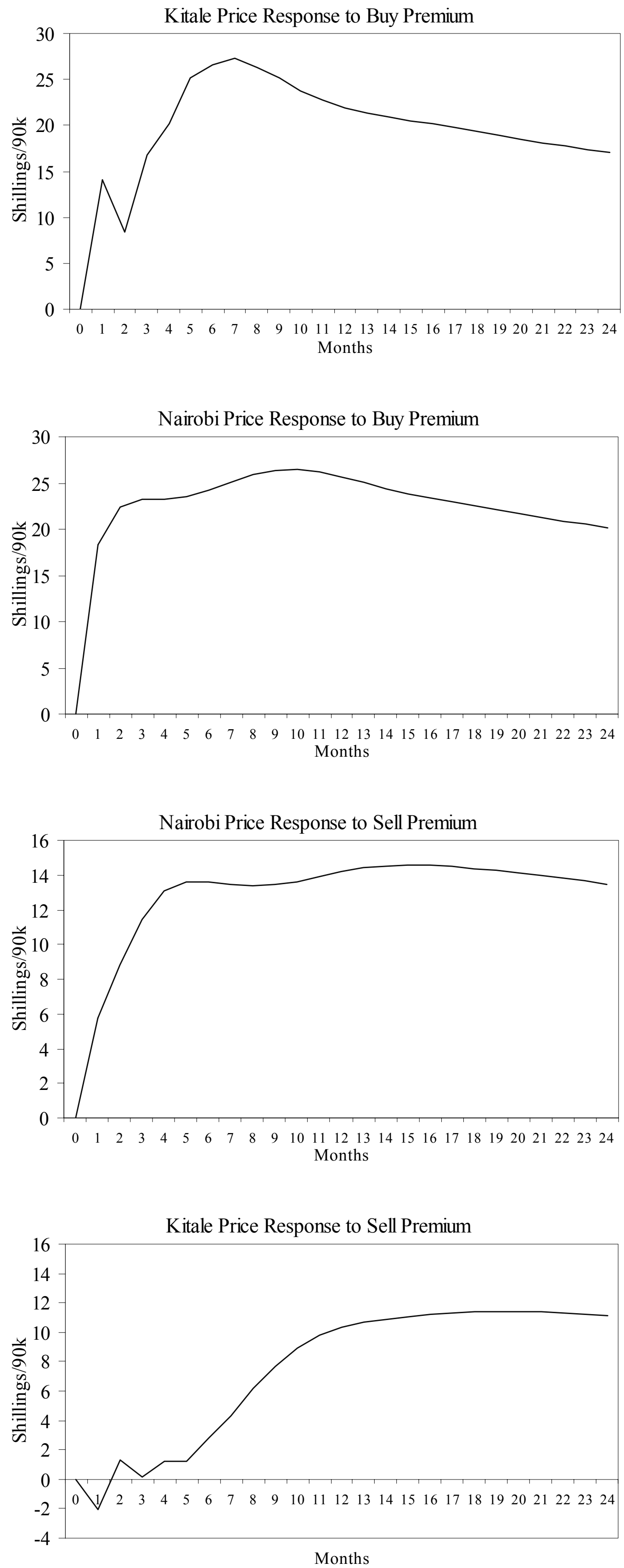


Figure 1. Impulse Responses

continues to be positive even after 24 months. This implies that when there is a positive shock to the buy price premium the NCPB tends to keep its administered prices at the relatively higher level for some time. The second panel of Figure 1 shows that the response of the Nairobi price to a positive shock in the buy price premium mirrors the positive effect on the Kitale price. This suggests that price changes in the Kitale market price pass through rapidly to the Nairobi price, so that both prices move up in tandem in response to the shock. These effects are consistent with product moving out of the market channel and into the NCPB channel (inward shift in market supply) in response to an increase in the NCPB buy price premium, as discussed earlier.

The third panel of Figure 1 shows the response of the Nairobi price to a positive shock to the NCPB sell price premium. In this case, demand for product through the market channel should increase because this channel has become relatively cheaper, leading to the observed positive response in the Nairobi market price. The initial response is muted but the response gradually gains momentum and is close to its peak after about six months. This effect is also quite persistent, indicating that when the NCPB raises its sell price premium it tends to maintain the higher relative price for an extended period of time. Even after 24 months the marginal effect of the shock remains high. The fourth and final panel of Figure 1 shows the effect of a shock to the sell price premium on the Kitale price. Notice that while the effect is positive, as expected, it takes six or seven months before there is a significant rise in the Kitale price. This suggests an asymmetry in price response, with supply shocks being manifested rapidly in Nairobi prices but demand shocks traveling more slowly back to the production area of Kitale. This could be due to poorer information flows back into outlying areas, differences in adjustment costs, or it could also be consistent with some forms of non-competitive behavior.

Overall, the impulse response results are quite consistent with economic logic and provide support for moving forward and using the VAR to estimate the historical effects of NCPB marketing activities.

The estimated effects of NCPB marketing activities

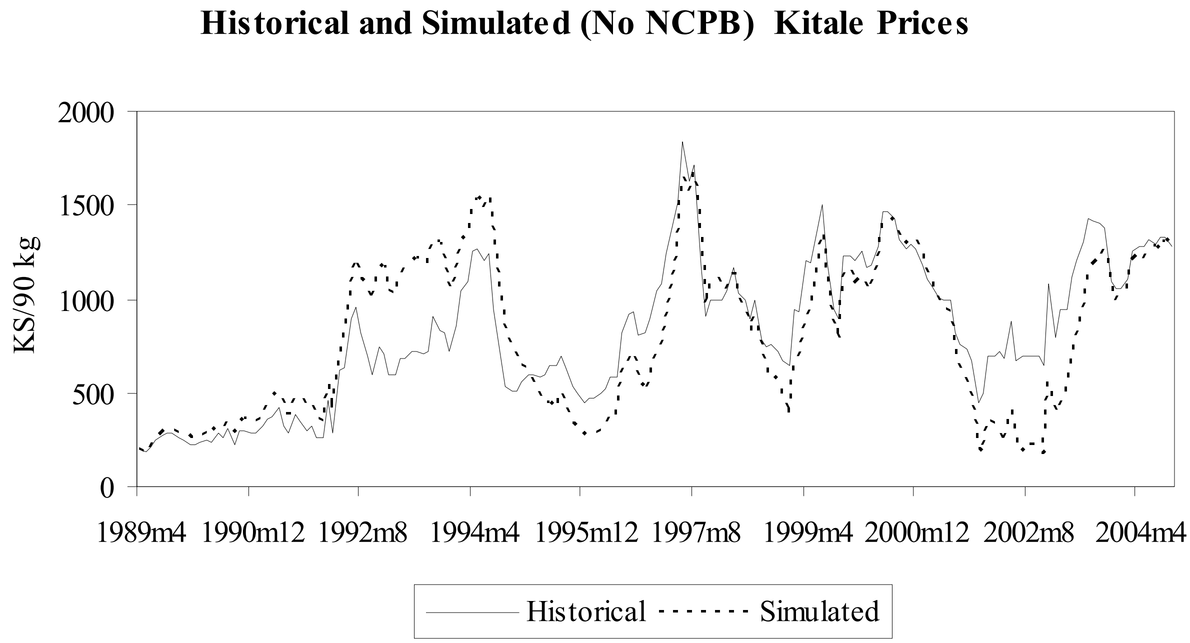
Prices in the absence of the NCPB marketing channel were simulated by: (a) recursively constructing a set of counterfactual policy shocks that generate zero values for NCPB buy and sell price premiums over the entire sample period; (b) assuming that the shocks to the market variables remain at their estimated sample values over the sample period; and (c) constructing dynamic forecasts of the Kitale and Nairobi maize price paths under the counterfactual policy shocks and actual market shocks. The resulting estimated NCPB price effects are tabulated in Table 5 and graphed in Figure 2. In addition, Figure 3 graphs the estimated NCPB price effects against the historical NCPB price premiums to illustrate the relationship between premium choice and the resulting price effect.

