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Impact of Public Market Information System (PMIS) on Farmers Food Marketing Decisions: Case of Benin

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Abstract

To sell their surpluses of maize, the main staple in Benin, farmers may choose among three modes of transaction: they may sell under a contract with itinerant traders, or they may sell without a contract at the farmgate or on distant markets. It has been postulated that farmers may choose a profitable mode of transaction if they have good access to information on the prevailing market conditions. Using detailed farm household survey data from Benin, this paper applies the Nested Logit model to test this hypothesis. The results show that farmers are likely to opt for selling at the farmgate without a contract if they have good access to information. However, such a decision may not be related to access to information through the government supported 'Public Market Information System' but rather it is likely to be induced by access to information through farmers' own social networks.

Key words: Public Market Information System, farmers, modes of transaction, liberalization.

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1 INTRODUCTION

Markets, formal and informal, are important for the poor who need them to sell their labor and products, to finance their investments and to be insured against the risks. When the markets function well, they stimulate the growth and open opportunities for the poor (World Bank, 2001). In particular, access to a well remunerated market is one of the most important factors influencing farm performance, especially in developing countries. Improving smallholder farmers' market access can thus be an essential component of the strategy of rural poverty reduction. This is why the multilateral and national aid agencies and governments in developing countries are favorable to the reforms aiming at releasing market forces.

Since 1990, most reform efforts in sub-Saharan countries are targeted to agricultural market liberalization. Most of the governments have stopped intervening directly in the markets via marketing boards or parastatal organizations. Market Information Systems (MIS) thus emerged as an accompanying measure of this reform. They were very much intended to correct the asymmetries created by economic liberalization, giving more bargaining power to farmers, creating a more transparent, open trading environment and fostering more efficient market systems for all stakeholders (Tollens, 2006).

Large positive impacts are expected from MIS, but empirical works to show them are missing. According to Tollens (2006), there is a lack of impact evaluation of PMIS. Have poor farmers obtained better market access? Has the price discovery process by farmers been more efficient? Tollens shows that most of these questions remain unanswered. In this article we propose to investigate how the Public Market Information System (PMIS) affects the patterns of smallholder participation in the market of a major staple food crop (maize) in Benin. An econometric approach (Nested Logit Model) is developed and tested with micro data from Benin. The results show that farmers are likely to opt for selling at the farmgate without a contract if they have good access to information. However, such a decision may not be related to access to information through the government supported 'Public Market Information System' but rather it is likely to be induced by access to information through farmers' own social networks.

The rest of the paper is organized as follows. Section 2 presents a brief conceptual discussion on the link between PMIS and smallholder market participation in the context of LDCs. Section 3 presents data on the patterns of smallholder market participation in the maize markets and characteristics of PMIS. The estimation approach is shown and the model variables are described in section 4. Section 5 presents and analyzes the results. Section 6 concludes.

2 PUBLIC MARKET INFORMATION SYSTEM (PMIS) AND SMALLHOLDER MARKET PARTICIPATION IN LDCS

A striking feature of agriculture in poor countries is that the majority of food staple producers opt out of markets, even when price incentives are offered to them in order to break out from this 'perverse' optimal choice (Barrett, 2008). Since the pioneering works of de Janvry *et al.* (1991) and Goetz (1992), various conceptual and empirical works have been applied to

analyze this problem, inspired more or less by transaction-cost theories. They confirm that subsistence agriculture trap, in poor countries, is the result of high market entry costs, the most prominent being the cost of access to information. This is the main reason why the implementation of PMIS is being encouraged. However, the literature also points out that to design a comprehensive policy package to eliminate the subsistence trap is problematic. Additional analysis is therefore useful.

The review of the literature indicates a gap, which, if filled, could be a good starting point for improving the policy agenda. Indeed, until now the smallholder market participation research agenda focus mostly on the (discrete) decision to participate or not in the market as well as the intensity of the participation. Detailed analysis on the "success stories" of those smallholders who take the risk to participate into the markets is still missing. What types of arrangements do they submit for when selling their surpluses (are these arrangements contractual or not; if not, do they sell at the farmgate or on distant markets?). How do they perceive the benefits from the available arrangements and what determine the decision to select a particular type of arrangement?

By asking such questions, obviously we intend to apply the tools of the New Institutional Economics to assess the patterns of smallholder market participation. In particular we exploit the governance approach developed by Williamson (1991, 2002). In the Williamson's framework, the arrangements to which the different parties involved in the transaction over a good can submit are designated by the term modes or forms of governance. Market is one of these modes. But, the parties may also choose hierarchy or a hybrid form.

One of the main characteristic of markets is that they imply autonomous relations between the parties while hierarchies involve authority relations (cooperation). The hybrid form exploits the advantages of the two polar modes (market, hierarchy) although it should not be viewed as loose amalgam of market and hierarchy but as a form that possesses its own disciplined rationale (Williamson, 1991). Williamson predicts that a particular mode is chosen always after comparison with alternative modes; in any case, it is the transaction cost economizing mode which is chosen and this choice is contextual. The regulatory framework, the economic environment and the characteristics of the good under transaction, all, play a role in the selection of a particular mode of governance (hereafter mode of transaction).

