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Determinants of Diversification of Urban Sahel Diets into Maize:
A Contingent Valuation Study of Processed Maize Demand in Mali

INTRODUCTION

The shift in urban diets from the traditional coarse grain (millet and sorghum) to (mainly) imported rice has worried policy makers in Sahelian West Africa for two decades. This trend has hurt trade balances, as cities have grown rapidly, and has sapped potential gains of a growing urban food market to coarse grain farmers (Delgado and Reardon, 1987). Moreover, there has been limited substitutability between coarse grains and rice in urban consumption (Rogers and Lowdermilk, 1991), probably because rice is easier and less time-consuming to process, prepare and cook than the traditional coarse grains (millet and sorghum) and with maize, a relative newcomer to Sahel urban diets (Bricas and Sauvinet, 1989). Even the large devaluation of the CFA (Communauté financière d'Afrique) franc in 1994 did not lead to any substantial reversal of rice consumption in the Sahel (Reardon *et al.*, 1996). Stagnating millet and sorghum yields have also exacerbated the situation over the past three decades, reducing optimism concerning their price competitiveness.

By contrast, policy makers have recently been turning a hopeful eye towards maize as a promising candidate to win back urban diets to domestically pro-duced coarse grains. Unlike millet and sorghum, increases in the output of which have come almost entirely through increases in area cultivated, maize has the potential for rapid yield growth through intensification with improved varieties, manure and chemical fertilizer. This will give maize an advantage as arable land constraints grow rapidly in the Sahel and fragile extensive margins degrade. There is already evidence of maize intensification and incipient com-mercialization in several Sahel countries, especially in cotton production areas where farm cash incomes and fertilizer availability contribute to the success of maize (Dione, 1989; Sanders *et al.*, 1996).

Nevertheless, there are important and unresolved questions about the poten-tial of maize on the demand side. Without an expanding urban market, Sahelian maize producers will hesitate to expand production because of price risk in thin markets (Témé and Boughton, 1992). A particularly important question concerning potential urban demand for maize addresses the demand for *proc-essed* maize, which may then compete with rice as a convenience food. The

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current 'conventional policy wisdom' is that, if maize were much more widely available in the market as flour of various grades of fineness of grind, thus appealing to different strata of consumers, demand would increase substantially. Maize consumption at present is nearly all in grain form, and represents less than 10 per cent of urban Malian cereal consumption (Rogers and Lowdermilk, 1991; Témé and Boughton, 1992).

This paper uses contingent valuation data from a survey undertaken in Bamako, Mali, in 1993, to examine the question of the potential (purchased) demand for various grades of processed maize, at various prices, and for different income groups. Moreover, a gender component is added to the analysis because, if these new products became available on the market, they would probably be perceived very differently by women who normally do the cooking and will, therefore, be most concerned with the allocations of time which most affect their time and utility.

The key issue will be addressed by analysing contingent valuation quantity responses as they vary by proposed prices, hence generating a demand curve. Here there are two points to note. First, contingent valuation has rarely been used in food policy analysis in developing countries. Recent exceptions in Africa have been in Zimbabwe and Kenya, where maize is the main staple and, hence, provides a very different context than the Sahel (for example, see Rubey, 1993; Jayne and Rubey, 1993). Second, it is rare for contingent valuation studies to generate a demand curve empirically; the only exception appears to be in the valuation of new water systems in India (Griffin *et al.*, 1995). This rarity is probably due to the bulk of applications of contingent valuation having dealt with public goods (such as a new irrigation project), where price differences and product differentiation are not major issues, as they are for maize products in urban Mali.