In the initial part of the sample period from April 1989 through May of 1992, prior to serious cereal market reform, NCPB marketing activities are estimated to have lowered average maize prices in both Kitale and Nairobi by approximately 17%, and also stabilized prices by reducing both the standard deviation and the coefficient of variation (CV) of prices over this period (see Table 5 and Figure 2). Figure 3 shows that during this initial period the NCPB set both their buy and sell prices persistently below market prices in Kitale and Nairobi, respectively. The lower prices in the NCPB channel would have increased supply to the market channel at the same time that demand from the market channel was decreased, thus putting downward pressure on market prices. At the same time, the NCPB was generally releasing stocks to meet increased demand at a time when supply to their channel was falling, and did import 75,000 metric tons of maize in February of 1992 (the only significant imports during this initial period). Hence, over this initial period the NCPB added stability to the market and lowered average market prices in both Kitale and Nairobi. Note, however, that while data on NCPB finances are not available it is clear that their activities over this period would have required significant subsidization, thus representing a drain on Government financial reserves.

Table 5. Summary of NCPB Effects on Kitale and Nairobi Wholesale Maize Prices

Period	Kitale wholesale maize price (Ksh per 90kg bag)				Nairobi wholesale maize price (Ksh per 90kg bag)		
	Historical	Simulated	% difference		Historical	Simulated	% difference
April 1989 – May 1992							
Mean	305.63	367.28	-16.8%		395.37	474.50	-16.7%
Standard deviation	96.29	127.43	-24.4%		62.17	113.35	-45.2%
Coefficient of variation	31.5%	34.7%	-9.2%		15.7%	23.9%	-34.2%
June 1992 – June 1995							
Mean	780.30	1064.38	-26.7%		942.00	1236.33	-23.8%
Standard deviation	217.20	304.88	-28.8%		159.93	295.31	-45.8%
Coefficient of variation	27.8%	28.6%	-2.8%		17.0%	23.9%	-28.9%
July 1995 – October 2004							
Mean	1006.65	831.47	21.1%		1225.72	1019.25	20.3%
Standard deviation	308.07	395.64	-22.1%		281.01	425.44	-33.9%
Coefficient of variation	30.6%	47.6%	-35.7%		22.9%	41.7%	-45.1%
Overall sample period (April 1989 – October 2004)							
Mean	819.41	783.23	4.6%		1000.85	951.50	5.2%
Standard deviation	378.10	408.79	-7.5%		398.60	439.13	-9.2%
Coefficient of variation	46.1%	52.2%	-11.6%		39.8%	46.2%	-13.7%

Notes: Historical refers to the historical data and simulated refers to estimated market prices in the absence of the NCPB marketing channel. Percentage differences are the estimated effects of the NCPB policies (percentage deviation of the historical price statistics from their simulated values).



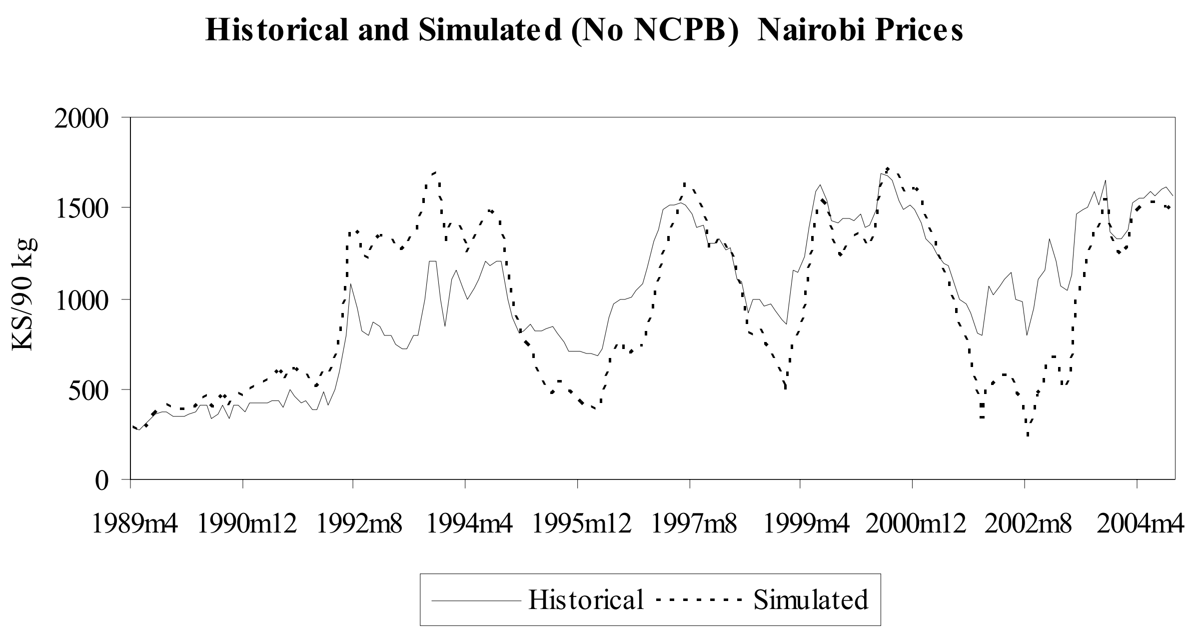
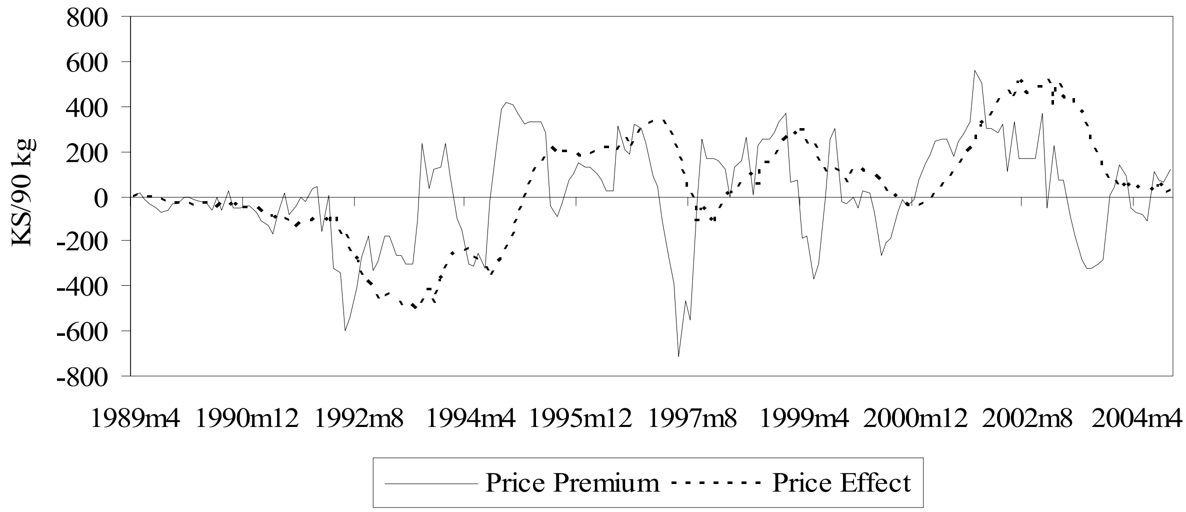