We exploit this framework to analyze the transactions for the major staple food crop in Benin (maize). It has been postulated that surplus farmers choose among several modes of transaction. With the availability of an institutional innovation such as a PMIS, the ranking of the modes of transactions may change; re-orienting farmers towards the mode which economizes transaction costs the most.

To test this framework approach, detailed farm household and market surveys have been carried out in important maize producing zones in Benin. Variation across farm households in the patterns of modes of transaction, in the use of PMIS and in other household and transaction-specific variables is used to construct an econometric model which shows how a particular mode of transaction for maize is chosen by smallholders. To the best of our knowledge, Fafchamps (2005) is the only attempt to date, to implement a systematic analysis of the farmers' choice of modes of transaction for the agricultural products in the context of

LDCs. While Fafchamps focused on an export crop (cocoa) we choose to examine the case of a staple food crop (maize); we also extend the analysis to the use of private contracts (between itinerant traders and smallholders) in the marketing of this crop.

3 PATTERNS OF SMALLHOLDER MARKET PARTICIPATION IN THE MAIZE MARKETS AND THE CHARACTERISTICS OF PMIS IN BENIN

In Benin, domestic agricultural trade is dominated by maize. The market share of this crop attained 40 to 50% (Minot *et al.*, 2001). In normal years, the country is self-sufficient in maize. As until 1995, Benin has a surplus of maize of around 30,000 tons which are exchanged with neighboring countries (Niger, Burkina-Faso, Togo and Nigeria). The level of cultivation of maize differs between the South and the North because of variation in climatic conditions. Further, the motivation for cultivation varies between the two regions. In the South, which is mostly humid, maize is a staple food, grown by farmers primarily to meet subsistence goals; there are two harvests per year (small and long rainy seasons). The North is semi-arid and has only one harvest and maize is almost a cash crop.

The distribution of maize is regulated by a private market system which is integrated into a larger network of markets including markets in neighboring countries. Traders operate within a spatial network of both formal (periodic spot markets) and informal market places. Numerous petty traders and wholesalers are involved in the business but most handle relatively small volumes (1,000 kg per market day); a few large wholesalers, with substantial market power, are present however (Lutz, 1994; Adégbidi *et al.*, 2003).

The functioning of the maize market is well-documented (Lutz, 1994; Adégbidi *et al.*, 2003; Galtier, 2002; Tassou, 2004; Ahohounkpanzon, 1992). For most studies, the level of transparency is not high and there are often difficult impediments to free entrance. This is not only a consequence of physical barriers but there are also various institutional barriers to trade; for example, powerful "corporations" of traders may prohibit entrance in the markets in certain localities and farmers are the most targeted for exclusion.

Institutional innovations such as a Public Market Information System (PMIS) can be useful to reduce these imperfections. The government of Benin has received grants from various organizations (FAO, GTZ, etc.) since the early 1990s to set up this system as an accompanying measure of economic liberalization. The aim is to improve the power of farmers and small traders in the bargaining process, to increase market transparency, to create open trading environment and promote efficient market systems that yield sufficient benefits for all stakeholders.

Unfortunately, a comprehensive assessment of PMIS and its influence on the patterns of smallholder market participation, using micro data, cannot be found in Benin. This research has been initiated to fill the gap. In the specialized survey that has been designed, we collect data on the characteristics of PMIS and detailed household and farm characteristics on a sample of maize surplus producers in the department of Plateau in Benin. A closer follow-up has also been carried out on a sub-sample to examine the characteristics of each transaction of maize (mode of transaction, price and transactions-cost related variables for each transaction). In table 1 the components of PMIS are shown with the extent of use of each of them. Table 2

presents data on key household and farm characteristics and the characteristics of the maize transactions in the study area.

Table 1: PMIS and the extent of its use by farmers (N=241)

Components of PMIS	Percentage
Monthly market bulletin of ONASA	0%
Community radio stations	43%
National radio station	6%
Posting of prices in market places	4%
SMS service	0%

Source: farm household survey, 2006/2007.

In Benin, PMIS is one of the most important activities of the national grain board, "Office National d'Appui à la Sécurité Alimentaire (ONASA)" established in 1989 as an integral part of the economic liberalization policy reform in Benin. The targeted public for PMIS is government, traders, farmers, consumers. As components the system includes the publication of food monthly market bulletins, posting of the prices of major staple food crops, in particular maize, in the market places across the country, broadcasting of prices and market information on radios (community radio stations, national radio station) and, recently, a SMS (Short Message Service) is also offered. This service is expected to be very effective, since there is these days a boom in the telecommunication sector. However, table 1 indicates that this SMS service was not used by the survey farmers. But a significant number (more than 40%) have access to PMIS by following the broadcastings on market data carried out by the community radio stations.

