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Maize acreage response under differential prices in the Republic of Benin, West Africa

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ABSTRACT

Price response of maize acreage in Benin was estimated with a particular emphasis on whether the prices were producer prices in rural markets or retail prices in urban markets. A second difference between prices was examined through a price adjustment model which takes into account the distortions caused by local units on maize price when one is concerned with the pricing system in the private marketing network relating rural and urban areas. Urban market price specification appeared to be the most relevant statistically in explaining acreage decisions in Mono province. Price elasticity of acreage was 0.445 in this area while its value, around 0.10, was not significant for Benin as a whole. The use of adjusted urban prices enabled an increase of 5.6% of the elasticity in Mono province.

The urban vs. rural difference was apparent, but the coefficients of the price variable were not significant in equations with rural prices. The latter were not as reliable as those of the urban market of Dantokpa (in Cotonou city) collected by the Institute of Statistics (INSAE) and the GTZ project.

INTRODUCTION

The type of price actually considered by farmers in deciding on the acreage and the quantity of inputs to be devoted to a given crop is of great importance in supply response analysis. This problem is especially relevant in the West African context where food-grain prices are either officially set by the government or are free market prices. Official prices are applied by State Marketing Boards and the latter prevail on the parallel markets where competition exists.

A major share of the marketable surplus is sold on the parallel markets because of the inefficiency of the official marketing system due to poor

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services of state marketing agents and low and uniform producer prices (La-Anyane, 1985; Adesina, 1985). Despite the satisfaction farmers apparently derive in dealing with private traders of the parallel markets, a lack of transparency in free market prices is reported by researchers on maize marketing in the Republic of Benin (MPSAE, 1983; Dohoue, 1986; Igue, 1985).

The Government of the Benin Republic (ex-Dahomey) previously regulated the trade of grains through marketing boards such as the 'Office de Commercialisation Agricole du Dahomey' (OCAD) from 1964 to 1974, and the 'Régies d'Approvisionnement et de Commercialisation' (RACs), 'Centres d'Action Régionale pour le Développement Rural' (CARDERs) and 'Sociétés Provinciales de Commercialisation Agricole' (SOPROCAs) from 1974 to 1980. But its intervention in maize marketing was abandoned in 1980. A new grain marketing board, the 'Office National des Céréales' (ONC) was set up in 1983 but no official price has been declared since then. Presently, maize and other food-crop prices are determined by the law of demand and supply.

But it is unknown whether these prices can stimulate farmers to produce beyond the level of the consumption needs of their households.

Therefore, instead of testing whether maize (the cereal widely cultivated and marketed in Benin) acreage is determined by official or private market prices as was recently done for millet in Niger (Brorsen and Adesina, 1990), this paper examines maize supply response under differential prices in the private system.

Firstly, these differentials include: (a) some distinctions that are intrinsic to urban and rural market prices because of different consumption patterns in rural and urban areas; and (b) distinctions related to the rural–urban flow of products. The imperfections attached to the flow of products are expressed in the way traders from urban areas manipulate local units in rural markets in order to adjust partially for marketing risks.

Hence, it is important to gain a better understanding of how the use of local units varies from one market to another. This variation can be expressed in some mathematical models to account for differences like observed vs. adjusted prices and rural vs. urban market prices.

Secondly, a distinction between annual average and harvest prices on the private-grain marketing channel is considered to be significant in acreage response estimation. The reason is that farmers' acreage decisions are assumed to be more sensitive to price changes prior to harvests than immediately after harvests. These changes are hidden by annual average prices.

Shepherd (1963) identified such differentials as he observed that retail and farm prices do not follow a parallel time path. Factors such as seasonality and speculation of agricultural products give a distinct character to each market level. Bogahawatte (1988) confirmed that retail and wholesale prices of rice in Colombo markets have different structures in economic terms. He also emphasized that seasonal trends appear more in retail than in wholesale prices. These findings apply also to sub-Saharan Africa where it is not easy to compare the behavior of local units between different marketplaces (Mondjannagni, 1977; Sherman, 1985; Honfoga, 1986). Considering the seasonality factor, the secondary distinction (annual average vs. harvest prices) is justified; it is, not only because of a sudden change in the quantities supplied but also because of the inversion of grain flow between rural and urban areas during shortage periods (Ensing, 1987).

In this paper, the theoretical considerations and restrictions are similar to those expounded by Brorsen and Adesina (1990). However, beside the question of what set of prices (rural vs. urban) are relevant, we also want to examine the extent to which acreage response is better explained when adjusted prices are used rather than observed prices. The adjustment procedure assumes that the price expectation process takes into account the role of local units that will be explained in the following sections. It compares a calculated adjustment parameter with the price expectation coefficient that characterizes the gap between actual and expected prices. The price expectation models have been used by Nerlove (1958). Later, Behrman (1968), and Ghatak and Ingersent (1984) provide the economic literature with useful discussions on the role of expected price in supply response.

Janssen and Perthel (1986) used the coefficient of the algebraic mean deviation of the lagged price variable in an adaptive supply response model [1] as an indicator of farmers' reaction to prices. They have identified that for maize, the most important crop in the Atlantique province of Benin, this coefficient was low and positive in districts where accessibility to marketplaces was good but negative where this accessibility was bad. Partial analysis regarding each cropping season allowed them to identify, with the Nerlovian model, that the first-season production was mostly held for home consumption whereas the second-season production responded to price changes. But they only relied on prices in an urban market (Dantokpa) and no distinction was made between harvest (July–September and November–December) and annual average prices. Honfoga (1987) showed the relevance of these distinctions to the price response of marketed surplus of foodstuffs and to farmers' decisions in allocating land to competitive crops.

[1] With area as the dependent variable.

EMPIRICAL MODEL SPECIFICATIONS AND MODEL SELECTION PROCEDURES

Non-nested hypothesis testing will be used to test whether maize acreage responds to rural or urban prices as Brorsen and Adesina (1990) did for official and private market prices of millet in Niger. This exercise will be done separately for observed prices and adjusted prices. Within each of these two groups, model selection for non-nested hypothesis testing was done by choosing between annual average or harvest price models on the basis of: (a) the signs and significance of the coefficients of price variables, (b) the significance of other parameters, and (c) the values of R^2, F, and DW.