Figure 2. Estimated Effects of NCPB Marketing Activities

NCPB Buy Price Premium and Kitale Price Effect



NCPB Sell Price Premium and Nairobi Price Effect

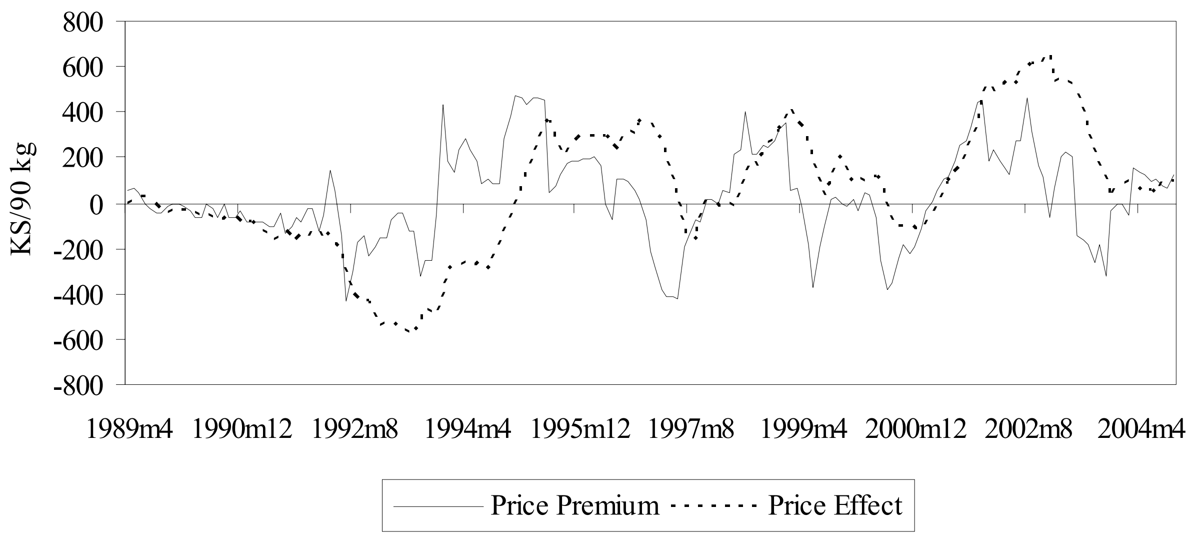


Figure 3. NCPB Premiums and Price Effects

The next part of the sample period from June 1992 through June 1995 contains two consecutive seasons of drought that pressured maize supplies in Kenya. During most of this period the NCPB intensified its efforts by setting administered prices at steep discounts to market price levels, at least until August of 1993 when their buy price shifted from being at a discount to the market to being at a premium (see Figure 3). The steep discounts had the effect of keeping average market price in Kitale (Nairobi) approximately 27% (24%) lower over this period than it would have been in the absence of the NCPB channel (see Table 5 and Figure 2). During this period, NCPB purchases fell markedly and their sales expanded, thus putting increased downward pressure on market prices. However, it is not clear where NCPB sourced the maize they were selling. There were no official NCPB imports during the drought years but official sales during the drought were well in excess of official purchases and it is unlikely NCPB had sufficient stocks at the beginning of this period to explain the difference. There were substantial private sector and relief imports during this period (211,000 metric tons of private imports and 251,000 metric tons from the World Food Program). Perhaps part of these imports leaked into the NCPB marketing channel. In any event, results suggest that NCPB price discounts during the drought years kept market prices considerably lower than they would have been in the absence of the NCPB marketing channel (see Table 5 and Figure 3).

The final part of the sample period from July of 1995 through October of 2004 corresponds to a period in which grain markets in Kenya were ostensibly liberalized and the NCPB was forced to take a more commercial stance in its operations. Yet Figure 3 shows that the NCPB continued to buy and sell maize at substantial premiums and discounts to the market over this period. The net effect of these premiums and discounts was to raise mean market prices in Kitale and Nairobi by approximately 21% over the period, and at the same time to reduce both the standard deviation and CV of prices (see Table 5 and Figure 2). These estimated effects suggest that the NCPB was still having a major influence on maize prices, despite the general perception that the market had been liberalized and despite the fact that the reported amount of product moving through the NCPB channel was lower than it had been in previous eras.

The effect of the NCPB over the entire sample period was to raise both average Kitale and average Nairobi prices (by approximately 5%) and also to stabilize prices by reducing their standard deviation and coefficient of variation over the sample period (see Table 5). However, these summary statistics for the entire sample period mask the large and differential impact that NCPB is estimated to have had over particular sub-periods (see Table 5 and the discussion above.).

The estimated effects of the tariff

The tariff is included in the model via an adjustment to Ugandan prices to ensure these prices reflect the formal tariff cost of importing maize into Kenya. Within this framework, a simple way of simulating the effects of eliminating the tariff would be to re-adjust the Uganda prices, period by period, to extract out the effect of the tariff, and construct dynamic recursive forecasts of the Ugandan, Kitale, and Nairobi maize price paths under the counterfactual assumption of no tariff. In constructing these dynamic forecasts all market and policy shocks would be set to their historical levels (i.e. we assume the NCPB was implementing its historical pricing rules). This is a fairly crude way of simulating the effect of the tariff because it assumes that the entire tariff effect can be captured by adjusting the applicable Ugandan price, even though there is also cross border trade with Tanzania and occasional imports from South Africa through Mombasa. Nevertheless, this is the best that can be achieved in the VAR model used here and will give an initial insight into the dynamic effects of the tariff.