Preliminary descriptive data on the link between the use of PMIS, modes of transaction and producer price levels for maize, based on table 2, are interesting. In the survey area, three modes of transactions have been observed: contract with itinerant traders, selling without contract on the village market, selling without contract on distant markets. Distant market is meant to indicate the closest urban market. An important feature of mode 'contract' in the area is that this mode is accompanied by an offer of credit by itinerant traders to farmers. The data indicate that enforcement problem with the contract system is minimum in the area. Table 2 indicates that, indeed, both expected and received (producer) prices differ across the modes of transaction. The data also suggest that both prices are, in general, much higher with PMIS, indicating that farmers can extract higher benefits from the transactions of maize if PMIS is provided. This preliminary result will be tested using a systematic (econometric) analysis.

Table 2 Descriptive statistics on the characteristics of maize sales and maize farmers

	Modes of transaction			
Variables	Contract	Village market	Distant market	All
Percentage of farmers in each mode of transaction	34.7	45.1	20.2	100
Number of transactions = 1 (%)	23.4	12.1	6.4	41.9
Number of transactions = 2 (%)	5.7	12.1	3.2	21.0
Number of transactions ≥ 3 (%)	5.6	21.0	10.5	37.1
Ex-ante information on alternative market prices through PMIS (% of farmers)	12.1	17.7	6.5	36.3
Ex-ante information on alternative market prices through farmers' own social networks (% of farmers)	8.9	24.2	11.3	44.4
No ex-ante information on alternative market prices before selling maize (% of farmers)	13.7	3.2	2.4	19.3
Expected sale (producer) price for maize (FCFA/kg)	114.8	120.2	116.0	117.5
With PMIS	133.4	119.5	132.9	126.5
Without PMIS	104.8	120.6	108.0	112.3
Sale (producer) price received (FCFA/kg)	70.2	84.3	77.3	78.0
With PMIS	89.5	87.5	96.7	89.8
Without PMIS	59.8	82.3	68.2	71.3
Net sale (producer) price received (FCFA/kg)	66.3	82.3	66.7	73.6
Marketing costs (FCFA/kg)	3.9	2.1	10.7	4.4
Transport costs (FCFA/kg)	0.9	0.3	5.6	1.6
Distance travelled (km)	4.2	2.3	11.4	4.8
Duration of a transaction (hours)	3.8	3.1	4.1	3.5
Age of farmer (number of years)	46.9	43.5	45.4	45.1
Number of wives =1 (%)	10.5	20.2	4.8	35.5
Number of wives = 2 (%)	16.9	19.4	12.9	49.2
Number of wives≥ 3 (%)	7.3	5.7	2.4	15.3
Household head cereal trade experience (years)	23.6	24.0	26.3	24.3
Household head education (years)	2.3	2.0	3.9	2.4
Household size (number of persons)	11.4	8.9	11.2	10.2
Farmers who live in Pobe (%)	7.3	28.2	7.3	42.7
Large-scale farmers (%)	24.2	7.3	9.7	41.1
Medium-scale farmers (%)	9.7	5.7	17.7	33.1
Small-scale farmers (%)	0.8	20.2	4.8	25.8
Opinion about entry barriers on distant markets (% of farmers)	21.0	14.5	3.2	38.7
Adopters of improved variety of maize (%)	31.4	32.3	17.0	80.7
Share improved variety in total production of maize (%)	98.1	100.0	94.4	98.2
75% of the marketable surplus is sold in the lean season – January to June (% of farmers)	20.2	18.5	7.3	46.0

Source: Farm household survey, 2006/2007

4 ESTIMATION APPROACH AND DATA

4.1 Specification of the Nested Logit

Farmers may choose among three modes of transaction: contract, village market and distant market. So, we have a case of discrete choice models in the context of random utility theory. In such a situation it is a multinomial logit model (MNL) which is usually applied. But the MNL assumes proportional substitution patterns IIA. To relax this strong assumption of the

multinomial (or conditional) logit model, we have chosen to apply the Nested Logit model which has become an important tool for the empirical analysis of discrete outcomes (Heiss, 2002; Silberhorn *et al.*, 2008). The Nested Logit model is the most often used hierarchical model in marketing (Suarez *et al.* 2004) and can be used for modeling in any situation where subsets of alternatives share unobservable utility components (Ben-Akiva and Lerman 1985).

In Random Utility Maximization (RUM) Models, econometricians assign a utility level U_{ij} to each alternative $j = 1, 2, ..., J$ for each decision maker $i = 1, 2, ..., I$. The decision makers are assumed to choose the alternative from which they derive the highest utility. The utilities are determined by a large number of characteristics of the decision maker and the alternatives. The researchers have information on some of these determinants, but not on all (Heiss, 2002). This is reflected by splitting the utilities into a deterministic part V_{ij} and a stochastic part ε_{ij}:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

The probability P_{ij} that individual i chooses some alternative j is equal to the probability of U_{ij} being the largest of all $U_{i1}, U_{i2}, ..., U_{iJ}$. With $y_i \in \{1...J\}$ denoting the alternative that decision maker i chooses, this probability is:

$$P_{ij} = P(y_i = j) = P(U_{ij} \succ U_{ik} \; \forall k = 1, ...J : k \neq j) \tag{2}$$

$$= P(\varepsilon_{ik} - \varepsilon_{ij} \leq V_{ij} - V_{ik} \; \forall k = 1, ...J : k \neq j) \tag{3}$$