A comprehensive picture of these model selection procedures is presented on Fig. 1.

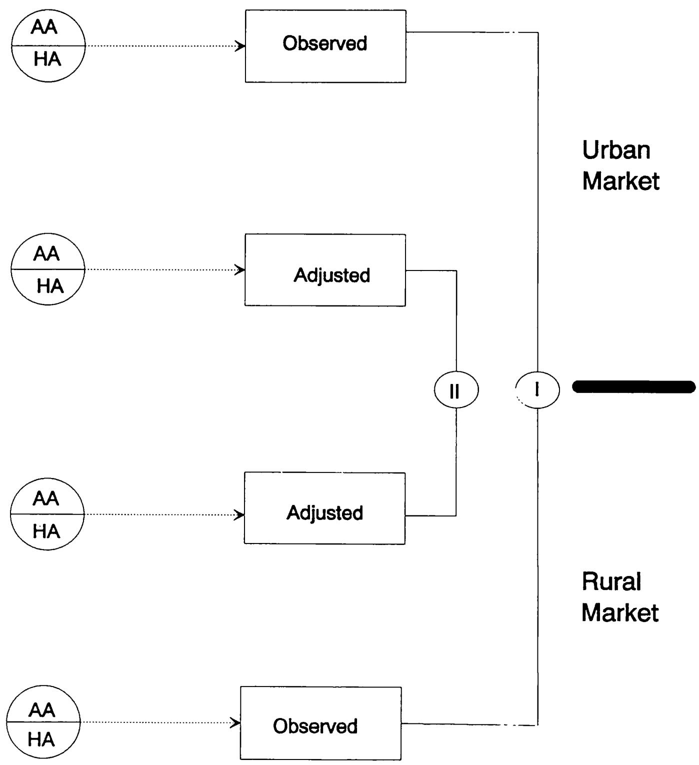

Fig. 1. Model selection procedures for non-nested hypothesis testing between urban and rural market prices. AA, annual average prices; HA, harvest period prices (1st-season and 2nd-season harvests); I, first exercise of non-nested hypothesis testing; II, second exercise of non-nested hypothesis testing. The selection between AA/HA models is based on signs and significance of price coefficients, and values of R^2, F, and DW.

Data and estimation procedures

Definition, characteristics and role of the local unit

A local unit of maize in a given market [2] is a bowl made of enamelled metal. Its name, form and size are well known by all dealers selling or buying maize in a given region. In southern Benin the local unit seems to follow the distribution of major ethnic groups. Each of them has its bowl as the local unit for one or several agricultural products.

However, even in a region where the majority of the population belong to the same ethnic group, several local units are used in different marketplaces for maize. Some of these units were introduced many years ago by merchants coming from other regions. They were adopted as such by the local population and bear names in the languages of these merchants (Mondjannagni, 1977). Hence, we can say that the local unit of maize may be the same or different between two marketplaces.

According to customs prevalent in a region, different ways of measurement are accepted using the same bowl. For each transaction the measurement is discussed. This series of discussions between the seller and the buyer is the bargaining which determine the weight of the local unit and (to a lesser extent) its nominal price. During the bargaining a consensus is necessary between them about how the measurement is done; that is, how the bowl is introduced in and removed from the big basin or basket containing maize brought to the market by the seller. Also discussed is the position of the buyer's hands around the bowl, for this represents a cheating that can add considerable amount to the normal content of the bowl.

Therefore, in a given marketplace and for a certain level of the marketing process, the weight of the local unit varies over time. At a point of time, it can decrease by 5–15% when one moves from the wholesale to the retail level at the same marketplace (Fanou et al., 1991). But during periods of maize shortage, variations of the weight between marketing levels are set to a minimum (about 2%). In this case the nominal price of the local unit helps one determine whether he's dealing with wholesale or retail level price information.

In this paper, the term local unit will usually refer to the weight (measured in kilogram) of the quantity of maize taken by the bowl during a sale/purchase operation. The bargaining process concerns mostly this weight even though it is also done about the nominal price during shortage periods.

[2] Marketplace and level in the marketing process.

It is important for anybody dealing with cereal marketing in West Africa to remember very often the role and use of the local units. For instance, in rural areas of southern Benin where the illiteracy rate is very high, only local units are used in the marketing of food crops. Their use varies between marketing levels (farm, wholesale and retail) when we refer to the ways measurement is done at each level.

Wholesalers or their commission agents may buy maize directly on farms or in farmers' houses. At this level the local unit is not usually the bowl described above. Rather, baskets are used to sell maize in husks. The farmer's children or other relatives are paid by the wholesaler to separate the grain and fill bags. This practice is still prevailing only in remote villages because it involves farmer exploitation. The farm level is now represented by assembly points (with one or two shelters) distributed around rural markets. Urban wholesalers, commission agents and rural retailers buy maize at these places using the bowl as local unit. Only the bowl is accepted in assembly points and official rural marketplaces [3] to buy maize from the farmers.

In urban or semi-urban markets, fertilizer or sugar bags of 50–180 kg are used by wholesalers to sell maize to retailers. The latter accept to buy when (a) the quality of maize and the size [4] (height and width) of the bag satisfy local standards and (b) the price of the bag converted to the one of the bowl-unit allows the desired profit given current retail prices.

The urban or rural retailer always sells maize to the consumer with the bowl. At this level, the bargaining over the content of the bowl is less tedious than what is observed at lower levels in rural areas. Variations over time of the weight of the local unit (the bowl) follow the trend in seasonal variations of production and marketed surplus. Micro or weekly variations obey rather to the intensity of the bargaining process described above. These micro-variations are important during harvest periods whereas shortage periods show no or little variations.

Although the activities of wholesalers in rural markets play a key role in all kinds of variations of the weight of the local unit, it is actually difficult to determine who takes the lead in altering the size of the local unit, because consumers also have important bargaining power. It is most instructive to say that in most rural markets where specialization is not neat among certain marketing agents (assemblers, rural wholesalers and retailers), the latter have a similar influence on the local unit.

[3] They are recognized by the local administrative authorities.

[4] This enables an estimation of the number of bowl-units in the bag.