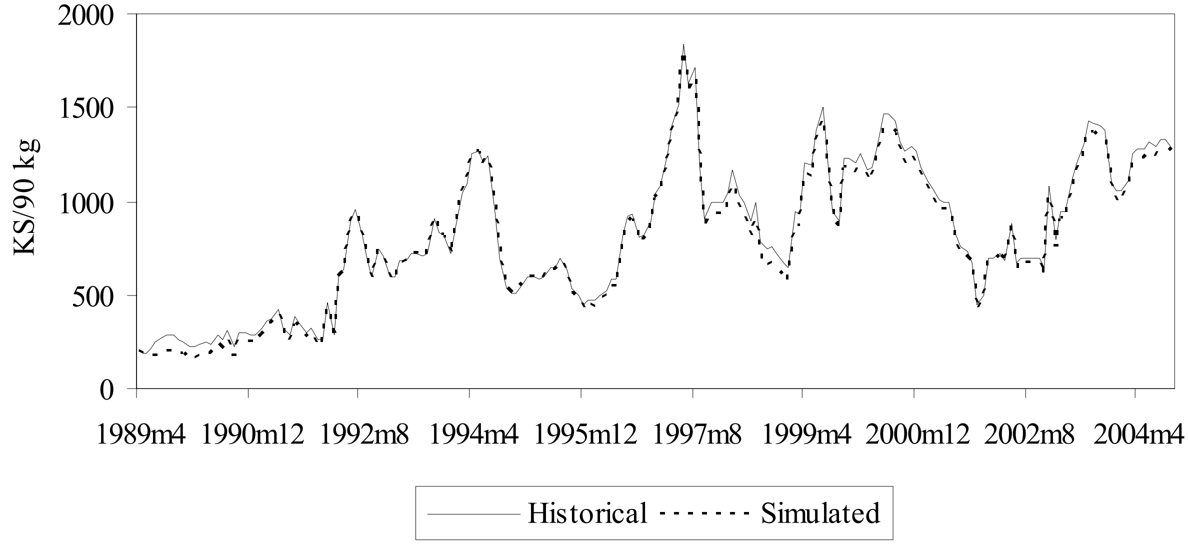
The simulated (no tariff) price paths are tabulated in Table 6 and graphed against the actual path of Kitale and Nairobi prices in Figure 4. In addition, Figure 5 shows the estimated price changes resulting from the tariff graphed against the tariff rate itself to illustrate the effect of the policy more directly. Figure 5 shows that higher (lower) tariff rates generally were associated with higher (lower) domestic maize prices than would have occurred in the absence of the tariff, but that the magnitude of the effect varied substantially over time, even over periods when the tariff rate itself varied little. This is to be expected because the impact of a given tariff rate on domestic prices depends on many different factors that may vary over time, including how much product is being imported, the availability of domestic supply, the sensitivity of supply and demand to

Table 6. Summary of Tariff Effects on Kitale and Nairobi Wholesale Maize Prices

Period	Kitale wholesale maize price (Ksh per 90kg bag)				Nairobi wholesale maize price (Ksh per 90kg bag)		
	Historical	Simulated	% difference		Historical	Simulated	% difference
April 1989 – May 1992							
Mean	305.63	261.82	16.7%		395.37	353.44	11.9%
Standard deviation	96.29	107.62	-10.5%		62.17	72.41	-14.1%
Coefficient of variation	31.5%	41.1%	-23.4%		15.7%	20.5%	-23.2%
June 1992 – June 1995							
Mean	780.30	779.33	0.1%		942.00	898.31	0.1%
Standard deviation	217.20	217.83	-0.3%		159.93	170.59	-1.4%
Coefficient of variation	27.8%	28.0%	-0.4%		17.0%	19.0%	-1.4%
July 1995 – October 2004							
Mean	1006.65	960.79	4.8%		1225.72	1182.26	3.7%
Standard deviation	308.07	300.93	2.4%		281.01	275.02	2.2%
Coefficient of variation	30.6%	31.3%	-2.3%		22.9%	23.3%	-1.4%
Overall sample period (April 1989 – October 2004)							
Mean	819.41	782.85	4.7%		1000.85	966.18	3.6%
Standard deviation	378.10	374.25	1.0%		398.60	395.24	0.9%
Coefficient of variation	46.1%	47.8%	-3.5%		39.8%	40.9%	-2.6%

Notes: Historical refers to the historical data and simulated refers to estimated market prices in the absence of the tariff but with historical NCPB marketing policies. Percentage differences are the estimated effects of the tariff (percentage deviation of the historical price statistics from their simulated values).

Historical and Simulated (No Tariff) Kitale Prices



Historical and Simulated (No Tariff) Nairobi Prices

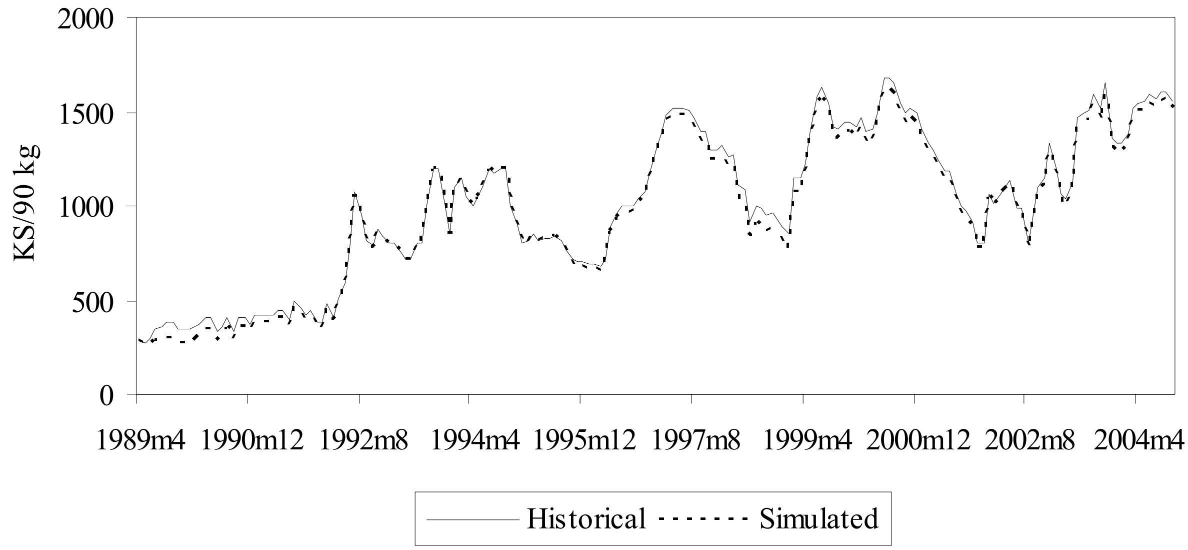
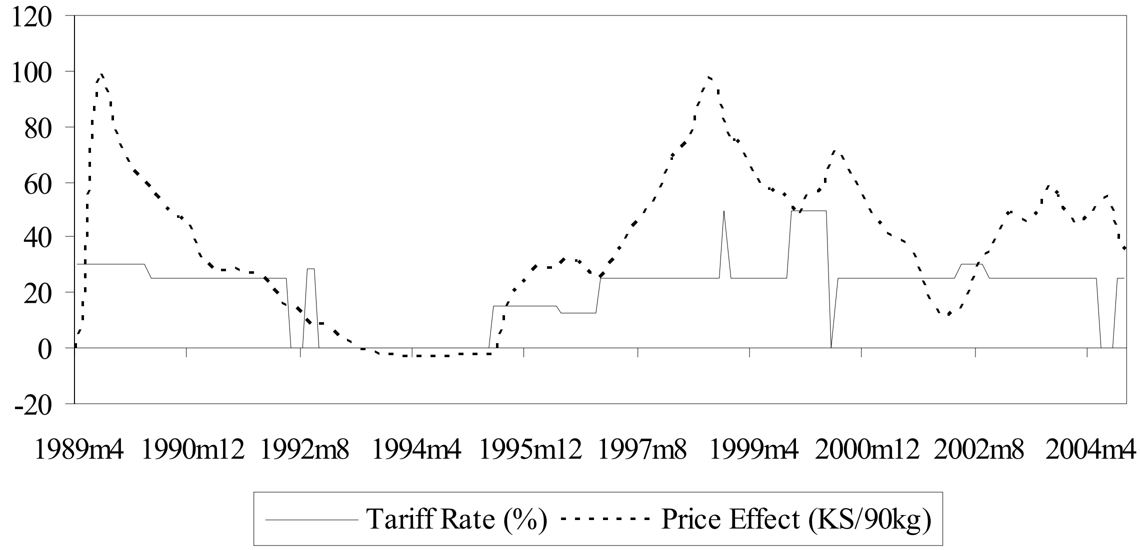


