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The Measurement of Poverty with Geographical and Intertemporal Price Dispersion

by

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Abstract

Little attention has been devoted to the effects of price dispersion at local and seasonal levels on the measurement of living standards in LDCs. In particular, it is not known if a substantial share of welfare or poverty is the consequence of price differences rather than of differences in living standards across households and seasons.

Using data from Rwanda, we show that the change in mean living standard due to price deflation is moderate although significant in every quarter. By contrast, the change in poverty can be considerable, for chronic as well as transient or seasonal poverty indicators.

The deflation generally yields a larger transient seasonal share of annual poverty. The choice of the poverty line or the season considered are more influential than the choice of the kernel function of axiomatically sound poverty indices. Moreover, the composition of the population of the poor can be substantially modified by the deflation.

Finally, the deflation using regional price indices instead of local prices is shown to only partially correct for the geographical price dispersion, when measuring seasonal poverty.

Résumé

Peu d'attention a été accordé aux effets de la dispersion des prix aux niveaux locaux et saisonniers, pour le mesurement des niveaux de vie dans les PVD. En particulier, on ne sait pas si une part substantielle du bien-être social ou de la pauvreté est la conséquence de différences de prix plutôt que de différences de niveaux de vie entre ménages ou saisons.

A partir de données du Rwanda, nous montrons que le changement du niveau de vie moyen du à la déflation des prix est modéré bien que significatif à chaque trimestre, contrairement au changement de la pauvreté qui peut être considérable, que ce soit pour des indices de pauvreté chronique, transitoire ou saisonnière.

La deflation produit en général en une plus grande part transitoire saisonnière de la pauvreté annuelle. Le choix de la ligne de pauvreté ou la saison considérée ont plus d'influence que le choix de la fonction noyau d'indices de pauvreté axiomatiquement corrects. En outre, la composition de la population de pauvres peut-être notablement modifié par la déflation.

Finalement, nous montrons que la déflation basée sur des indices de prix régionaux, au lieu d'indices de prix locaux corrige seulement partiellement la dispersion géographique des prix, pour la mesure de la pauvreté saisonnière.

1. <u>Introduction</u>

The design of policies against poverty (The World Bank (1990)) calls for a precise measurement of household living standards. Atkinson (1987), Lipton and Ravallion (1993) and Ravallion (1994) discuss the literature of applied poverty measures, in which the importance of a careful measurement is a permanent concern. This careful measurement is all the more difficult in LDCs because, owing to the high seasonal variability of agricultural output in poor agrarian economies and to the presence of liquidity constraints, prices and living standards of peasants fluctuate considerably across seasons. In addition, Chaudhuri and Ravallion (1994) show that no static indicator can precisely approximate averaged dynamic poverty, which justifies calculating both chronic and transient poverty indices. In an earlier paper (Muller (1997)), we have shown that the transient component of annual poverty, coming from seasonal fluctuations of consumption, is substantial in Rwanda and cannot be neglected.

Another difficulty arises from the fact that, because of high transport and transaction costs as well as deficient information in underdeveloped economies, prices may vary considerably across regions, but also across neighbouring areas.

The treatment of geographical and temporal price dispersions is crucial. Indeed, if the correction for differences in prices that distinct households face at separate periods is inaccurate, then apparent welfare fluctuations, or welfare differences between households, might result only from unaccounted large price differences. In that situation, household living standards could be more stable or heterogeneous, or the opposite than they appear to be.

On the one hand, price indices have been the object of extensive economic analyses, often derived from consumer theory (Fisher and Shell (1972); Pollak (1978); Diewert (1981); Foss, Manser and Young (1982); Baye (1985); Diewert (1990), Selvanathan and Rao (1995)), and have been used in applied welfare analysis, particularly for inequality studies (Muellbauer (1974); Glewwe (1990)). Theoretically, some price indices can be considered as ratios of cost functions representing the preferences of agents. In practice, applied price indices are most of the time Laspeyres or Paasche price indices.