It happens, however, that during harvest periods when the nominal price of a given local unit is set almost at the same value over all marketplaces where it is used, the wholesaler take such a lead to account for transport and other transaction costs. In urban markets, better infrastructures enable a clear specialization and wholesalers again take the lead in altering over time the size of the local unit at the retail level. The ways they fill the bags sold to retailers tell a lot about their influence in the temporal variations of the weight of local units.

Validity of the conversion of the local unit to its kilogram equivalent

Given the complexity of the bargaining process described above which determines the variations over time and space of the weight of a local unit, it is obvious that its conversion to a standard unit such as the kilogram equivalent is necessary to compare prices between different markets. Then the nominal price should be converted to actual price in FCFA[5] per kg which should be compared among different markets. But how valid are such comparisons as we know that variations over time of the weight and the nominal price of a same local unit have different patterns in different markets? How valid and reliable then are average prices in FCFA/kg used in official statistics?

Fanou et al. (1991, p. 22) do not hesitate to affirm that "the price per kilogram (FCFA/kg) is without any importance in the maize commercial system." Their rather pessimistic conclusion stems from the observation of non-proportional and usually inverse variations between the volume (or weight) and the nominal price of the local unit. To our point of view, if the price per kilogram is to be used for comparison between, and average price calculation over several markets, it might be affected by a 'parameter of adjustment' that characterizes these variations in each market. Such a valid unit of comparison is required as several local units are used in different ways in the markets.

Role of local units in the price expectation procedure

According to Behrman (1968), the price adjustment process explicitly quantifies distributed lags and includes them in the expression of the expected price. However, the number of years covered by the lags is arbitrary and, consequently, the value of the adjustment parameter is determined a priori by the researcher's knowledge of some specific features of the study area and farmers' behavior in that area regarding the crop under study. For example, Berte and Epplin (1989) assumed that the

[5] FCFA, Franc de la Communauté Financière Africaine (US1.00 = FCFA270).

Market of Sey (the local unit is 'Tohungolo')

Price (FCFA)

```
80 +
   |
   |
   |                             S
70 +               S
   |                                           S             S
   |                             S                           S
   |                             S
60 + S             S             S                           S             S
   |               S
   |
   |
50 +                                                                       kg
   --+-------------+-------------+-------------+-------------+-------------+--
    1.3           1.4           1.5           1.6           1.7           1.8
                                      Weight
```

Market of Ouagbo (the local unit is 'Tohungolo')

Price (FCFA)

```
85 +
   |
   |                             0
   |
80 +
   |
   |
   |
75 + 0             0             0             0             0             0
   |
   |                             0
   |
70 +                                                                       kg
   --+-------------+-------------+-------------+-------------+-------------+--
    1.3           1.4           1.5           1.6           1.7           1.8
                                      Weight
```

expected price of cotton was a weighted average of the last three years' period. But they did not explain why these weights should be 0.5, 0.3 and 0.2 instead of, say, 0.7, 0.2 and 0.1. Hence the weights seem arbitrary and their values depend on the researcher's judgement.

The relationship between the nominal price and the equivalent in kg of the local units over time is specific to the different marketplaces. In other words, its direction (sign of the correlation coefficient) and its magnitude (value of the coefficient) are not the same in every marketplace. The scatter diagrams on Fig. 2A, where the weight (kg) of the local unit is plotted against its nominal price (FCFA/local unit), represent this relationship for four marketplaces in the Atlantique province of Benin in 1986. If a fixed unit such as the kilogram were used in any marketplace, only

```
Market of Aïfa (the local unit is 'Sogo')

Price (FCFA)

250 +                                    A
    |
    |
225 + A                                  A
    |
    |
200 + A                    A      A      A
    |
    |
175 +                                    A                    A             A
    |
    |
150 +                                                         A            kg
    --+------+------+------+------+------+------+------+------+------+------+-
     3.0    3.1    3.2    3.3    3.4    3.5    3.6    3.7    3.8    3.9    4.0

                                       Weight
```

```
Market of Zè (the local unit is 'Tohungolo')

Price (FCFA)

    |
    |
100 + Z
 95 +
 90 + Z                           Z
 85 + Z
 80 +
 75 + Z
 70 +
 65 +
 60 + Z             Z                                         Z
    |                                                                      kg
    --+-------------+-------------+-------------+-------------+-------------+-
     1.0           1.1           1.2           1.3           1.4           1.5
                                       Weight
```

Fig. 2 (A) Relationships between the weight and the nominal price of local units of maize in rural markets of Atlantique province (Benin), March–July 1986. The points of the scatter diagrams are represented by the letters S, O, A, and Z, which are the initials of the markets' names (total observations: 34; in Sey 21, in Ouagbo 26, in Aïfa 23, and in Zè 26 observations hidden).

different values of the nominal price would be recorded over time for a unique value (1) of the second variable. The scatter diagrams would show points aligned vertically for every marketplace. The variations of the nominal price would then suffice to describe price variations. The different frequency distributions for the two variables on Fig. 2B show clearly why the specificity of the local unit in each marketplace would be hidden if prices are converted to the standard unit, FCFA/kg.