MODEL, ESTIMATION PROCEDURE AND DATA

The model seeks to explain the demand for maize flour (the monthly quantity of maize flour a household would purchase, in kilograms per adult equivalent), as a function of the following independent variables (with the expected signs of their coefficients):

(1) (hypothetical) maize flour price (–);
(2) household income (+);
(3) flour quality (+);
(4) gender-related variables:
    (a) respondent's gender (+ for females),
    (b) gender of household head (+ for females),
    (c) proxies for women's opportunity cost of time:
        (c.1) proportion of women in the household (–); (c.2) proportion of children in the household (–); (c.3) proportion of women working outside home (+); (c.4) household has a maid (–);
(5) demographic and qualitative variables:
    (a) household size (–),

    (b)   region of origin (+ for maize-growing area),
    (c)   currrent (actual) maize consumption (+),
    (d)   whether the household head works in the civil service or the military[1] (–),
    (e)   food preparer's evaluation of the quality of dishes prepared from flour samples (+).

As the contingent valuation dependent variable has a number of zero observations, but is essentially continuous over positive values, OLS estimators will be biased. Hence we use maximum likelihood estimation of a standard censored Tobit model which, subject to the assumption of constant variance of the error term, is well suited to the problem at hand (Amemiya, 1984).[2]

Information was obtained through consumer tests of refined maize flours (made from dehulled grain) and whole-grain maize flours (made from whole grain). The respondents (household heads and food preparers) belonged to a sub-sample of 115 Bamako households drawn from a current year-long (1993) study of cereal consumption (using a sample of 640 households) (Témé and Boughton, 1992). Using the sample flour, respondents prepared and tasted the principal coarse grain-based dishes ('bouillie', a thin porridge usually consumed at breakfast, and 'toh', a thick porridge for the evening meal). They also observed the 'keeping quality' of the dish. Respondents were then asked at how many meals during a week they would use the maize flour product. Responses were recorded first for the superior dehulled flour at flour prices (starting with the highest price) and then for the whole-grain flour over the same price range. The highest price corresponded to the current market price of import-quality rice, the lowest to the current market price of unprocessed maize.

REGRESSION RESULTS

Table 1 presents the Tobit regression results based on the contingent-valuation survey data.[3] In general, we find that the gender-related determinants of demand for flour are important, especially in interaction with other household characteristics (such as regional origin and income), and lower transaction costs of cereal acquisition (proxied by being in the military) increase demand for flour. Statistically significant results are discussed below.

As expected, an (hypothetical) increase in the maize flour price decreases the quantity demanded. Although the effect of income is not statistically significant, the effect of 'income squared' is, and is negative, as expected. The income effect is also expressed in interaction terms. The coefficient on 'income-by-flour-quality' is positive, indicating that there is a positive demand response to income for dehulled (superior-quality) flour.

The effect on maize flour demand of the household being headed by a woman is positive (note that only 25 per cent of the sample households are headed by women), and the effect of household size is negative, as expected. But the coefficient on the sole effect of the respondent being a woman is negative (recall that women respondents were surveyed in all households, not

TABLE 1   *Maize flour demand, Tobit regression results*

	Coefficient	T-ratio	Prb|t|≥x
Constant	21.262	11.086	0
Price	-0.15111	-13.993	0
Gender	-6.8085	-3.993	0.00007
Flour quality	0.01277	0.011	0.99151
Gender–price	0.050095	3.942	0.00008
Gender–quality	1.6117	1.093	0.2746
Income–quality	0.2174	2.727	0.00639
Gender–income	0.28819	3.782	0.00016
Gender–income–quality	-0.213	-2.285	0.02231
Income per adult equivalent	-0.029061	-0.342	0.73272
Income per adult equivalent squared	-0.0035288	-3.005	0.00265
Household size	-0.20876	-2.272	0.02311
Household size squared	0.0029427	1.394	0.16332
Woman ratio	-8.7645	-4.503	0.00001
Child ratio	-0.7609	-0.528	0.59769
Women w/primary job	1.4419	3.857	0.00011
Women w/secondary job	-1.4445	-3.865	0.00011
Maize consumption	-0.097399	-5.796	0
Region of origin	-0.0021541	-1.723	0.08487
Gender–region	1.8279	2.541	0.01106
Gender–region–quality	0.28495	0.292	0.77022
Civil servant	-0.67493	-1.209	0.22684
Military	5.6055	1.113	0.26558
Military–quality	-2.0103	-0.963	0.33576
Military–income	1.218	2.125	0.03356
Military–income squared	-0.053206	-3.095	0.00197
Military–gender	-23.313	-6.147	0
Military–gender–income	0.60132	2.431	0.01507
Military–gender–quality	6.7565	1.798	0.07211
Military–gender–income–quality	-0.1158	-0.495	0.6207
Military–price	0.039659	2.355	0.01853
Household head = woman	2.0717	1.755	0.07927
Maid	0.00047612	0.188	0.85119
Toh quality	0.0038731	2.749	0.00598
Bouillie quality	0.00066136	-0.696	0.48653