On the other hand, to the best of our knowledge, no poverty analysis with price deflation involving *local and seasonal* prices, and no statistical analysis of the impact of such deflation is presented in the literature. In cross-section poverty measurement, many authors use aggregate Laspeyres and Paasche indices based on regional prices ((Grootaert and Kanbur (1994), Jalan and Ravallion (1996), Grootaert and Kanbur (1996), Appleton (1998), Dercon and Krishnan (1998)). In some instances (Grootaert and Kanbur (1994)), it has been noticed that using different formulations of such indices can yield different poverty levels, even if no statistical tests of these differences have been implemented. In other cases (Slesnick (1993)), the use of different price indices (including true price indices) does not produce very different sets of poverty rates.

Finally, we suspect that in several poverty studies, notably in some analyses of the World Bank's Living Standard Measurement Surveys, deflation using local prices might have been implemented without attention being specifically drawn to this when writing up the studies[1]. In any case, the impact on poverty of this correction has not been statistically analysed, and this is our intention in this paper.

Inflation, and relative and geographical price dispersions are positively related, though only partially (Glezakos and Nugent (1986), Danziger (1987), Domberger (1987), Tang and Wang (1993)). Moreover, some categories of goods are characterised by much larger price fluctuations than others, with these fluctuations having a substantial local component (Riley (1961)). This is particularly true in agricultural context. All this implies deflating with local price indices that incorporate the local movements of prices of specific goods rather than with national or regional inflation indicators. It also implies accounting for the seasonal dispersion of prices as well as annual variations.

In particular, scant attention has been paid to the role of price dispersion in the measurement of *fluctuations* of poverty. The treatment of price variability in the literature dealing with living standards fluctuations sometimes refers to a standard national inflation index (Rodgers and Rodgers (1992), Slesnick (1993)) or else is not specified (Bane and Elwood (1986), Stevens (1995), Jalan and Ravallion (1996)).

Price fluctuations may have serious implications in terms of welfare analysis (Jazairy, Alamgir and Panuccio (1992)). For example, Baris and Couty (1981) suggest that, in Africa, seasonal variations of prices may worsen social differentiation. Slesnick (1993) discusses the distributional impact of relative price changes, although he uses an inflation index only to adjust poverty lines over time and not across households (prices are assumed to be the same for all households).

Unfortunately, even if the question studied in this paper is of considerable concern for welfare economics in general, it is not possible to infer results directly applicable to all contexts. This being accepted, the only direction of progress is to investigate a data set using rigorous and robust analytical methods. While by definition any empirical results are specific to the data used, as for the quasi-totality of applied microeconomic studies, there are some reasons to believe that the results may be valid in other contexts, and at least that systematic investigation of local price effects for poverty measurement is worthwhile in other contexts.

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1 In some internal documents of The World Bank that cannot be cited due to administrative rules, log-price equations have been estimated showing whether local prices can be considered as different from regional prices. Although this approach provides hints about the likelihood of local price effects in poverty analyses, it is different from testing that price effects are significant for poverty measurement that is the topics of this paper.

Firstly, if we are to study poverty, it is necessary to take particular notice of countries where poverty is both prevalent and severe. This is particularly the case in South of Sahara Africa, India and other disadvantaged regions of the world[2]. To this extent, the case of Rwanda in the 1980's is at the core of the poverty in the world. Poverty in this country had dramatic political consequences demonstrated by the outbreak of civil war in this country in the 1990's, much caused by the general misery of peasants (Braeckman (1994), Erny (1994)). Note that our results correspond to a population of nearly six millions of people at the time of the survey, which is based on a representative sampling scheme.

Secondly, the case of Rwanda is interesting in that it is a geographically small country with relatively limited climatic seasonal fluctuations, which explains why both geographical and seasonal price dispersions are smaller than in most agricultural LDCs[3]. One expects that found effects of price dispersion on poverty might be amplified when considering larger agricultural developing countries.

Is the impact of geographical and temporal price deflations statistically significant for measuring aggregate living standards, as well as measuring the composition of the population of the poor and aggregate poverty indicators? Can we find systematic effects in poverty indicators, induced by accurate price deflation? Is the correction with regional price indices sufficient to account for significant price differences? The aim of this article is to answer these questions by studying the effects of the price deflation on seasonal, transient and chronic poverty indicators using data from Rwanda. We define poverty indices and price indices, and present poverty estimators in section 2. We describe the data used in the estimation in section 3. In section 4, we discuss estimation and test results. We conduct in section 5 a comparison of poverty indices deflated respectively using local and regional price indices. Finally, we conclude in section 6.