Given what has been said above about local units, it is assumed that farmers' views of the relationship between the nominal price and the

```
PRICE (FCFA)          Market of Sey
                                                                 PERCENT
             |
     58      |*                                                     2.94
     60      |*******************************                      61.76
     63      |*                                                     2.94
     64      |*                                                     2.94
     65      |*                                                     2.94
     66      |*                                                     2.94
     67      |*                                                     2.94
     68      |****                                                  8.82
     70      |****                                                  8.82
     73      |*                                                     2.94
             -----+----+----+----+----+----+----+----+----+----+
                 10   20   30   40   50   60   70   80   90  100 %
WEIGHT (kg)
             |
    1.3      |***                                                   5.88
    1.4      |****************                                     32.35
    1.5      |*************                                        26.47
    1.6      |*                                                     2.94
    1.7      |***************                                      29.41
    1.8      |*                                                     2.94
             -----+----+----+----+----+----+----+----+----+----+
                 10   20   30   40   50   60   70   80   90  100 %
```

```
PRICE (FCFA)          Market of Ouagbo
                                                                 PERCENT
             |
     72      |*                                                     2.94
     75      |***********************************************      94.12
     82      |*                                                     2.94
             -----+----+----+----+----+----+----+----+----+----+
                 10   20   30   40   50   60   70   80   90  100 %
WEIGHT (kg)
             |
    1.3      |***                                                   5.88
    1.4      |**********                                           20.59
    1.5      |**********************                               44.12
    1.6      |****                                                  8.82
    1.7      |*******                                              14.71
    1.8      |***                                                   5.88
             -----+----+----+----+----+----+----+----+----+----+
                 10   20   30   40   50   60   70   80   90  100 %
```

```
PRICE (FCFA)          Market of Aïfa
                                                               PERCENT
           |
     150   |*                                                     2.94
     175   |*************                                        26.47
     200   |******************                                   35.29
     225   |***************                                      29.41
     250   |***                                                   5.88
           -----+----+----+----+----+----+----+----+----+----+
               10   20   30   40   50   60   70   80   90  100 %
WEIGHT (kg)
           |
     3.0   |******************                                   35.29
     3.3   |***                                                   5.88
     3.4   |******                                               11.76
     3.5   |***************                                      29.41
     3.8   |****                                                  8.82
     4.0   |****                                                  8.82
           -----+----+----+----+----+----+----+----+----+----+
               10   20   30   40   50   60   70   80   90  100 %
```

```
PRICE (FCFA)          Market of Zè
                                                               PERCENT
           |
      60   |************                                         23.53
      75   |****************************                         55.88
      85   |*                                                     2.94
      90   |*******                                              14.71
     100   |*                                                     2.94
           -----+----+----+----+----+----+----+----+----+----+
               10   20   30   40   50   60   70   80   90  100 %

WEIGHT (kg)
                                                               PERCENT
           |
     1.0   |**********************************************       91.18
     1.1   |*                                                     2.94
     1.2   |*                                                     2.94
     1.5   |*                                                     2.94
           -----+----+----+----+----+----+----+----+----+----+
               10   20   30   40   50   60   70   80   90  100 %
```

Fig. 2 (B) Frequency distributions of the nominal price and the weight of local units in Atlantique province (Benin), March–July 1986.

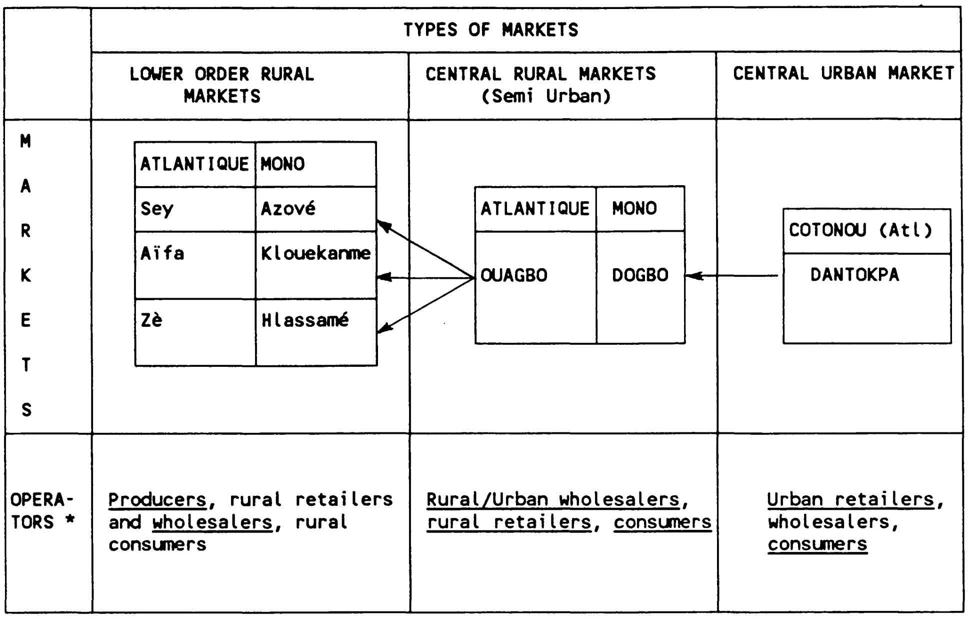

Fig. 3. Maize market hierarchy in Atlantique and Mono. * The value of (gamma) depends on their interactions, especially those whose names are underlined. The arrows indicate traders' movements towards rural markets.

kilogram equivalent of local units should be of great importance in deciding on the value of the price adjustment parameter. Thus, this parameter derives from an average coefficient of correlation gamma (Γ) [6] between the weight and the nominal price of the local unit of measurement in each rural market.

The maize markets' hierarchy presented in Fig. 3 offers a simple view of the maize distribution process. It explains that Γ should differ between marketplaces of rural and urban areas because of different behavior of wholesalers and retailers affecting local units as explained above. If Γ_i is the coefficient for a market i, the average Γ obtained for all markets surveyed should be used as a global index of variability of the local units through space at a given time.

The theoretical background of this application will be set up as follows. The statistic gamma (Γ), which is a coefficient of association between two ordinal variables, expresses the percentage gap between agreements (correct predictions) and misses (bad predictions) when we predict a positive

[6] This is used rather than Pearson's coefficient because of a great number of tied pairs.

relationship between these variables. It is used here to quantify the relationship between the weight (equivalent in kg) and the nominal price of local units. Let p and q be, respectively, the probabilities of agreements and misses.

Therefore:

$$p + q = 1 \quad \text{and} \quad p - q = \Gamma$$

so that

$$p = (1 + \Gamma)/2 \tag{1}$$

Assuming that the farmer directly relates the probability p to present price information, and predicts the future price on the date $t+1$ (P^*_{t+1}) as a weighted average of the previous price (P_{t-1}) and the current price (P_t), the weights being q and p, respectively, it follows that:

$$P^*_{t+1} = qP_{t-1} + pP_t = (1-p)P_{t-1} + pP_t = P_{t-1} + p(P_t - P_{t-1})$$

Therefore, the predicted price on date t is:

$$P^*_t = P_{t-2} + p(P_{t-1} - P_{t-2}) \tag{2}$$

where P_{t-1} and P_{t-2} are the observed prices in FCFA/kg on dates $t-1$ and $t-2$, respectively.