just women-headed households), controlling for other important interaction effects of respondent gender–employment and gender–income. These interaction effects are interesting. The respondent gender–income interaction has a positive effect, which makes sense in that one expects women's opportunity cost of time to influence choice of convenience foods. Yet the interaction term gender–income–flour quality is negative. The two effects together im-

ply that women have a higher maize flour demand response to income than do men for (less costly) whole-grain flour, but this response is not significantly affected by flour quality. The gender–price interaction term has a positive effect on flour demand, indicating that women's demand is less price-responsive than is that of men. Finally, the effect of the household being from a maize-growing area is negative, though numerically very small; yet women from those areas have stronger demand for maize flour than do men.

The proportion of women in the household has a strongly negative effect on maize flour demand, as expected (as household labour supply for grain processing and cooking is higher). The proportion of women with primary cash-earning activities has a strong positive effect on demand for maize flour, but the proportion of women with secondary cash-earning activities has a negative effect. A possible explanation for these apparently conflicting results is that coarse-grain processing tasks do not compete for time with secondary activities (such as petty commerce operated from the home) but do in the case of primary activities (such as marketing activities away from home).

The characteristics of household maize flour demand where the household head is in the military give rise to a substantially different demand pattern. They are interesting because the army's cereal credit provision provides a 'living experiment' of the effect of decreasing transaction costs for cereal acquisition, and the demands of the military profession put a premium on access to convenience foods. The interaction terms military–income, military–gender–income and military–gender–flour quality are all positive. The military–price interaction term's effect is positive. These results imply that flour demand by military households is more income-responsive and less price-responsive than that by civilians. Possible explanations for this are that the army provides interest-free credit for the purchase of cereals, and male household heads are often absent for long periods on military duties. In contrast to military households, the coefficient for households where the head is employed in the civil service is not significantly different from zero.

Moreover, the effect is positive, but small, for the perceived quality of 'toh' prepared from the flour. The coefficient on the quality of porridge prepared from flour is not significant, which suggests that most of the total variation in flour quality relevant to consumer demand has been captured by the flour quality and flour quality interaction terms. It does not imply that flour quality is unimportant.

PREDICTED DEMAND FOR MAIZE FLOURS AND FOOD POLICY IMPLICATIONS

Predicted demand is first calculated for six sub-groups, then aggregated on the basis of the weight of each sub-group in the population of Bamako. The sub-groups are military and civilian, each comprising three income terciles.[4] For each of the six sub-groups, the quantity demanded is based on the responses of male respondents (that is, all gender interaction terms are restricted to zero) at the sub-group mean value of each independent variable. Evaluation

of expected demand for male respondents reflects the prevailing household characteristic that its head is responsible for cereal purchases.