Given the deterministic parts of the utility functions $V_{i1}, V_{i2}, ..., V_{iJ}$, this probability will depend on the assumptions on the distribution of the stochastic error terms $\varepsilon_{i1}, \varepsilon_{i2}, ...\varepsilon_{iJ}$. The multinomial logit (MNL) and conditional logit (CL) models are probably the most widely used tools for analyzing discrete dependent variables. In these models it is assumed that the error terms $\varepsilon_{i1}, \varepsilon_{i2}, ...\varepsilon_{iJ}$ are i.i.d. as 'Extreme-Value Type I'. This distribution has a variance of $\sigma^2 = \pi^2 / 6$, which implicitly sets the scale of the utilities. Instead, the Random Utility Maximization Nested Logit (RUMNL) model assumes a generalized version of this distribution. This special form of the 'Generalized-Extreme Value' (GEV) distribution extends the 'Extreme-Value Type I' distribution by allowing the alternatives within a nest to have mutually correlated error terms. This distribution takes into account the degree of independence (λ_k) in unobserved utility among the alternatives in nest k. A higher value of λ_k means greater independence and less correlation. The statistic $1 - \lambda_k$ is a measure of correlation, in the sense that as λ_k rises, indicating less correlation, this statistic drops (Train, 2003). So, When $\lambda_k = 1$ for all k, representing independence among all the alternatives in all nests, the GEV distribution becomes the product of independent extreme-value terms. In this case, the Nested Logit model reduces to the standard logit model.

The deterministic utility components V_{ij} may consist of different types of determinants.

- alternative-specific constants α_j for all but one (the reference) alternative should enter the model. They capture choice probabilities relative to the reference alternative that cannot be attributed to the other explanatory variables.
- individual-specific variables describe characteristics of the decision maker. These variables may influence the relative attractiveness of the alternatives. Prominent examples are socio-economic variables like household income, household head education, household head age, household head cereal trade experience or household land owned, etc. They are collected in a vector z_i for each decision maker $i = 1, 2, ..., I$. A parameter vector γ_j for each alternative j is associated with the individual-specific variables. Since only utility differences are relevant for the choice, the parameters for one (the reference) alternative have to be normalized to zero for purposes of identification. The other parameters can be estimated freely. They represent the effect of the individual-specific variables on the utility of the respective alternatives relative to the reference alternative.
- alternative-specific variables vary both over individuals and alternatives. Prominent examples are the expected sale (producer) price for maize, distance to market, transport costs, etc. These variables will be collected in a vector x_{ij} for each decision maker $i = 1, 2, ..., I$ and for each alternative $j = 1, 2, ..., J$. They may enter the utilities in two different ways. Since the variation over alternatives provides additional ground for identification, a separate parameter for each alternative is statistically identified. A parameter β_j is estimated for each alternative $j = 1, 2, ..., J$ or the researcher may often want to constrain the coefficients β_j of alternative-specific variables to be equal for each alternative. In this case, only a joint coefficient β is estimated for all alternatives. This is possible because of the variation of x_{ij} over the alternatives. In this case, we will call these variables generic variables and add the restriction: $\beta_j = \beta \ \forall j = 1, 2, ..., J$. According to Heiss (2002), the introduction of a generic variable into the model improves the estimates and makes it possible to interpret the coefficient considered as being the implicit value of the variable in terms of utility.

Including all these variables, the deterministic part of the utility V_{ij} can, in general, be written as: $V_{ij} = \alpha_j + x_{ij}\beta_j + z_i\gamma_j$

Let us suppose that we gathered the choices set into L subsets ('nests'). In each group l, there are J_l possible choices. On the whole, the individual has $J = J_1 + J_2 + \cdots + J_L$ possible options. In our case, the number of nests is $L = 2$ (figure 1). The group of the producers who has a contract with the traders has only one choice, therefore $J_1 = 1$. On the other hand, the producers with no contract have two choices: sell on the village market or on a distant market. So, $J_2 = 2$ and, consequently, the producer has the choice between three

options $J = J_1 + J_2 = 1 + 2 = 3$. Denote the nest to which alternative $j = 1, 2, ..., J$ belongs as $J_j:\ J_j = \{J_l : j \in J_l, l = 1, 2, ...,\ L\}$.