In summary, the price adjustment model is built of equations (1) and (2). Equation (1) refers to a static view of a dynamic pattern of the price–weight relationships through space and time of local units of measurement. Equation (2) refers to a dynamic behavior of the farmer according to his knowledge of local units expressed in equation (1).

Equation (2) can be compared with the equation in the theory of price expectation used by Nerlove (1958), described by Askari and Cummings (1977) and used later by Berte and Epplin (1989):

$$P^*_t = P^*_{t-1} + b(P_{t-1} - P^*_{t-1}) \tag{3}$$

In doing so, the probability p is assimilated to the price expectation coefficient b in Nerlove's equation (equation 3) and the previous expected price (P^*_{t-1}) is taken as equal to P_{t-2} in equation (2).

Although equation (3) deals directly with annual average prices, equation (2) will be used here [7] as applied to monthly observed prices (FCFA/kg) to compute monthly adjusted prices. For this purpose, monthly prices are in time series beginning from January of the first year to

[7] Because of the particularity of the parameter p.

December of the last year. Then annual average [8] prices will be calculated to cope with annual acreage data in the next models.

Urban prices were those prevailing in Dantokpa market (in Cotonou city) recorded by the Benino–German project (GTZ) and INSAE (National Institute of Statistics) during 1979–1985 and 1986–1989. This market receives food products from the six provinces of the country and especially from the three southern provinces (Atlantique, Mono and Oueme). We also considered this adjustment on rural market prices recorded by the Direction of Agricultural Price Control (DCCPA) in the central province (Zou) during 1979–1985 and by INSAE during 1986–1989. The coefficient Γ, computed using 4-day periodic price and weight data was extracted from previous surveys (Honfoga, 1986; Fanou and Honfoga, 1988). Acreage data (ha), cotton yield (kg/ha) and cotton prices (FCFA/kg) came from the Ministry of Rural Development and Co-operative Action (MDRAC).

Empirical models for non-nested hypothesis testing

A general model (equation 4) was specified which presents the relationship between maize acreage (AC_t) at time t and maize price ($P_{ij}t$) at time t and the national average cotton gross income ($R\,\text{COT}_{t-1}$) in thousands FCFA/ha at time $t-1$. Here, actual acreage is taken as equal to desired acreage because we do not have a strong understanding of factors determining the adjustment parameter between these two variables:

$$\text{AC}_t = a_0 + a_1 P_{ij} t + a_2 R\,\text{COT}_{t-1} + e_t \tag{4}$$

Within each major set of prices (rural or urban), OLS technique is applied on equation (4) and the most significant equation is selected as described above, given the different types of P_{ij}, where: $i = 0$ (annual average), $i = 1$ (1st harvest), $i = 2$ (2nd harvest), or $i = 3$ (all harvests); and $j = 1$ (urban market) or $j = 2$ (rural market).

Based on these considerations, empirical model specifications for non-nested hypothesis testing are:

- urban market

$$\text{AC}_t = a_0 + a_1 P_{i1} t + a_2 R\,\text{COT}_{t-1} + e_{1t} \tag{5}$$

- rural market

$$\text{AC}_t = b_0 + b_1 P_{i2} t + b_2 R\,\text{COT}_{t-1} + e_{2t} \tag{6}$$

where the variables are the same as in equation (4) and e_{1t}, e_{2t} are error terms. The variable $R\ \text{COT}_{t-1}$ stresses the assumption that a certain share

[8] Simple arithmetic means of monthly prices.

of previous year cotton (the major cash crop) income is used for buying fertilizers (if used) and mainly for paying hired labour on greater cropped area. Hence the coefficient of $R\,\text{COT}_{t-1}$ is expected to be positive. Considering the important differences between urban and rural environments, especially regarding maize marketing, equations (5) and (6) can be considered as referring to two separate sets of prices; therefore none of them is a special case of the other, thus allowing the use of non-nested hypothesis testing procedures (Pesaran, 1980; Davidson and MacKinnon, 1981; MacKinnon et al., 1983). The procedure will be repeated using adjusted prices.

The *J*-test (Davidson and MacKinnon, 1981) is used here to test the hypothesis H1: urban market prices are relevant in farmers' acreage decisions (equation 5); against hypothesis H2: rural market prices are the relevant ones (equation 6). Predicted values of AC_t obtained, respectively, from equations (5) and (6) are denoted $\text{AP}_{u,t}$ and $\text{AP}_{r,t}$.

For the *J*-test, they become additional explanatory variables, $\text{AP}_{u,t}$ in equation (5) and $\text{AP}_{r,t}$ in equation (6), to yield equations (7) and (8):

– urban market

$$\text{AC}_t = a_0 + a_1 P_{i1} t + a_2 R\,\text{COT}_{t-1} + \text{AP}_{r,t} + e'_{1t} \tag{7}$$

– rural market

$$\text{AC}_t = b_0 + b_1 P_{i2} t + b_2 R\,\text{COT}_{t-1} + \text{AP}_{u,t} + e'_{2t} \tag{8}$$

where the significance of their coefficients is compared to reject one – say equation (6) if the coefficient of $\text{AP}_{u,t}$ is significant – both or none of the previous equations.

These tests are done first with observed price data and then with adjusted prices.

The supply response will be evaluated by calculating acreage elasticities with respect to price and gross cotton income. Regarding the magnitude of these elasticities, the following hypotheses are made:

- price elasticities are greater with rural market prices than with urban market prices; that is, farmers are more responsive to rural prices;
- these elasticities are greater with adjusted prices than with the corresponding observed prices in each case (rural or urban).