2. Definition and Estimators of Poverty Indices and Price Indices

2.1. Price indices

The common practice in applied welfare analysis is to deflate living standard indicators by using Laspeyres and Paasche price indices. Because we want to assess the impact of accurate price correction in studies actually carried out in most statistical institutes, ministries or public offices and by most welfare economists, these indices will constitute our comparison basis. No attempt is made to deal with substitution effects or economies of scale effects in consumption since it is not a standard practice in most institutions producing official poverty indices in LDCs[4].

2 Although interesting in itself, poverty in industrial countries is not the main place to search.

3 Sahel countries or India are well known example of large regions with considerable climatic fluctuations allied to high transportation costs.

4 Although these questions are of legitimate interest, it might be that their impact on actual measurement of poverty is often secondary from the perspective of many statistical institutes, compared to basic calculus difficulties for the calculus of welfare indicators. True price indices could be derived from the estimation of a complete demand system (as in Braithwait (1980) and Slesnick (1993)). Braithwait found a 1.5 percent bias of the overall Laspeyres price index over the period 1958-1973 in the U.S. Such a magnitude seems considerably smaller than the other sources of error in our problem. However, the situation may be quite different in Central Africa. In any case, we avoid in this paper disturbing the analysis of the question under study by mixing it with considerations of robustness in the estimation of equivalence scales (van Praag and Warnaar (1997)) or of true price indices (Deaton and Muellbaure (1980)).

The sampling scheme has been modelled in Roy (1984) and completed by our own investigations during our stay at the Direction Générale de la Statistique du Rwanda. It has four sampling levels: communes, sectors, districts and household. The drawing of the communes was stratified by prefectures, agro-climatic regions and altitude zones. One district was drawn in each commune and one cluster of three neighbouring households was drawn in each district. From this information, we have calculated sampling weights that reflect the probabilities of drawings of units at every stage of the sample scheme.

We use a Laspeyres price index (I_{it}) specific to each household and each quarter, in which the comparison basis is the annual national average consumption.

$$I_{it} = \sum_j w^j \frac{p^j_{gt}}{p^j_{..}} \quad (1)$$

$$where\; w^j = \frac{\sum_i \sum_t POND_{it}\, p^j_{it}\, q^j_{it}}{\sum_j \sum_i \sum_t POND_{it}\, p^j_{it}\, q^j_{it}}$$

is the weight of good j in the price index; $POND_{it}$ is the sampling weight of household i belonging to cluster g at date t, corrected for missing values; p_{gt}^j (resp. p_{it}^j) is the price of good j in cluster g in which household i is observed (respectively for household i); and q_{it}^j is the consumed quantity of good j by household i at date t (in cluster g).

The annual national price of good j, $p^j_{..}$, is calculated as follows.

$$p^j_{..} = \frac{\sum_i \sum_t q^j_{it}\, p^j_{it}\, POND_{it}}{\sum_i \sum_t q^j_{it}\, POND_{it}} \quad (2)$$

This means that we simultaneously consider the seasonal and geographical dispersions of prices. Another approach would be to focus on the geographical dispersion by choosing the price basis as a national average of the prices for each considered season. We could have also focused on the aggregate seasonal dispersion of prices by choosing the price basis as a yearly local average. While interesting, these too approaches would only pick up part of the error made when not correcting for price differences.

The living standard indicator for household i at period t is

$$y_{it} = \frac{c_{it}}{S\; I_{it}} \quad (3)$$

where c_{it} is the value of consumption of household i at period t ; S is the household size and I_{it} is the price index associated with household i and period t . We denote $x_{it} = c_{it}/S$, the non-deflated living standard indicator (nominal living standard).

We have checked that using other equivalence scales does not substantially change the results of this paper. Other elements could have been included in economic welfare, such as leisure time (Riddell (1990)), but would have created intractable valorisation difficulties.

2.2. Poverty indices

Most of the poverty indices used in applications can be written in the following form[5].

$$P = \int_0^z f(y,z)\, d\mu(y) \quad (4)$$

where μ is the probability distribution of living standards y, and z is the poverty line. This formula can be used with quarterly living standards y_t in quarter t and a quarterly poverty line to yield the quarterly poverty index P_t . We consider the most popular of these poverty indices.