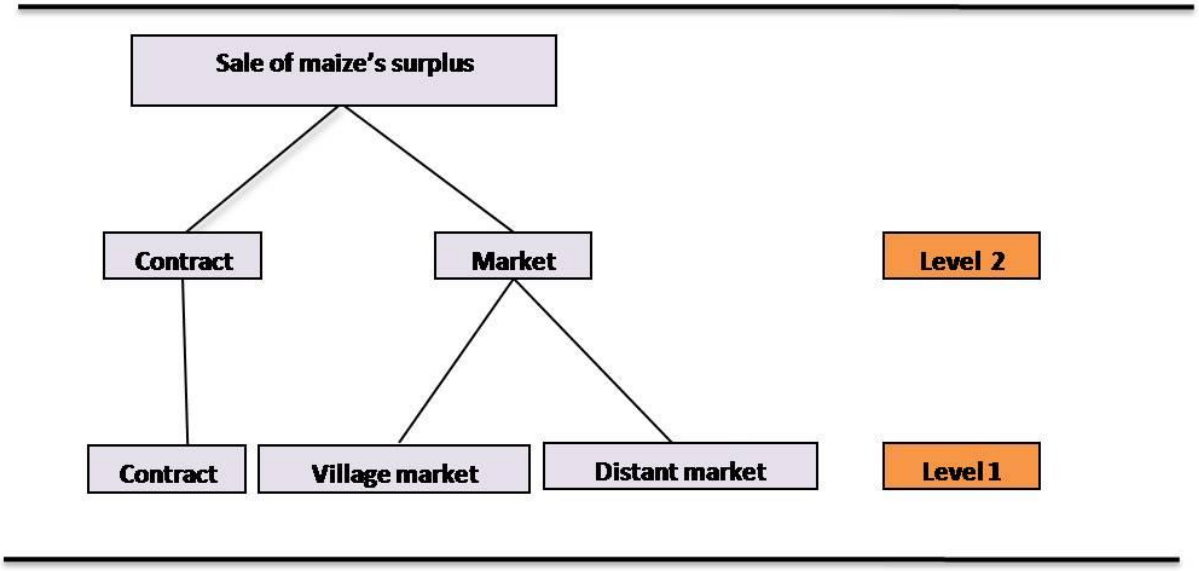

Figure 1. Nested structure for the sale of maize's surplus
Source: Farm household survey, 2006/2007

In order to develop an intuitive expression for the choice probabilities, it is useful to decompose them into two parts. The probability of individual i choosing alternative j $P(y_i = j)$, is equal to the product of the probability to choose some alternative in nest J_j, $P\{y_i \in J_j\}$, and the conditional probability to choose exactly alternative j given some alternative in the same nest J_j is chosen $P\{y_i = j \mid y_i \in J_j\}$; that is

$$P_j = P(y = j) = P\{y = j \mid y \in J_j\} \cdot P\{y \in J_j\}$$

where the individual subscript i is dropped from now on for the sake of a more concise notation. In our example, the probability of choosing to sell on a distant market $P(y = distant\ market)$ is equal to the probability of choosing to sell on market $P\{y \in J_{market}\}$ times the conditional probability of choosing to sell on distant market given a mode of transaction "market" is chosen $P\{y = distant\ market \mid y \in J_{market}\}$. This decomposition follows the rules of conditional probability and is especially useful for thinking about the Nested Logit model.

There are two different specifications of the Nested Logit model with different outcomes (Heiss, 2002; Silberhorn *et al.*, 2008): the Random Utility Maximization Nested Logit (RUMNL) model and the Non-Normalized Nested Logit (NNNL) model. If there are no generic coefficients in the model the NNNL and the RUMNL specification are equivalent (Heiss, 2002).

The RUMNL conditional choice probability of choosing alternative j given some alternative in its nest is chosen is $P\{y = j \mid y \in J_j\}$, which corresponds to a simple Conditional Logit model for the choice between the alternatives in nest J_j. But the utilities are rescaled by the inverse of the parameter τ_j for this nest. The parameter τ_j is often called dissimilarity parameter because it is an inverse measure of the correlation of the error terms of all alternatives within this nest:

$P\{y = j \mid y \in J_j\} = \frac{\exp(V_j/\tau_j)}{\sum_{k \in J_j} V_k/\tau_j}$. The log of the denominator of this expression (IV_l) is called inclusive value or inclusive utility in the nest l. It corresponds to the expected value of the utility individual i obtains from the alternatives in nest l: $IV_l = \ln \sum_{k \in J_j} V_k/\tau_j$. So, $P\{y = j \mid y \in J_j\} = \frac{\exp(\tau_j IV_j)}{\sum_{l=1}^{L} \exp(\tau_l IV_l)}$. The marginal choice probability for alternative j which is the full information likelihood contribution is:

$$P(y_i = j) = P_j^{RUMNL} = \frac{\exp(V_j/\tau_j)}{\exp(IV_j)} \times \frac{\exp(\tau_j IV_j)}{\sum_{l=1}^{L} \exp(\tau_l IV_l)}.$$

If a nest contains only one alternative (as in our case), it is called a degenerate nest. The dissimilarity parameter of degenerate nests is not defined in the RUMNL model. Since the degenerate nest J_j only contains alternative j, its inclusive value simplifies to $IV_j = V_j/\tau_j$. The dissimilarity parameter τ_j cancels out of the choice probability. This is intuitive since the concept of (dis)similarity does not make sense with only one alternative. In the NNNL model, however, the dissimilarity parameter of degenerate nests does not vanish from the choice probability and may be statistically identified. Without generic variables, the dissimilarity parameters are not jointly identified with the other parameters, so they can be constrained to any nonzero value. If at least one generic variable is included in the NNNL model, the IV parameter of degenerate nests may be identified along with the other model parameters. This identification comes from the restriction of equally scaled parameters β_j/τ_j across alternatives and nests, and the parameters only constitute this scaling. A conventional approach to restrict the IV parameter to be equal to unity does not result in a model that is consistent with the underlying RUM model.