Figure 4. Estimated Effects of the Tariff

Tariff Rate and Kitale Price Effect



Tariff Rate and Nairobi Price Effect

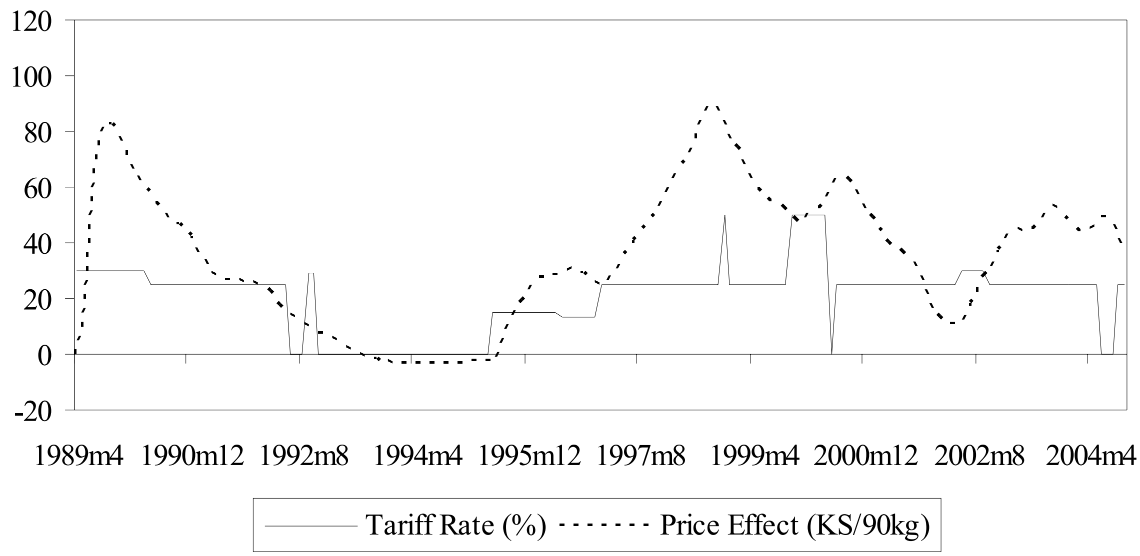


Figure 5. Tariff Rate and Price Effects

price changes, etc. Figure 5 also shows that the full effect of tariff changes does not occur instantaneously but is spread over time as adjustment costs and other rigidities cause responses to tariff changes to occur gradually.

In the first part of the sample period from April 1989 through May of 1992 the tariff is estimated to have raised average maize prices in Kitale and Nairobi by approximately 17% and 12%, respectively, and to have also stabilized prices to some extent (see Table 6). This was a period in which the tariff was set consistently in the 25-30% range. During the drought period from June 1992 through June 1995 the tariff was zero and the price effect was negligible (as expected). Finally, in the last part of the sample from July 1995 through October 2004 the tariff was again set consistently in the 25-30% range with occasional increases to 50% in some months and reductions to zero in others (see Figure 5). Over this period the tariff was estimated to have increased average maize prices by almost 5% in Kitale and almost 4% in Nairobi. These effects are much smaller in percentage terms than the effect of the same tariff rates in the first part of the sample, even though the magnitude of the price effects is somewhat similar (see Figure 5). This is because the base level of prices on which the tariff effect is operating is much higher in the latter part of the sample compared to the first part (see Table 6).

Over the entire sample period the tariff is estimated to have raised average prices in Kitale by 4.7% and in Nairobi by 3.6%, with only minor effects on price stability (as expected). These effects may seem fairly minor given that the tariff was consistently set at 25-30% and at times went to 50%. However, there are several reasons why we would not expect Kenyan prices to increase by the full official tariff rate. First, it is widely believed that a substantial share of total imports from Uganda and Tanzania is smuggled into Kenya in an attempt to evade official border crossings (Awuor, 2003; RATES, 2004). Although such activities are likely to involve additional marketing costs, they presumably are lower than the costs that would otherwise be incurred by crossing through official border crossings, otherwise traders would not resort to such activities. Second, two focus group interviews of traders in 2004 reveals that there appear to be informal agreements between traders and border officials whereby the trader pays less (sometimes considerably less) than the official tariff rate on maize importation.[9] Third, in at least two marketing years trade flows were reversed due to bad seasons in Uganda, causing the Kenyan import tariff to have little effect on market prices.

Combined effects of the NCPB and the tariff

The combined effects of NCPB marketing activities and the tariff were simulated by constructing dynamic forecasts of the Kitale and Nairobi maize price paths assuming NCPB price premiums and the tariff were both set to zero, but market shocks continue to follow their historical path. Graphs of the resulting Kitale and Nairobi maize price paths look very similar to Figure 2 and are not shown here. However, a summary of the combined effects are provided in Table 7.

Results show that during the first part of the sample period the NCPB and the tariff were working in opposite directions, with the NCPB reducing prices and the tariff raising them. The net effect is a relatively small reduction in average price levels (-4.9% for Kitale and -8.2% for Nairobi) and a more substantial increase in price stability (see Table 7). During the drought period the NCPB kept prices substantially lower than they would have been without the NCPB marketing channel and the tariff was removed and had little effect on prices. Hence, average price levels during this period were substantially lower than they would have been without the policies (-26.5% for Kitale and -23.7% for Nairobi) and prices were again stabilized (see Table 7). In the final part of the sample period, from July 1995 through October 2004, NCPB marketing activities and the tariff were both keeping mean prices higher than they would have been otherwise (combined effect of 27.2% for Kitale and 24.9% for Nairobi). Prices were also more stable over this period (see Table 7). The average effect of both policies combined over the entire sample period was to generate modestly higher average prices (9.4% for Kitale and 8.9% for Nairobi) and moderate increases in price stability (see Table 7).

[9] The advantage of the second process, from the standpoint of the trader, is that he/she obtains a form indicating formal customs clearance of the maize, which reduces the likelihood of having to pay bribes later at subsequent checkpoints in the way to Nairobi or other demand centers.

Table 7. Summary of Combined NCPB and Tariff Effects on Kitale and Nairobi Wholesale Maize Prices

Period	Kitale wholesale maize price (Ksh per 90kg bag)				Nairobi wholesale maize price (Ksh per 90kg bag)		
	Historical	Simulated	% difference		Historical	Simulated	% difference
April 1989 – May 1992							
Mean	305.63	321.25	-4.9%		395.37	430.50	-8.2%
Standard deviation	96.29	138.77	-30.6%		62.17	123.33	-49.6%
Coefficient of variation	31.5%	43.2%	-27.1%		15.7%	28.6%	-45.1%
June 1992 – June 1995							
Mean	780.30	1061.73	-26.5%		942.00	1234.07	-23.7%
Standard deviation	217.20	304.04	-28.6%		159.93	294.30	-45.7%
Coefficient of variation	27.8%	28.6%	-2.8%		17.0%	23.8%	-28.8%
July 1995 – October 2004							
Mean	1006.65	791.35	27.2%		1225.72	981.29	24.9%
Standard deviation	308.07	383.67	-19.7%		281.01	415.14	-32.3%
Coefficient of variation	30.6%	48.5%	-36.9%		22.9%	42.3%	-45.8%
Overall sample period (April 1989 – October 2004)							
Mean	819.41	749.32	9.4%		1000.85	919.38	8.9%
Standard deviation	378.10	409.25	-7.6%		398.60	439.85	-9.4%
Coefficient of variation	46.1%	54.6%	-15.5%		39.8%	47.8%	-16.8%

Notes: Historical refers to the historical data and simulated refers to estimated market prices in the absence of NCPB marketing activities and the tariff. Percentage differences are the estimated effects of the combined policies (percentage deviation of the historical price statistics from their simulated values).