RESULTS AND DISCUSSIONS

Previous survey data on prices and weights of local units of maize in eight rural markets of Atlantique province (Honfoga, 1986) and Mono province (Fanou and Honfoga, 1988) generated values of Γ ranging between -0.540 and 0.177. The average value was -0.210 with a standard deviation of 0.259. Only the upper limit was significant at 5% level, and it

TABLE 1.1

Equations for maize acreage response to observed prices and cotton gross incomes in Benin (1979–1989)

Market	Model	R^2	F	DW	Intercept	APX	H1PX	H2PX	H3PX	R COT
Urban	1	0.44	3.11 [a]	2.2	347174 (5.80) **	415.692 (0.74)	–	–	–	686.02 (2.4) *
	2	0.40	2.69	2.4	397196 (7.09) **	–	–109.48 (–0.20)	–	–	649.04 (2.13) *
	3	0.40	2.70	2.3	375434 (6.71) **	–	–	120.89 (0.24)	–	692.90 (2.26) *
	4	0.40	2.65	2.4	387442 (6.09) **	–	–	–	–0.33 (0.00)	667.90 (2.15) *
Rural	1	0.40	2.70	2.3	374310 (6.03) **	257.17 (0.23)	–	–	–	638.87 (2.00) [a]
	2	0.40	2.70	2.3	369886 (4.85) **	–	324.13 (0.25)	–	–	652.64 (2.21) *
	3	0.43	3.09 [a]	2.5	432369 (6.42) **	–	–	–1096.12 (–0.72)	–	805.50 (2.37) *
	4	0.40	2.67	2.4	395797 (5.10) **	–	–	–	–171.07 (0.12)	681.01 (2.18) *

APX, maize annual average price; H1PX, maize 1st-harvest price; H2PX, maize 2nd-harvest price; H3PX, maize average price of the two harvests; R COT, cotton gross income on year $t-1$.
Number of observations: 11.

TABLE 1.2

Equations for maize acreage response with adjusted prices and cotton gross income in Benin (1979–1989)

Market	Model	R^2	F	DW	Intercept	APXA	H1PXA	H2PXA	H3PXA	R COT
Urban	1	0.45	3.22 [a]	2.3	342818 (5.76) **	471.54 (0.82)	–	–	–	675.30 (2.43) *
	2	0.41	2.79	2.2	367499 (6.63) **	–	199.75 (0.41)	–	–	677.46 (2.35) *
	3	0.40	2.65	3.4	384745 (5.66) **	–	–	25.62 (0.04)	–	674.84 (2.03) [a]
	4	0.41	2.73	2.3	368758 (5.61) **	–	–	–	184.47 (0.31)	692.21 (2.32) *
Rural	1	0.41	2.75	2.3	368922 (6.18) **	347.40 (0.34)	–	–	–	633.58 (2.08) [a]
	2	0.43	2.97 [a]	2.2	354823 (6.04) **	–	523.48 (0.62)	–	–	621.51 (2.12) *
	3	0.41	2.75	2.5	406992 (6.34) **	–	–	–441.00 (–0.33)	–	709.20 (2.26) *
	4	0.41	2.74	2.3	369612 (5.91) **	–	–	–	324.95 (0.31)	637.96 (2.10) *

APXA, maize adjusted annual average price; H1PXA, maize adjusted 1st-harvest price; H2PXA, maize adjusted 2nd-harvest price; H3PXA, maize adjusted average harvest price; R COT, cotton gross income per ha on year $t-1$. Number of observations: 11.

TABLE 1.3

Econometric estimates of alternative maize acreage-price equation specifications with observed prices in Benin, 1979–1989

Acreage equation	Intercept	Urban maize price	Rural maize price	Cotton gross income	$AP_{u,t}$	$AP_{r,t}$	R^2
With observed urban market price	347174 (5.80) **	415.69 (0.74)	–	686.02 (2.44) *	–	–	0.44
With observed rural market price	369886 (4.85) **	–	324.13 (0.25)	652.65 (2.21) *	–	–	0.40
With observed urban market price and $AP_{r,t}$	−1507995 (−0.74)	830.33 (1.14)	–	−2425.35 (−0.71)	–	4.68 (0.91)	0.50
With observed rural market price and $AP_{u,t}$	−468542 (−0.63)	–	1518.54 (0.91)	−737.99 (−0.59)	1.99 (1.14)	–	0.50

TABLE 1.4

Econometric estimates of alternative maize acreage-price equation specifications with adjusted prices in Benin, 1979–1989

Acreage equation	Intercept	Urban maize price	Rural maize price	Cotton gross income	$AP_{u,t}$	$AP_{r,t}$	R^2
With adjusted urban market price	342818 (5.76) **	471.54 (0.82)	–	675.30 (2.43) *	–	–	0.45
With adjusted rural market price	354823 (6.04) **	–	523.48 (0.62)	621.51 (2.12) *	–	–	0.43
With adjusted urban market price and $AP_{r,t}$	−204987 (−0.31)	588.02 (0.98)	–	−248.38 (−0.22)	–	1.39 (0.82)	0.50
With adjusted rural market price and $AP_{u,t}$	−140857 (−0.28)	–	725.32 (0.83)	−229.36 (−0.25)	1.25 (0.98)	–	0.50

–, Not applicable; values in parentheses are computed t-values of the coefficients.
[a] Significant at 10% level, * at 5% level, ** at 1% level, in reference to Tables 1.1–1.4.

yields a value of 0.589 for the probability p used in the adjusted price calculation. Considering the annual average vs. harvest price distinction, four equations (among 16) were selected for non-nested hypothesis testing in each region. They were those containing annual average and first-harvest prices for urban and rural markets, respectively, in Benin as whole. For Mono province, only equations with annual average prices were selected.

Tables 1.1, 1.2, 2.1 and 2.2 display all the equations calculated; the selected ones are printed with enhancement. Second-harvest prices (H2PX) and all-harvest (H3PX) prices show some depressive effects on maize acreage that respond negatively to them. This result supports the reluctance of government officials in seeing farmers sell the bulk of their maize production during harvest periods. However, the importance of first-harvest prices (H1PX) for farmers in Mono province is revealed by equations (2) in Table 2.2.

Case of Benin as a whole Maize acreage–price response was positive as shown by coefficients of price in Tables 1.3 and 1.4 (first two equations). But this response was too low and non-significant, with elasticities around 0.10 whatever the price specification examined.

In what concerns the performance of adjusted prices (Table 1.4), disregarding parameter significance, it should be pointed out that the urban maize price coefficient increased by 13.4% (in comparison to the observed price coefficient) while the rural maize price coefficient increased by 61.5%. But the evidence of a good performance is denied by low levels of significance. The adjustment model is likely to increase farmers' price responsiveness if more accurate data are collected with the initial objective of testing the model.