4.2 Data

The data used in this paper come from a survey carried out in the communes of Pobè and Kétou in the department of Plateau, the largest maize producing zone in Benin. Previous studies suggest that market entry barriers are erected against producers and the non-residents traders in this region (Lutz, 1994; Adégbidi *et al.*, 2003).

A sample of 241 farm households were randomly selected among maize surplus producers. Detailed data on the characteristics of households and farms, sources of information on

market conditions, agricultural financing and participation have been collected. In a second step, a sub-sample of 124 farm households was drawn to implement a closer follow-up over one year (October 2006 - September 2007) for each maize transaction carried out in that period. Each month enumerators visit the households to collect the data. In total 323 transactions were observed, on average 3 transactions per household. For each of them farmers are asked to give a description: where the maize is sold, whom to, how much was sold, at what price, the kinds of arrangements used and other aspects of transactions. Data at community-level were also collected (identification of farmers' unions and analysis of their role in the cereal markets).

Table 2 describes the characteristics of the maize transactions and maize farmers for the sub-sample comprising 124 farmers.

For the three modes of transaction observed in the survey area the percentages are : 35% for the mode 'contract with itinerant traders', 45% for 'selling without contract on the village market' and 20% for 'selling without contract on a distant market'.

The average household size is 10 persons. Average years of schooling for the household head is limited (2.4). The highest level of schooling is found among farmers selling on distant markets (almost 4 years). Mean age of the household head is 45 years, and the number of years of experience in cereal trade is 24. Market entry barriers are perceived as high by almost 40% of the respondents, from which more than 50% are those that have chosen to sell under contract; farmers who sell to distant markets hardly see any barriers to trade.

Three categories of farmers have been formed based on the size of the maize area. (1) large: $\geq$ 6 ha – 41%; (2) medium : 3-5.5 ha – 33%: (3) small: < 3 ha – 26%. Table 2 shows that more than 50% of large farmers sell under contract. Most of the small farmers (78%) opt for selling without contract on the village market. Maize yield are 1973 $kgha^{-1}$, 2104$kgha^{-1}$ and 1646$hakg^{-1}$ for large, medium and small farmers respectively.

The percentage of farmers who are informed about PMIS and used it is 36.3%. Among them 47% and 18% sell, without contract, on the village and distant markets, respectively. It is useful to indicate that many of those who decide to sell under contract also show interest into the PMIS.

Apart from PMIS, farmers use additional sources of information (say through own social networks) about market conditions. The percentage is 44%. From this, the majority (55%) are those who sell on the village market and 25% is obtained for those who sell on distant markets.

5 EMPIRICAL RESULTS

As indicated earlier, there are two different specifications of the Nested Logit model with different outcomes (Heiss, 2002; Silberhorn *et al.*, 2008): the Random Utility Maximization Nested Logit (RUMNL) model and the Non-Normalized Nested Logit (NNNL) model. The estimated coefficients from RUMNL model can be readily interpreted and simple tests like asymptotic t tests directly test hypotheses of interest. This holds irrespective of the type of included explanatory variables and specified nesting structure. But, the estimated parameters

from NNNL model may not be interpreted as the structural parameters of an underlying Random Utility Maximization model as many researchers tend to do (Heiss, 2002). If there are only alternative-specific coefficients in the model, the Nested Logit specification chosen can be accommodated merely by a nest-specific re-scaling of the estimated coefficients obtained from the NNNL software before interpretation. As soon as a generic coefficient enters the model, the NNNL model is not consistent with random utility theory without imposing restrictions on the scale parameters. But these restrictions on the parameters are often counterintuitive and undesired (Heiss, 2002). It is why it is important to run the RUMNL model. In many publications, the specification used is not explicitly mentioned (Silberhorn *et al.*, 2008) and this a source of confusion. Since it is possible to estimate the Random Utility Maximization Nested Logit (RUMNL) model with Stata 9 or Stata 10, we implement the preferred RUMNL model with the package nlogitrum in Stata 10.

The dependent variable is mode of transaction: sale under contract (contract, c), sale in the village market without contract (village market, v) and sale in the distant market without contract (distant market, m). Sale on the village market is the base category. The functions of utility V_j of the three alternatives are defined as follows:

$$V_v = \beta_{PE} \cdot PE_v + \beta_{CO} \cdot CO_v + \beta_{DI} \cdot DI_v + \beta_{DU} \cdot DU_v + \varepsilon_v$$

$$\begin{aligned} V_c = {} & \alpha_c + \beta_{PE} \cdot PE_c + \beta_{CO} \cdot CO_c + \beta_{DI} \cdot DI_c + \beta_{DU} \cdot DU_c + \lambda_{EXP} \cdot EXP_c + \lambda_{INST} \cdot INST_c + \lambda_T \cdot T_c \\ & + \lambda_{COM} \cdot COM_c + \lambda_{GP} \cdot GP_c + \lambda_{PM} \cdot PM_c + \lambda_{BAR} \cdot BAR_c + \lambda_{VAR} \cdot VAR_c + \lambda_{PMIS} \cdot PMIS_c \\ & + \lambda_{CPV} \cdot CPV_c + \lambda_{PER} \cdot PER_c + \varepsilon_c \end{aligned}$$