7. Conclusions

The objectives of this paper were to determine the effects of NCPB maize marketing activities, and the maize import tariff, on wholesale maize market price levels and variability in Kenya. The analysis uses monthly maize price and trade data covering the period January 1989 through October 2004. Results are based on a vector VAR approach that allows estimation of a counterfactual set of maize prices that would have occurred over the 1989-2004 period had the NCPB not set administered prices and trade restrictions had been removed. The VAR approach can be especially useful when sparse data preclude a full structural simultaneous equations approach. The VAR may not bas as informative as a structural model regarding the underlying economic structure driving results because the equations do not have the structural interpretations as supply, demand, and policy equations. Nevertheless, the partially reduced form summarizes historical correlations and interactions among the observable variables and can still provide some useful insights into the reduced form effects of policy variables on market variables of interest.

In particular, imposing a Choleski factorization or other means to identify the contemporaneous relationships among the endogenous variables allows identification of a set of policy shocks without putting any restrictions on the dynamic interrelationships between the variables in the system. These policy shocks can then be used to construct a counterfactual price path that would have existed under an alternative hypothetical path for the policy shocks, again leaving the dynamics of the system essentially unrestricted.

There are two main disadvantages to this approach. First, while it can estimate the net effect of a policy shock on the path of Kenyan maize prices it cannot provide definitive information on the underlying economic mechanism that brings about that net effect. Second, this modeling approach is very data intensive and the number of parameters to estimate can grow quickly to an unmanageable level.

Despite these disadvantages, the approach has been used successfully to evaluate policy effects in both macroeconomic models and microeconomic commodity market models (see, for example, Bernanke, 1986 and Myers, Piggott and Tomek, 1990). And in cases like the Kenyan maize market where many of the variables required to estimate a full structural economic model are not observable, an approach based along these lines would seem to be the only viable econometric method available.

Results of the VAR modeling and counterfactual simulations indicate that the NCPB's activities have indeed had a marked impact on both maize price levels and variability. The NCPB's administered prices have, on average, raised wholesale market prices in Kitale (a major surplus production area) and Nairobi (the main urban center) by 4.6 and 5.2 percent, respectively, over the entire sample period. However, the NCPB's impact on the market varied considerably between periods. The estimated effect was large and negative during the 1992/93 drought and 1993/94 when the NCPB was both buying and selling maize at major discounts to market prices. Since the 1995/96 season, however, NCPB prices were mainly set at premiums to the market and their operations are estimated to have raised average Kitale and Nairobi maize prices by around 20%, implying a significant transfer of income from maize purchasing rural and urban households to relatively large farmers who account for roughly half of the country's domestically marketed maize. The NCPB's activities have also reduced the standard deviation and coefficient of variation of prices, consistent with its stated mandate of price stabilization.

The maize import tariff is estimated to have exerted much more consistent effects on market maize price levels, and contributed little to price stability. Despite being set at 20-30% over much of the sample period, the tariff is estimated to have raised market maize price levels by only about 4-5%. The relatively weak impact of the tariff is likely due to widespread maize smuggling across borders, informal arrangements at border crossings that reduce effective tariff rates, and trade reversals in some years. These factors would presumably weaken or decouple the relationship between Uganda and Kenyan prices that otherwise might be expected if Ugandan maize consistently supplied Kenya, and if the official tariff were strictly enforced.

The results imply very important income distributional effects arising from Kenya maize marketing and trade policy. Because 70 percent of Kenya's maize surplus is believed to be produced by roughly 1 percent of the farm population (mainly large farmers in the North Rift Valley), and because 65 percent of the rural small-scale farm families are typically net buyers of maize, policies that raise maize price levels are likely to have highly concentrated benefits and anti-poor distributional effects.

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Appendix on Sensitivity Analysis

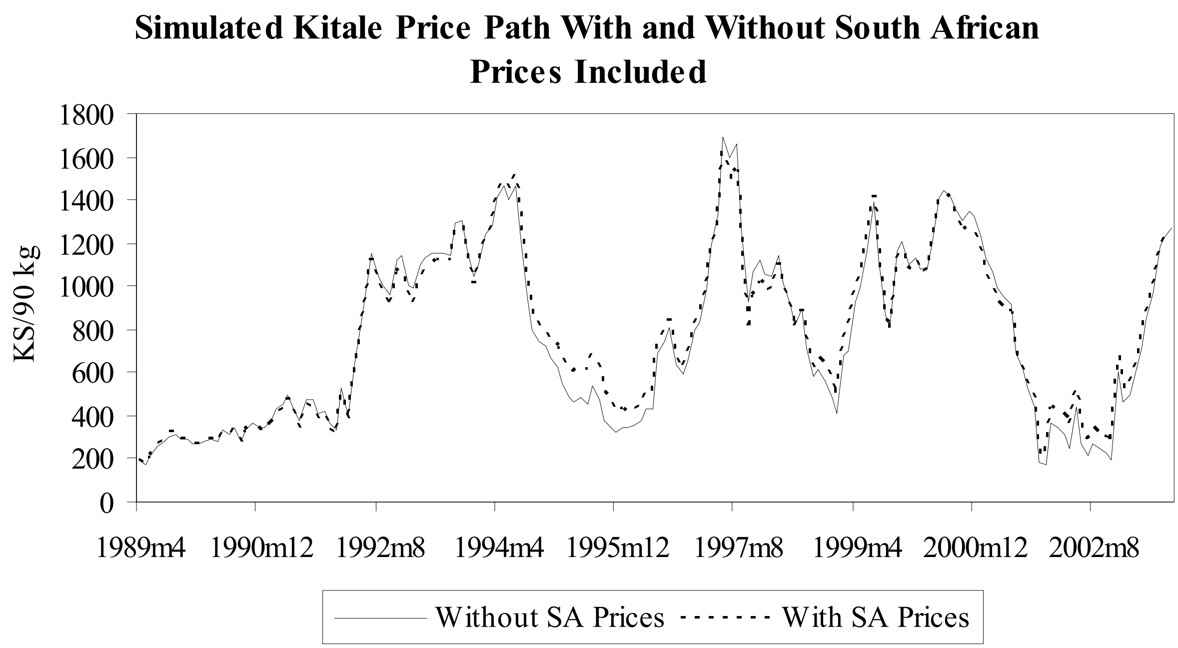
This appendix contains an analysis of the sensitivity of simulated Kitale and Nairobi price paths to alternative model specifications. We study three alternative model specifications—one that includes a variable representing South African Prices as an additional market variable, one that includes the net change in official NCPB stocks as an additional policy variable, and one that includes the consumer price index as an additional market variable. In each case the simulated Kitale and Nairobi price paths are quite robust to the alternative model specification.