We first define the Foster-Greer-Thorbecke (FGT) poverty indices with a = 0, 1, 2, 3, the poverty aversion parameter of the public planner. Foster, Greer and Thorbecke (1984) discuss the detailed properties of this family of indices. They are additively decomposable, and satisfy the monotonocity axiom (for a > 0), the transfer axiom (for a > 1), the transfer sensitivity axiom (for

$$FGT\ (a) = \int_0^z (1 - y/z\ )^a\, d\mu(y) \quad (5)$$

a > 2), and the subgroup monotonocity axiom..

The Watts' poverty index (Watts (1968)) is defined in eq. (6). The Watts index satisfies the monotonicity, subgroup consistency, transfer and transfer sensitivity axioms.

$$W = \int_0^z -\ln(y / z)\, d\mu(y) \quad (6)$$

and the Ch poverty indices (Chakravarty (1983)), variants of poverty indices proposed by Clark, Hemming and Ulph (1981), are

5 This does not include the important Sen's index (Sen (1978)), although this index has played a more important role in the axiomatic of poverty theory than in recent applied analysis of poverty.

$$Ch(c) = \int_0^z 1 - (y/z)^c \, d\mu(y) \quad (7)$$

where c is a positive parameter. The Ch indices satisfy the monotonicity and subgroup consistency axioms. They satisfy transfer and transfer sensitivity axioms for $c < 1$.

We now present notions of seasonal poverty, chronic poverty, transient poverty. A complete theory of both interpersonal and intertemporal aggregation of poverty indices would be needed for an axiomatic construction of these notions. Such a theory is presently not available. However, we shall mention a few of the difficulties that it involves. For the empirical analysis we use simple definitions that provide practical analytical tools.

y_{it} is the living standard of household i at season t. It is denoted seasonal living standard, or living standard in season t. $\overline{y_i}$ is the average living standard of household i over the studied period. We call it chronic living standard, although it is not here the permanent income corresponding to the entire lifetime of the household. Moreover, because of the very short length of our observation period we neglect discount factors between quarters.

Even if the definitions for poverty indices share similar names, they are of different origin since they come directly from past poverty studies (Ravallion (1988), Rodgers and Rodgers (1993), Jalan and Ravallion (1996)). P_t is the poverty index calculated in quarter t using the observations y_{it} for all households. We call it seasonal poverty at season t.

We call *annual poverty* the arithmetic average of seasonal poverty indices, which is a central tendency of its observations: P_1 ,..., P_T: $AP = \frac{1}{T}\sum_t P_t$. It is the expected poverty when all periods have the same probability.

The *chronic poverty*, denoted CP, is defined as the poverty index formula applied to the *chronic living standard* which is the total annual living standard divided by the number of periods.

The *transient poverty* over the year is defined as the residual of the annual poverty once the chronic poverty has been accounted for: TP = AP – CP.

TP is the poverty increase that can be attributed to the variability of living standards during the year. To stress the fact that this component of the annual poverty comes from the seasonal fluctuations of living standards, we call it *transient-seasonal poverty*.

We examine now several difficulties occurring in the study of intertemporal poverty. First, in the presence of borrowing constraints, the expected income, especially when it is conditional on resources and information of the household at the beginning of the period (Paxson (1992)), is not necessarily equal to the arithmetic average of consumption over the set of considered periods. However, CP is still the indicator calculated in the literature using total annual consumption without considering variations of consumption across seasons.

Second, a poverty measure that is both intertemporally and interpersonally additive is a simplified specification that involves two elements: firstly, considerations coming from the aggregation of households in the social evaluation functions, which are related to poverty aversion of the public planner and to risk-aversion of households; and secondly considerations coming from the aggregation of periods for specific households, which are associated with intertemporal substitution parameters. Attempts to model simultaneously risk aversion and intertemporal substitution exist in the consumer literature (Epstein and Zin (1989)), although the choice of the relevant specification for poverty analysis is still an open question.

Measurement of the variability of poverty indicators is implicitly based on the identifying assumption that the main fluctuations in consumption are not deliberately chosen in the short term by poor households, but imposed upon them by, for instance, past production choices, subsistence and liquidity constraints. This approach is supported by empirical several elements (Muller (1997)). A possible endogeneity of consumption fluctuations would not change the estimates of poverty indices but only their interpretation.