$$\begin{aligned} V_m = {} & \alpha_m + \beta_{PE} \cdot PE_m + \beta_{CO} \cdot CO_m + \beta_{DI} \cdot DI_m + \beta_{DU} \cdot DU_m + \lambda_{EXP} \cdot EXP_m + \lambda_{INST} \cdot INST_m + \lambda_T \cdot T_m \\ & + \lambda_{COM} \cdot COM_m + \lambda_{GP} \cdot GP_m + \lambda_{PM} \cdot PM_m + \lambda_{BAR} \cdot BAR_m + \lambda_{VAR} \cdot VAR_m + \lambda_{PMIS} \cdot PMIS_m \\ & + \lambda_{CPV} \cdot CPV_m + \lambda_{PER} \cdot PER_m + \varepsilon_m \end{aligned}$$

where:

PE	=	Expected sale (producer) price for maize
CO	=	Marketing costs
DI	=	Distance to the market
DU	=	Duration of a transaction
EXP	=	Household head cereal trade experience (years)
INST	=	Household head education
T	=	Household size
COM	=	1 if the residence of the head household is Pobe (regional fixed effects)
GP	=	1 if the maize producer belongs to the category of large-scale farmers
PM	=	1 if the maize producer belongs to the category of medium-scale farmers
BAR	=	1 if the producer estimates that there exist entry barriers on the distant (urban) markets
VAR	=	Share of improved variety in total production of maize (%)
PMIS	=	1 if the farmer uses the Public Market Information System to obtain data about the market price before deciding to sell maize
CPV	=	1 if the farmer has information about the market price before deciding to sell maize without using PMIS
PER	=	1 if the largest share of the maize sold (75% minimum) is exchanged during the lean

season - January to June

In the model, we introduce four alternative-specific variables: expected sale (producer) price for maize (PE), marketing costs paid for selling maize (CO), distance to market (DI) and duration of a transaction (DU). All these attributes of mode of transaction are introduced into the model like generic variables taking into account the advantages related to that.

Variables like age of the household head, capacity of negotiation, quality of the road which connects to distant markets were also included in the regression in preliminary analyses. But they were not finally selected for various reasons, in particular they were found to be strongly correlated with other variables of the model. For the variable ‘age’, we found that its coefficient is not significant and it is also strongly correlated with the variable household head cereal trade experience (years) whose coefficient is significant. ‘Capacity of negotiation’ is found to be positively correlated with variables capturing access to information about market prices; it may be that farmers who have access to price data before selling gain more bargaining power.

As the model is partially degenerated on the level of the contract, the IV parameter doesn't exist for RUMNL model. The IV parameter for market is within the unit interval and implies that this model is consistent with Random Utility Maximization.

Table 3 presents empirical results of the RUMNL and the Conditional Logit models. Both models seem to fit the data fairly well. However, because of the earlier conceptual discussions, only the results for the RUMNL model will be discussed.

The model results show that farmers are likely to opt for selling on the village or distant markets if they have good access to information. However, such a decision may not be related to access to information through the government supported ‘Public Market Information System' but rather it is likely to be induced by access to information through farmers’ own social networks. Indeed, it has been found that the coefficients for PMIS are negative as expected but insignificant. In contrast, the coefficient of the variable "Ex-ante information on alternative markets prices through farmers' own social networks without PMIS (CPV)" is negative and significant for transaction mode "contract". The negative sign of this coefficient seems to say that farmers are prepared to avoid contractual arrangements with itinerant traders when they have access to information through their own social networks; rather they prefer to use market (village market or distant market) for maize transaction. However, it may be useful to indicate that the model does not indicate clearly in this case what is the dominant mode of transaction between selling on the village market or on a distant market. This result does not invalidate the role of PMIS but rather it tends to reinforce the importance of this system. The message is that the government-supported MIS in Benin needs to be improved to be effective.

The result shows also that the farm size has an effect on the modes of transaction. They indicate that large-scale and medium-scale farmers (i.e those with larger surpluses) are more prepared to accept a contract with itinerants traders for selling their maize surpluses; small-scale farmers opt for the market (village or distant). Given that this result is obtained after controlling the model for PMIS, interesting conclusions can be derived. Given that the use of PMIS induces higher received prices as table 2 seems to show, this means that 'big' farmers

may use purposively PMIS to improve benefits from transactions while remaining under contract. Contract may not be the best choice and we have seen that as soon as access to information is facilitated farmers tend to break out from this mode of transaction. Therefore the question arises 'why does this mode persist?' A plausible answer is that farmers lack access to credit; indeed a key advantage of contract in the study area is that this mode is accompanied by an offer of credit by itinerant traders. It may be useful to find out how the patterns of modes of transaction will be altered if farmers are offered an alternative source of credit in addition to the implementation of PMIS.