Low price response for the whole country can be explained by the fact that price figures did not include data (not available) from a major maize producing area; that is, Oueme province, at the south-eastern part of the country. Furthermore, prices in Zou province were used as rural prices which can not reflect diversity across all rural areas in Benin during eleven years (1979–1989).

The results of the *J*-test are presented in Tables 1.3 and 1.4. The t-values for the coefficients of $\mathrm{AP}_{u,t}$ and $\mathrm{AP}_{r,t}$ are not significant at 10% level. Thus, both urban market and rural market price specifications should be accepted. The variable $R\,\mathrm{COT}_{t-1}$ shows its importance in explaining maize acreage decisions. The reasons are two-fold: (a) Cotton follows maize (when the maize crop has ripened in June) in the crop rotation system so that extended land is prepared for maize in view of cotton sowing on the same plots. (2) Increasing values for $R\,\mathrm{COT}_{t-1}$ will induce greater interest in cotton production. More money will also be available for hiring labor used at land preparation. Therefore increased acreage will be sown to maize and cotton in the following year.

Case of Mono Province Regression parameters for equations selected in Tables 2.1 and 2.2 and reported in Tables 2.3 and 2.4 are significant at 1% level for the variable $R\,\text{COT}_{t-1}$ in every model. The coefficient of the maize price variable was significant at 5% level with urban prices and non-significant with rural prices. The *J*-test rejects the rural price specification with observed prices at 10% level, as the coefficient of the variable $\text{AP}_{u,t}$ is significant (t-value = 2.10) at this level (Table 2.3). This results are supported by figures of adjusted prices in Table 2.4 where the coefficient of $\text{AP}_{u,t}$ becomes significant (t-value = 2.16) at 5% level. Therefore the urban market price specification is the most relevant statistically in explaining farmers' acreage decisions in the Mono province. Almost all maize production in southern Mono and 31% in northern Mono are sold to wholesale traders coming from Dantokpa market of Cotonou [9]. Hence the strong relationship between maize acreage and urban price ($R^2 = 0.71$) is justified.

The adjustment model supports the hypothesis that farmer response is increased with it. The urban price elasticity of maize acreage (Table 4) is increased by 5.6% when we move from observed prices ($e = 0.445$) to adjusted prices ($e = 0.470$). These elasticities are calculated at means (shown in Table 3) over the period 1979–1989.

It is surprising that maize acreage showed a low response to rural prices as it should be expected, given that farmers have a direct access to rural markets. The relevance and accuracy of the rural price data used (Zou province) can be criticized for not reflecting the actual situation in Mono province. We used these data because they were those available and most suitable for the adjustment model. Furthermore the evidence that only 25% of maize production in Mono province was sold in the Zou central market (Abomey) [10] can explain such a low and non-significant ($e = -0.16$) response of maize acreage to these prices.

Krishna (1967) reported that for maize, which is a commercial crop in some parts of India and in the Punjab, short-run price elasticities of acreage are in the range 0.1–0.4.

Urban price elasticities of acreage in Mono province are comparable to those reported by Krishna. The 5.6% increase of elasticity obtained with the adjustment model (Table 4) is already important as far as a period of 11 years is concerned. This period involves the execution of two state develop-

[9] Fanou and Honfoga, 1988.
[10] Fanou and Honfoga, 1988.

TABLE 2.1

Equations for maize acreage response with observed prices and cotton gross income in Mono province (1979–1989)

Market	Model	R^2	F	DW	Intercept	APX	H1PX	H2PX	H3PX	R COT
Urban	**1**	**0.71**	**9.72 ****	**2.9**	**13 757 (0.92)**	**318.32 (2.27) ***	–	–	–	**278.71 (3.96) ****
	2	0.56	5.16 *	2.7	31 487 (1.89) [a]	–	146.38 (0.89)	–	–	290.17 (3.21) **
	3	0.58	5.60 *	3.1	28 754 (1.77) [a]	–	–	159.62 (1.10)	–	297.82 (3.35) **
	4	0.59	5.76 *	3.0	25 136 (1.38)	–	–	–	209.24 (1.17)	302.97 (3.39) **
Rural	**1**	**0.54**	**4.65 ***	**3.0**	**54 006 (2.85) ***	**– 185.23 (– 0.55)**	–	–	–	**287.26 (2.95) ****
	2	0.63	6.75 *	3.1	74 440 (3.56) **	–	– 552.45 (– 1.52)	–	–	290.97 (3.59) **
	3	0.56	5.15 *	3.1	61 466 (2.99) *	–	–	– 411.98 (– 0.89)	–	316.57 (3.05) *
	4	0.62	6.64 *	3.1	74 473 (3.49) **	–	–	–	– 610.10 (– 1.49)	311.44 (3.64) **

APX, maize annual average price; H1PX, maize 1st-harvest price; H2PX, maize 2nd harvest price;
H3PX, maize average harvest price;
R COT, cotton gross income per ha on year $t-1$.
Number of Observations: 11.

TABLE 2.2

Equations for maize acreage response with adjusted prices and cotton gross income in Mono province

Market	Model	R^2	F	DW	Intercept	APXA	H1PXA	H2PXA	H3PXA	R COT
Urban	**1**	**0.72**	**10.22 ****	**2.9**	**12 841 (0.87)**	**335.50 (2.38) ***	–	–	–	**270.11 (3.92) ****
	2	0.70	9.31 **	2.5	18 021 (1.31)	–	266.31 (2.19) *	–	–	277.55 (3.89) **
	3	0.56	4.99 *	3.0	29 709 (1.46)	–	–	142.79 (0.79)	–	303.22 (3.06) **
	4	0.67	7.97 **	2.7	15 224 (0.89)	–	–	–	290.20 (1.87) [a]	303.04 **
Rural	**1**	**0.54**	**4.65 ***	**3.0**	**53 689 (2.93) ****	**– 171.35 (– 0.55)**	–	–	–	**281.83 (3.02) ****
	2	0.54	4.78 *	3.0	55 212 (3.04) **	–	– 170.95 (– 0.65)	–	–	280.05 (3.09) **
	3	0.58	5.62 *	3.2	63 538 (3.41) **	–	–	– 427.22 (– 1.11)	–	304.83 (3.35) **
	4	0.56	5.04 *	3.1	58 605 (3.12) **	–	–	–	– 256.25 (– 0.82)	288.54 (3.17) **

APXA, maize adjusted annual average price; H1PXA, maize adjusted 1st-harvest price;
H2PXA, maize adjusted 2nd-harvest price; H3PXA, maize adjusted average harvest price;
R COT, cotton gross income on year $t-1$. Number of observations: 11.