Including South African Prices

Monthly prices in South Africa were available from January 1989 through September 2003. Using this sample period we first simulated the effect of NCPB marketing policies using the base model (excluding South African prices) following identical procedures to those outlined above. Next we included the South African price series in the VAR as an additional market variable and re-estimated the model computing a new simulated price path by extracting out the effect of NCPB marketing policies. The alternative simulated paths (with and without the South African prices included in the model) are shown in Figure A.1. The two paths are very similar in almost every period and the average price over the two simulated paths is less than 1.5% different for both Kitale and Nairobi. Hence, we conclude that the simulated effects of NCPB marketing activities reported in the paper are robust to inclusion of a South African price variable in the model.

Including the Net Change in NCPB Stocks

The net monthly change in NCPB stocks might be included as an additional policy variable in the model. Data on NCPB purchases and sales are available from January 1990 through June 2004. Using this sample period we first simulated the effect of NCPB marketing policies using the base model (excluding the NCPB net change in stocks variable) following identical procedures to those outlined above. Next we included the net change in stocks in the VAR as an additional policy



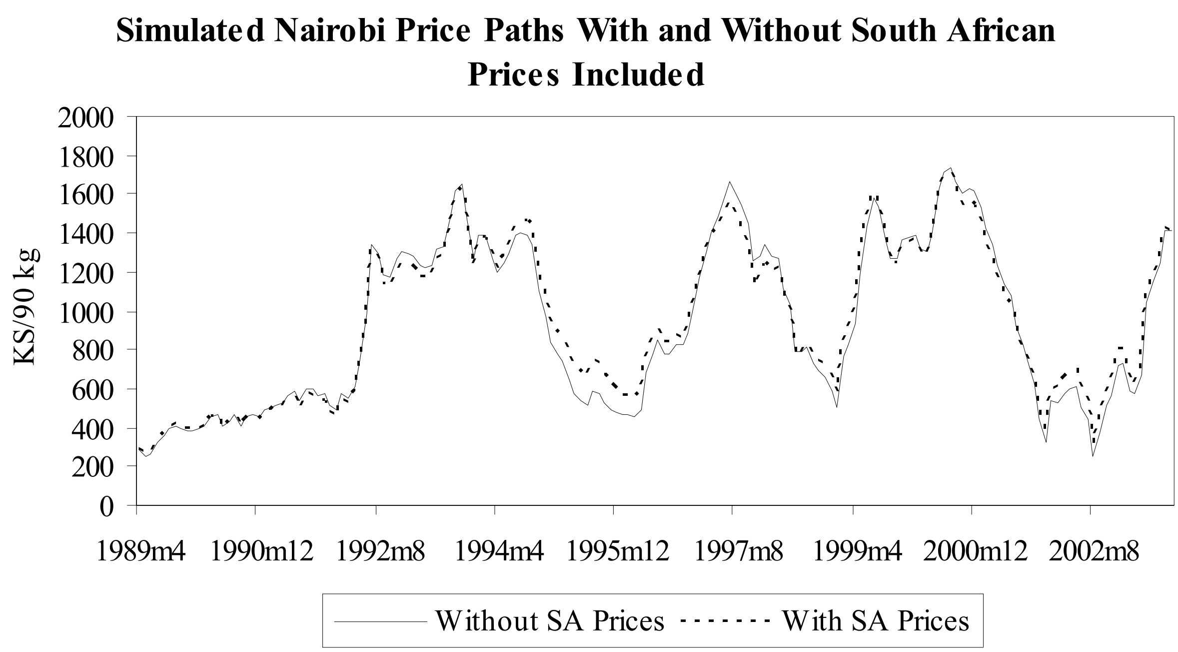
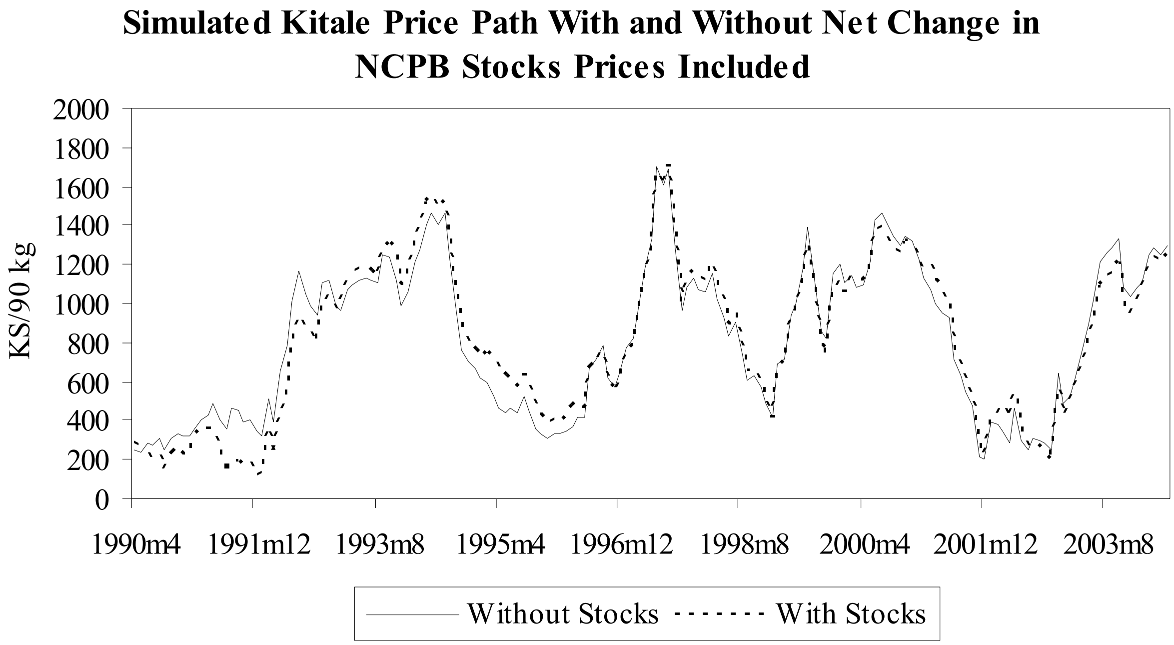


Figure A.1 Comparing Simulated Price Paths With and Without South African Prices Included

variable and re-estimated the model computing a new simulated price path by extracting out the effect of NCPB marketing policies. The alternative simulated paths (with and without the net change in NCPB stocks included in the model) are shown in Figure A.2. The two paths are very similar in almost every period and the average price over the two simulated paths is less than 1% different for both Kitale and Nairobi. Hence, we conclude that the simulated effects of NCPB marketing activities reported in the paper are robust to inclusion of the NCPB net change in stocks variable in the model.

Including the Consumer Price Index

Monthly estimates of the consumer price index (CPI) in Kenya were available from January 1989 through August 2004. Using this sample period we first simulated the effect of NCPB marketing policies using the base model (excluding the CPI) following identical procedures to those outlined above. Next we included the CPI price series in the VAR as an additional market variable and re-estimated the model computing a new simulated price path by extracting out the effect of NCPB marketing policies. The alternative simulated paths (with and without the CPI included in the model) are shown in Figure A.3. The two paths follow each other closely and have very similar patterns. The average price over the two simulated paths is less than 1.1% different for both Kitale and Nairobi. Hence, we conclude that the simulated effects of NCPB marketing activities on nominal Kitale and Nairobi prices reported in the paper are robust to inclusion of the CPI in the model.