Table 3: Nested and conditional logit models for the choice of the modes of transaction for maize

Variables	Nested Logit	Conditionnel Logit
Alternative-specific constants		
Contract	41.435 (0.05)	34.958 (8.74)***
Distant market	42.139 (0.05)	35.706 (8.80)***
Alternative-specific variables		
PE	-0.001 (-0.09)	-0.001 (-0.04)
CO	-0.006 (-0.56)	-0.006 (-0.98)
DI	-0.055 (-1.33)	-0.068 (-1.74)*
DU	0.014 (0.67)	0.019 (1.15)
Individual-specific variables		
PMIS *contract	-1.210 (-1.47)	-1.254 (-1.61)
PMIS *distant market	-0.033 (-0.04)	0.089 (0.09)
CPV *contract	-2.398 (-3.06)***	-2.437 (-3.35)***
CPV * distant market	-0.787 (-0.94)	-0.903 (-1.05)
EXP *contract	-0.044 (-1.74)*	-0.043 (-1.81)*
EXP * distant market	0.004 (0.20)	0.007 (0.34)
INST*contract	-0.068 (-0.74)	-0.065 (-0.65)
INST* distant market	0.051 (0.70)	0.069 (0.78)
T *contract	0.095 (1.70)*	0.099 (1.97)**
T * distant market	0.039 (0.78)	0.049 (0.80)
COM *contract	-0.650 (-0.80)	-0.728 (-0.90)
COM * distant market	-0.575 (-0.64)	-0.823 (-0.77)
GP *contract	4.022 (2.95)***	4.086 (2.84)***

Variables	Nested Logit	Conditionnel Logit
GP * distant market	1.420 (1.24)	1.787 (1.58)*
PM *contract	2.503 (1.94)*	2.452 (1.75)*
PM * distant market	-0.333 (-0.44)	-0.456 (-0.43)
BAR * distant market	-1.342 (-1.58)	-1.640 (-2.11)**
VAR *contract	-0.431 (-0.05)	-0.365 (-10.86)***
VAR * distant market	-0.421 (-0.05)	-0.358 (-11.36)***
PER *contract	0.690 (1.11)	0.690 (1.02)
PER * distant market	-0.243 (-0.46)	-0.340 (-0.53)
IV Parameters (inclusive value)		
Contract	_	_
Market	0.722 (1.44)	_
Model parameters adjustment		
Numbers of observations	372	372
Log likelihood	-87.137629	-87.259786
LR chi^2(28)	98.18059	_
Pseudo R^2	_	0.3595
Prob > chi2	0.0000	0.0000
In the brackets are reported statistics Z, *** significant at 1%; ** significant at 5%; * significant at 10%		

Source: Farm household survey, 2006/2007.

Two additional results from the model can be mentioned. It has been found that none of the alternative-specific variables influences the choice of the modes of transaction. Higher years of experience in cereal trade for the household head (EXP) induces higher probability of opting for the market (village or distant) where probably higher benefits can be extracted. This result combined with those found for the variable 'access to information' points to the idea that implementing a training program in the area of food marketing for farmers can be very useful. As Shepherd (2000) emphasizes agriculture extension services must also be able to help producers to obtain information about market opportunities, to find buyers, to decide about quantity to produce, quantity to sell, to whom to sell, where to sell and when to sell, etc. Unfortunately such programs are often absent from the agenda of the extension administration in Benin or they are placed at the bottom on the list of priorities.

6 CONCLUSIONS

This paper shows how different transactions-cost related variable influence decisions and outcomes of farm-households in rural Benin. In particular, it investigates how the Public

Market Information System (PMIS) affects the mode of transaction for the major staple food crop (maize).

To sell their surpluses of maize, the main staple in Benin, farmers may choose among three modes of transaction, each of which yields a different benefit: they may sell under a contract, established at the onset of the crop season with itinerant traders, or they may sell without a contract at the farmgate (village market) or on distant (urban) markets. It has been postulated that farmers may choose a profitable mode of transaction if they have good access to information on the prevailing market conditions. Using detailed farm household survey data from Benin, this paper applies the Random Utility Maximization Nested Logit (RUMNL) model to test this hypothesis. The results show that farmers are likely to opt for selling at the farmgate or on distant markets without a contract if they have good access to information. However, such a decision may not be related to access to information through the government-supported 'Public Market Information System (PIMS)' but rather it is likely to be induced by access to information through farmers' own social networks. This result does not invalidate the role of PMIS but rather it tends to reinforce the importance of this system. The message is that the government-supported MIS in Benin needs to be improved to be effective.

It has also been found that higher years of experience in cereal trade for the household head (EXP) induces higher probability of opting for the market (village or distant) where probably higher benefits can be extracted. This result combined with those found for the variable 'access to information' points to the idea that implementing a training program in the area of food marketing for farmers can be very useful.

The data indicate that many farmers opt for a contract rather than to sell freely in the market because itinerant traders provide them with credit to accompany the contract. How the patterns of modes of transaction will be altered if farmers are offered an alternative source of credit, in addition to the provision of PMIS, remain an open question.

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