The proportion of annual poverty caused by seasonal fluctuations is the ratio:

$$F = \frac{(AP - CP)}{AP} \quad (8)$$

2.3. Estimators

We estimate the poverty indices at period t, with ratios of Horwitz-Thompson estimators (Kish (1967), Gouriéroux (1981)):

$$\hat{P}_t = \frac{\sum_{s=1}^{n} \frac{f(y_{st}, z) 1_{[y_{st} < z]}}{\pi_{st}}}{\sum_{s=1}^{n} \frac{1}{\pi_{st}}} \quad where\ \pi_{st} = \frac{m_h\, r_{hij}\, q_{hijk}}{M_h\, N_{hi}\, R_{hij}\, Q_{hijk}} \quad (9)$$

π_{st} is the inclusion probability (in the sample) of household s at date t (s = 1,...,n); f is the kernel function associated with the poverty index; M_h is the number of communes in strata h; m_h is the number of communes drawn in strata h; N_{hi} is the number of sectors in commune i of strata h, R_{hij} is the number of districts in sector j of commune i of strata h, r_{hij} is the number of drawn districts in sector j of commune i of strata h, Q_{hijk} is the number of households in district k of sector j of commune i of strata h, and q_{hijk} is the number of households drawn in district k of sector j of commune i of strata h.

The complexity of the actual sampling scheme does not enable a robust use of classical sampling variance formula[6]. We use an estimator for sampling standard errors (see appendix 1), inspired from the method of balanced repeated replications (Krewski and Rao (1981), Roy (1984)).

Calculating sampling errors for both poverty indices and differences in poverty indices is particularly important in this context. Indeed, the deviations in poverty measures with and without accounting for prices can only be analysed in terms of statistical significance. Even with the small sample size, significant differences can occur. This has been made possible thanks to the substantial stratification involved in the sampling scheme, which enhances considerably the accuracy of estimators. To this extent the small sample size should not leave much concern. A fortiori, bigger samples would provide more significant differences.

[6] Kakwani (1993) provides an estimator for sampling standard errors of poverty indices, but it is only valid for a simple random sample frame, which is not the case in most national surveys.

Finally, we do not consider sampling error or measurement error in the consumer price index itself (Wilkerson (1966)). They are several reasons to this limitation. Firstly, we do not have precise information about these two errors. The process leading to price indicators is extremely complex with combination of “expert choices” at the level of the enumerators and of the analyst, and empirical statistical decisions based on several levels of temporal and geographical aggregation. A very complex and non tractable sampling scheme specific to prices would be necessary to model it. Secondly, our intention in this paper is to focus on simple comparisons of poverty indicators, assuming explicitly that the source of the differences is the price correction and that the main error stems from the sampling process for the consumption observations and not from measurement errors or price inaccuracy.

3. The Data

3.1. Context and survey

Rwanda in 1983 is a small rural country in Central Africa. Its population estimated at 5.7 million, nearly half under 15 years of age and increasing at 3.7 percent annually is a major constraint on development and eradication of poverty. Rwanda is one of the poorest countries in the world, with per capita GNP of US $ 270 per annum. More than 95% of the population live in rural areas (Bureau National du Recensement (1984)). Agriculture is the cornerstone of the economy, accounting for 38% of GNP and most of the employment. One could argue that because Rwanda is very rural, empirical results in the impact of seasonal price variations may be close to the upper bound of results obtainable in other LDCs. However, one could also pretend that because it is a geographically small country, these results may also be very close to the lower bound. The case of Rwanda will provide a comparison basis for other potential studies.

Data for the estimation is taken from the Rwandan national budget-consumption survey, conducted by the government of Rwanda and the French Cooperation and Development Ministry, in the rural part of the country from November 1982 to December 1983 (Ministère du Plan (1986a))[7]. 270 households were surveyed about their budget and their consumption. The consumption indicators are of a very high quality. Indeed, every household was visited at least once a day during two weeks for every quarter. The consumption has been systematically recorded with daily and retrospective interviews, and all food was weighted. Every household also had to register a lot of information in a diary between the quarterly survey rounds. The overlapping of different methods of collection enabled a thorough cleaning of the data by more than thirty ex-enumerators after the collection under our supervision. Also, sophisticated verification algorithms have been designed. The consumption indicators which are used are based on algorithms which reduce measurement errors by comparison of several information sources. The measurement errors of the consumption levels should therefore be smaller than usual. This is a major requirement if we want to study price effects in welfare measurement, since these effects may be of moderate size and may be lost among data contamination when the consumption indicators are inaccurate.