TABLE 2.3

Econometric estimates of alternative maize acreage-price equation specifications with observed prices in Mono province, 1979–1989

Acreage equation	Intercept	Urban maize price	Rural maize price	Gross cotton income	AP$_{u,t}$	AP$_{r,t}$	R^2
With observed urban market price	13 757 (0.92)	318.32 (2.27) *		278.71 (3.96) **	–	–	0.71
With observed rural market price	54 006 (2.85) *	–	– 185.23 (– 0.55)	287.26 (2.95) **	–	–	0.54
With observed urban market price and AP$_{r,t}$	– 15 644 (– 0.23)	311.72 (2.10) [a]	–	99.89 (0.24)	–	0.67 (0.43)	0.71
With observed rural market price and AP$_{u,t}$	7 285 (0.27)	–	– 124.84 (– 0.44)	20.58 (0.14)	0.98 (2.10) [a]	–	0.71

TABLE 2.4

Econometric estimates of alternative maize acreage-price equation specifications with adjusted prices in Mono province, 1979–1989

Acreage equation	Intercept	Urban maize price	Rural maize price	Gross cotton income	AP$_{u,t}$	AP$_{r,t}$	R^2
With adjusted urban market price	12 841 (0.87)	335.50 (2.38) *	–	270.11 (3.92) **	–	–	0.72
With adjusted rural market price	53 689 (2.93) **	–	– 171.35 (– 0.55)	281.83 (3.02) **	–	–	0.54
With adjusted urban market price and AP$_{u,t}$	– 8 169 (– 0.12)	327.86 (2.16) *	–	140.83 (0.34)	–	0.49 (0.32)	0.72
With adjusted rural market price and AP$_{u,t}$	5 462 (0.20)	–	– 83.55 (– 0.32)	14.30 (0.10)	0.98 (2.16) *	–	0.72

–, Not applicable; values in parentheses are computed t-values of the coefficients.
[a] Significant at 10% level; * at 5% level, ** at 1% level, in reference to Tables 2.1–2.4.

TABLE 3

Variables' mean values used to calculate elasticities

Region	Acreage	Cotton gross income	Observed prices				Adjusted prices			
			APX urban	APX rural	H1PX urban	H1PX rural	APXA urban	APXA rural	H1PXA urban	H1PXA rural
Benin	442980	83.19	93.18	–	–	58.00	93.27	–	–	69.64
Mono	66605	83.19	93.18	61.00	–	–	93.27	61.45	–	–

APX, annual average price observed; APXA, annual average price adjusted; H1PX, 1st-harvest price observed; H1PA, 1st-harvest price adjusted.
–, Not applicable.

TABLE 4

Elasticities [a] of maize acreage with respect to price and cotton gross income

Region	Observed			Adjusted		
	Urban market price	Rural market price	Cotton gross income	Urban market price	Rural market price	Cotton [b] gross income
Mono	0.445 *	–	0.348 **	0.470 *	–	0.337 **
	–	−0.169	0.359 **	–	−0.158	0.352 **
Benin	0.087	–	0.129 *	0.099	–	0.127 *
	–	0.042	0.123 *	–	0.082	0.117 *

[a] Elasticities at means.
[b] Adjustment is not applicable to this variable.
Significance level: * 5%, ** 1%.

ment programs in Benin (the end of 1977–1980, and 1983–1987), the last one allowing a greater allocation of resources to the rural sector, from 10.7% to 23% (an increase of 114%) [11]. A dummy variable considering the periods of these programs or a separated analysis for each period may improve the results. Using mean values of acreage during the periods 1979–1983 and 1984–1989, elasticities are 0.515 and 0.416 with observed urban prices. They are, respectively, 0.554 and 0.439 with adjusted urban prices. The latter allow then an increase of elasticity by 7.6% in the first period and 5.5% in the second.

Despite the greater emphasis on rural development in the second program, its execution suffered seriously from lack of funds. This may be the reason for lower elasticities in the second period.

Generally, food crop respond less to price than cash crops and elasticities calculated to date (Krishna, 1967; Berte and Epplin, 1989) for pure cash crops such as cotton and jute are less than 1. Elasticities calculated in Mono province confirm this conclusion. However, Ghatak and Ingersent (1984) reported short-run price elasticities of maize acreage of 2.27, and 0.27 to 4.47 calculated, respectively, by Askari, Cummings and Harik in Syria (1961–72) and Behrman in Thailand (1949–63).

Maize farmers in Benin and particularly in Mono province have become increasingly responsive to price incentives owing to the improved maize varieties and other cropping techniques introduced in the country during the last two decades. Increasing cash needs faced by them strengthened this behavior. The maize–cotton rotation and fertilizer use on cotton are likely to favor maize production in southern Benin. Maize acreage does not respond significantly to maize price alone whereas previous year's cotton gross income is an important explanatory variable.

CONCLUSIONS

In this study, we were concerned with the meaningfulness of differences between urban and rural prices for maize acreage response estimation. A price adjustment model based on the specific behavior of local units in rural and urban markets was also tested. Urban market price specification proved to be statistically significant in explaining acreage decisions. Results with data for Mono province are interesting. The price adjustment model performed well enough (greater and more significant coefficients for the price variables were obtained with the urban price specification). The relevance of rural prices is denied and the depressive effects of these prices

[11] DPE/MPS (1983) in Houngbo (1986).

on acreage over a long period (11 years) seem to have overcome positive trends usually observed over short periods (6 years).

Nonetheless, price differentials through space and time and other relevant variables, especially those describing the marketing channels, need to be considered when evaluating farmers' price responsiveness for crops marketed through the private system. Accurate data pertinent to the rural area are seldom available. We are therefore limited in our conclusions about the actual level of farmers' reaction to economic incentives. Detailed information about the pricing system in the private-grain marketing network is still needed to help policy makers design appropriate pricing policies for the food-grain sector.

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