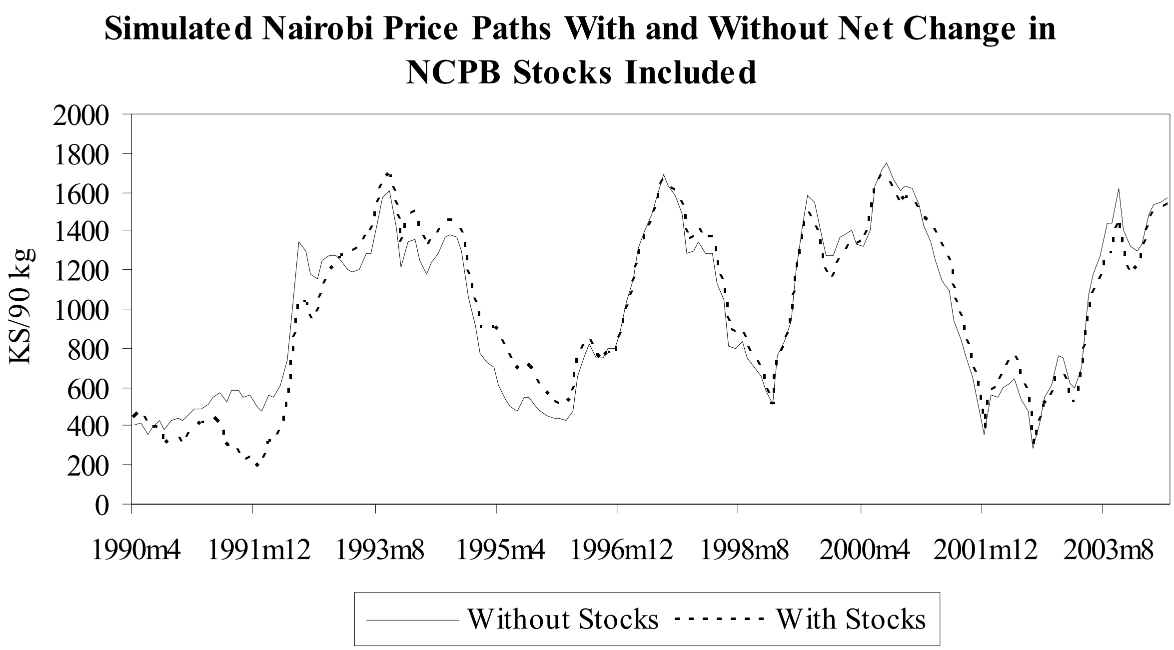
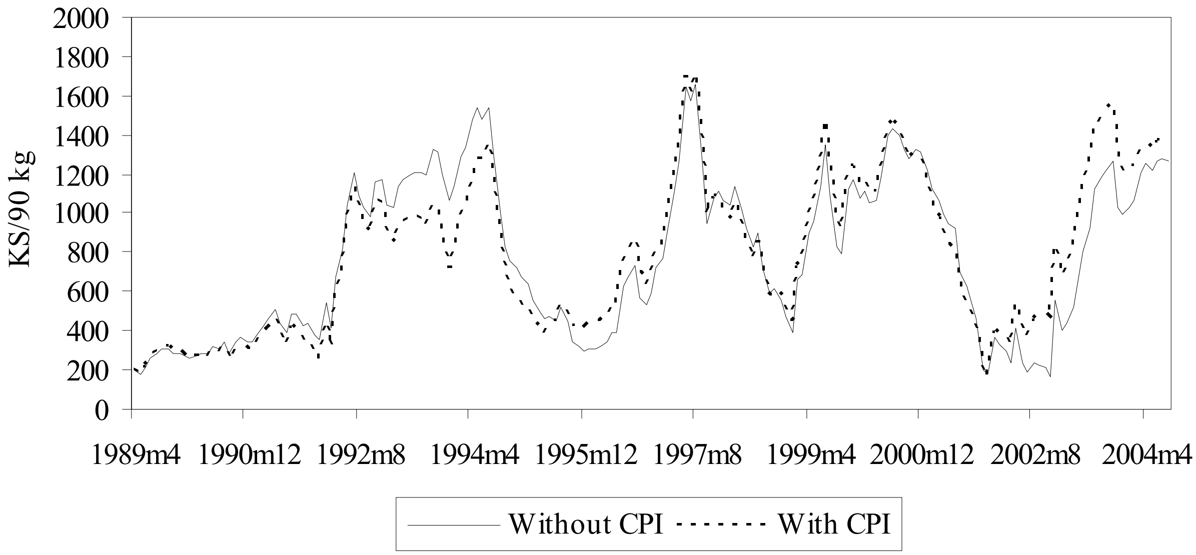


Figure A.2 Comparing Simulated Price Paths With and Without Net Change in NCPB Stocks Prices

Simulated Kitale Price Path With and Without CPI Included



Simulated Nairobi Price Paths With and Without CPI Included

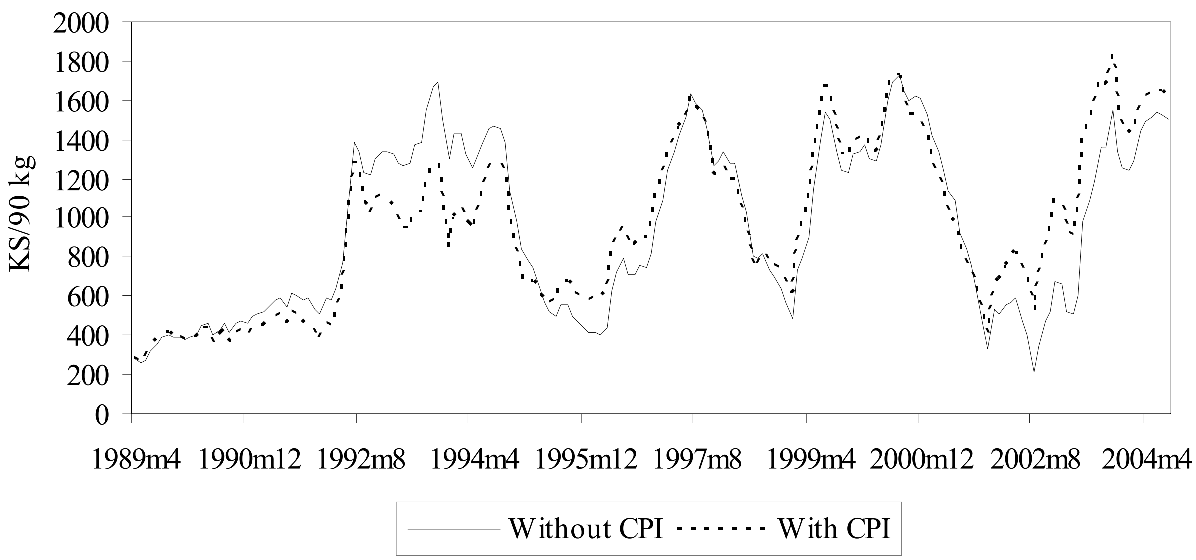


Figure A.3 Comparing Simulated Price Paths With and Without the Consumer Price Index