[7] The main part of the collection was designed with the help of INSEE (French national statistical institute). The author was itself involved in this project and supervised the end of the analysis as a technical advisor from the French Ministry of Cooperation and Development.

Bigger and more recent surveys exist in Africa and LDCs. However, firstly, as we said above, the size of the survey does not matter as soon as we can get significant results. Secondly, because we do not intend to use the results of this paper for direct and short term policy recommendations, the date of the survey is also indifferent.

The collection of the consumption data was organised in four rounds that can be assimilated to quarters. Their dates are the following:
Round A: 01/11/1982 until 16/01/1983.
Round B: 29/01/1983 until 01/05/1983.
Round C: 08/05/1983 until 07/08/1983.
Round D: 14/08/1983 until 13/11/1983.

Agricultural year 1982-83 was a fairly normal year in terms of climatic fluctuations (Bulletin Climatique du Rwanda (1982, 1983, 1984)). It was also relatively preserved from extreme economic or political shocks. The agricultural year can be divided into four climatic seasons and two growing seasons. The long rainy season goes from February to May, and accounts for 41 to 61 percent of annual precipitation. The long dry season extends from June to September. The short rainy season occurs in October and November, and the short dry season from December to January. In fact, the two latter seasons constitute an intermediary season not very delimited. Moreover, the climate may be quite different in different years, with slight shifts of seasons.

Let us consider the main products in the daily nutrition basket. The first growing season extends from October (seeding) to January (harvest), and is dominated by the cultivation of pulses, mostly beans. Corn cultivation is also concentrated in this season. The second growing season is from March (seeding) to July (harvest). Cereals, mostly sorghum, are often cultivated in this season. The collection of cassava and banana is more spread across the year than for other products, while the date of harvest for sweet potatoes depends a lot on the location. The harvest periods for all products are mostly in end December until April, then from June to July. The fourth round of our survey is a period with limited harvest.

However, this aggregated picture cannot accurately account for the extreme variety of cultural contexts in Rwandan. An examination of each specific crop shows first that high altitude and low altitude areas may have very different agricultural rhythms, sometimes organised about different products. Beans are harvested at the end of December or the beginning of January; in April and in July. Sweet potatoes are harvested at the end of February and the beginning of March, in May, September and end of November. The harvest period for sweet potatoes can also vary with altitude. Finally, because of its mountainous character, Rwanda is divided in a large number of microclimates and every family has its own crop decisions in each season, according to the type of land and inputs owned.

The average household has 5.22 members. The mean land area farmed by each household is very small (1.24 ha). Table 1 shows that, for the sample used in estimations, it corresponds in real terms to an average production of 57 158 Frw (Rwandan Francs[8]) of agricultural output, which is close to the value of average consumption (51 176 Frw or 10613 Frw per capita). Muller (1989) provides a detailed description of the consumption of Rwandan peasants. Eight main categories of goods are defined for their representativity in the mean household budget in rural Rwanda. Their share in the aggregate value of consumption is given in table 1.

We discuss now the process of constitution of the price data base, used for the calculus

[8] In 1983, the average exchange rate was 100.17 Frw for 1 $ (source: IMF, International Finance Statistics).

of price indices.

The first stage in the calculus of price indices is the creation of a price data base. This data base contains three types of prices. Firstly, the “consumption prices” are mean prices for each product, calculated using the records of consumption purchases from the household survey. The means are weighted using the sampling scheme and by the consumption levels of surveyed households for the considered good. We use the means at the cluster and quarterly levels as our basic price indicators. A cluster is composed of 11 surveyed households that are neighbours living in the same district (small geographical unit included in a sector of a commune). However, only means based on a sufficiently large sample of observations have been kept in the price file. Secondly, the “production prices” are mean prices for each product, calculated using the records of production sales from the household survey. Here, the means are weighted using the sampling scheme and by the production level of surveyed households for the considered good. Again, a minimal sample size of observations is imposed before to include the prices in the data set. Thirdly, with adapted conditions of significance of the sample of prices,”market prices” are simple means calculated using the price survey in the markets or transaction sites close to the location of households. The selection of admissible mean prices does not only rely only on statistical criteria such that the size of the price sample, but also on the expertise of enumerators and analysts of the survey. Appendix 2 discusses the properties of these price samples.