The contingent valuation data were collected prior to the 50 per cent devaluation of the CFA franc in January 1994. To estimate post-devaluation demand, we assume a 40 per cent decline in real income for civilian sub-groups, based on average price increases in the first quarter following devaluation, and a 33 per cent decline for the military (civil servants received a 10 per cent pay increase to compensate for the rise in cost of living). Average maize consumption by the sub-sample households over the one-year survey (excluding flour provided for the tests) was approximately 8kg. per adult equivalent, compared to 22kg. for millet, 55kg. for sorghum and 107kg. for rice. Aggregated for the population of Bamako, maize consumption amounts to approximately 4800 tons per year, or 400 tons per month. Before devaluation, assuming prices of 150 CFA F/kg. for dehulled and 115 CFA F/kg. for whole-grain flour, projected demand would be approximately 380 tons per month for dehulled and 815 tons per month for whole-grain flour. After devaluation, assuming a price of 175 CFA F/kg. for dehulled and 130 CFA F/kg. for whole-grain flour, projected demand falls sharply, to 70 tons per month for dehulled and 490 tons per month for whole-grain flour. Even for the cheaper whole-grain flour, this is only slightly higher than current levels of maize grain consumption. This result is consistent with Dibley *et al.* (1995), which shows that the cost of preparing coarse grain-based dishes with pre-processed flour in Bamako would actually be 13 per cent higher than home-processed grain at prevailing opportunity costs of women's time.

Before devaluation, own-price elasticities of demand at estimated retail flour prices, for civilian households and averaged across income terciles, are −7.4 for dehulled maize flour, and −4.8 for whole grain flour. Such high elasticities reflect the small quantities households would purchase at estimated retail prices. After devaluation, own-price elasticities increase to −11.5 and −6.14 for dehulled and whole grain flour, respectively, reflecting the still smaller quantities purchased at higher retail prices.

In sharp contrast to price elasticities, income elasticities of demand for maize flour are low. Prior to devaluation, income elasticities of demand were 0.8 for dehulled maize flour and −0.1 for whole-grain flour (and thus an inferior good for predominantly male household heads). Although we cannot calculate cross-price elasticities (to evaluate whether processed maize products can improve substitutability with rice), analysis of the meals at which maize flour would be used provides a preliminary indication. As the price of maize flour decreases, increased consumption occurs primarily at meals where coarse grains are already predominant (namely breakfast and dinner) and there is little increase in consumption of maize flour at lunch, where rice is more important.

CONCLUSIONS

The results point to the importance of the convenience characteristics of maize flour, especially to working women. The demand for this convenient flour rises as a function both of ability to afford it and of the opportunity cost of time

(both of which rise with household income). Yet, as many urban households are poor, the overall effect on aggregate demand for the grain of the availability of new maize flour products is still relatively modest. This is consistent with budget analysis of the costs of preparing coarse grain-based dishes that show purchased flour to be uncompetitive with household processing owing to low average opportunity costs of women's time in Bamako.

NOTES

[1]The military and the civil service often provide interest-free credit for the purchase of cereals (sacks of cereal in the form of grain), either directly to the employee or through employee cooperatives.

[2]One possible concern with use of the Tobit is violation of the assumption of constant variance (heteroskedasticity), which would theoretically result in biased parameter estimates. A reason for suspecting that the violation might occur is that, when respondents are asked about behaviour in hypothetical situations, the further the situation is removed from their experience the harder it is for them to predict their own behaviour, leading to higher variance in the error term. The problem goes beyond one of biased parameter estimates, however. Heteroskedasticity in the latent model would imply different formulae for the calculation of partial effects and expected demands. These formulae would depend on the specific functional form of the heteroskedasticity. The cost of identifying its specific form, and deriving the partial effects and expected demands for the heteroskedasticity-robust case, would be high. Yet, since both the estimated coefficients and the formulae for deriving partial effects and expected demands change, the results obtained may not differ greatly from those generated by a model that ignored the violation. The question of the magnitude of error in predictions of the actual rather than latent dependent variable is one that requires further research.

[3]Given the non-linear estimation procedure, estimated coefficients cannot be interpreted directly as partial effects.

[4]We divide the sample into military and civilian to correct for the overrepresentation of military personnel in the sub-sample compared to the population.

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