We obtain optimal price indicators by comparing market prices, consumption prices and production prices at different geographical and temporal aggregation levels for every good. At each stage of the algorithm of calculus of the price indicators (Muller (1998a)), we account for the number of observations for each type of price (controlling for the representability of means of recorded prices) and for their plausibility (controlling for measurement errors).

Because of market imperfections and high own-consumption rates, production and consumption decisions of most agricultural households may be non separable. For this reason, shadow prices (deduced from the separating budget constraint of an agricultural household model (Pollak (1978), Singh, Squire and Strauss (1986), Benjamin (1992)), would be better adapted to the calculus of price indices for this type of household[9]. However, these shadow prices are unobserved. Because of the high own-consumption ratios observed in the sample, these shadow prices are expected to be intermediate between observed consumption prices and observed production prices (de Janvry, Fafchamps, Sadoulet (1991)). However, at the local geographical and temporal level, consumption prices correspond better to the timing of the observed consumption of households, and market prices have been specifically collected to value the observed food for consumption. The average market price minus the average consumption price is : 2.3 percent for sorghum; 1.1 percent for potatoes; 2.1 percent for beans. Because of their temporal proximity with actual consumption, market price means and consumption price means, at the cluster level, are considered as a reasonable approximation of shadow prices, and we use them where possible in the calculus of price indices.

The second stage of the calculus of price indices is the estimation of the structure of the aggregate consumption for the rural Rwanda by categories of goods. Muller (1989) presents these results and shows that in practice only a very small number of goods are regularly consumed by

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[9] The effect of observed prices may imply conflicting effects on the consumer-side and the producer-side of the household’s behaviour (see, for example, Besley and Kanbur (1988)), which cannot be properly analysed using a mere consumer model with observed prices. However, such considerations are relevant for the analysis of global household behaviour, but not necessarily for the measurement of living standards. In the latter case, all that we need are the shadow prices.

households. This structure is rearranged in categories of products that are believed to represent a balanced image of the average consumption of Rwandan peasants (Muller (1992)).

The prices of every category are represented by the price of the main product in the category, which allows the comparability of prices across seasons and clusters with little quality bias.

The third stage of the calculus of price indices consists of replacing the missing values of the mean prices of these representative products. Fire wood has been eliminated from the consumption (2.9 percent of the aggregate consumption), because corresponding price means are missing in too many clusters. For the other categories the mean price is sometimes missing because of too rare consumption of the product. This is attributed to a penury of the product, the consumption demand fluctuating less than the production supply for seasonal agricultural products. In that case, the price of the product should be higher than usual and we used the maximum price mean observed in the same region as an approximation.

Price means at the national level vary with the quarter. The means and standard deviations of seasonal prices for the main goods used in the price index are shown in table 2 for each of the four seasons, together with the price index. The local price variability is larger than the seasonal price variability. Indeed, for specific product prices as well as for the price index, the geographical coefficients of variation are much larger than the temporal coefficients of variation of quarterly price means, showing that the aggregate seasonal variability of prices cannot summarise properly the differences in prices.

There are two groups of products: the ones with high local and seasonal price dispersions, and the ones with local dispersion only. As show the coefficients of variation of quarterly price means across the four seasons, the average prices of soap and palm oil, are characterised by relatively moderate quarterly fluctuations. The seasonal fluctuations of price means are larger for other goods, with the more variable national prices being those of beans and sweet potatoes. Many products show seasonal variations: sweet potatoes (low price in period C, 7.90 Frw, and high price in period A, 10.11 Frw); sweet cassava (14.4 Frw in C, 17.0 Frw in A); banana beer (36.9 Frw in D, 43.0 in C); plantain banana (12.21 Frw in B, 14.78 Frw in C), and beans (24.80 in B, 38.70 Frw in A). The general level of prices, shown by the average of the price index across households, is relatively high in quarters A (1.109) and D (1.085), and low in quarter B (0.953). The months before the major December-January harvests are those were the highest mean prices are reported (except for banana, banana beer and soap).

However, as revealed by the standard deviations at each quarter, the national price means hide considerable geographical differences. The quarterly coefficient of variation of local prices for different clusters varies from 0.12 through 0.45 following the product or the quarter. The geographical variability of prices is substantial for specific products at some seasons (beans in C; plantain in B, C, D; sweet potatoes at all quarters), sometimes more limited (coefficient of variation below 0.15 for palm oil in quarters A, B, C). The averaging process over products intervening in the calculation of the price indices yields relatively moderate coefficients of variation at all quarters (from 0.09 to 0.12), compared to the coefficients of variation of prices for specific products. However, the geographical spread of price indices is clearly not negligible.

Finally, several studies from various price surveys in Rwanda support the existence of both substantial geographical and seasonal price dispersions (Niyonteze and Nsengiyumva (1986), O.S.C.E. (1987), Ministère du Plan (1986b), Muller (1988)). All these elements illustrate the relevance of accounting for the diverse sorts of price dispersions in welfare analysis.

Figure 1 shows the evolution curves of aggregate consumption and aggregate production across quarters, respectively with and without price correction. The price deflation enables us to better distinguish both the poverty crisis during the last quarter and lead to dampen the fluctuations of consumption during the remainder of the year, as the levels of production and consumption are re-evaluated at periods A and B, when prices are respectively high and low, before and after the large harvests of January.

Finally, Muller (1999) shows that the hypothesis of independence of price indices and real living standards cannot be rejected at every quarter. This might suggest to some that the correction for prices may be neglected in welfare analysis, without necessarily implying a bias in welfare estimations. Moreover, the moderate size of standard errors of price indices suggests that their dispersion could be neglected without much consequences for poverty analysis (as it is done in Ravallion et al. (**AV**).The following estimations show that this is not the case[10].

4. <u>Estimation Results</u>

We first present the estimates of mean living standards, then the estimates of poverty indices and finally the estimates of changes in composition of the population of the poor.

4.1. Quarterly mean living standards

Table 3 presents the means and standard deviations of per capita consumption and total consumption for indicators deflated and non-deflated. The data are recorded for each of the four quarters, and for both the global sample and each quintile of the annual per capita consumption. These statistics are of outstanding importance since they are among the main output of household surveys. Per capita consumption is the most used living standard indicators from household survey data. It is generally presented for the whole country and for sub-populations defined using variables of interest. Here, the quintiles of per capita consumption are important sub-populations.

Since the standard deviations of these variables are substantial, we implement t-tests of comparisons of means[11]. At the national level, deflated mean living standards in quarters A, B and D are statistically different from non-deflated mean living standards in the same quarters. This is not the case for period C in which the correction with the price index is not significant (P-value = 0.14). Using different equivalence scales leads to results qualitatively similar.

These features persist, at least partially at the quintile level. Within each quintile of the annual living standard distribution, the effect of deflation is also pervasive. The results of t-tests generally indicate a strong rejection of the hypothesis of equality of means. However, in a few cases, this hypothesis is not rejected at the 5% level. That is the case: in the second quintile, for period B (P-value = 0.18); and in the fifth quintile for annual living standard (P-value = 0.90) or period C (P-value = 0.15). Even here, the results are not sensitive to the use of different equivalence scales. Therefore, except in a few cases, the deflation is significant for the estimation of mean living standards in most quarters and quintiles. This result is interesting, since, most of

10 See also Muller (1998b) for a theoretical poverty analysis with fixed poverty lines.

11 See Tassi (1984) for a discussion of these tests, and Wang (1971) for the calculus of the P-values.

the time, living standards statistics are published non-deflated in the statistical reports of household surveys. Caution seems advisable when interpreting non-deflated results as genuine welfare statistics.

However, close examination of means reveals that the differences in these aggregates, with and without deflation, are always moderate, generally below ten percent. Quarter D is unambiguously a period of crisis: mean per capita consumption and mean total consumption are clearly lower whether measured with or without correcting for prices. For the first three quarters, these averages seem to evolve more regularly when deflated indicators are used, although the fall in consumption is actually larger at the last quarter when a price adjustment is made. Note that the latter results do not always persist at the quintile level, which suggests that aggregate means might be sometimes misleading where fluctuations in living standards are concerned.

Which dimension is the most relevant: geographical or seasonal variability? A variance analysis[12] has shown us that for both prices and living standards, the geographical variability contributes much more than the seasonal variability. However, both directions of variability must be considered when one wants to compare to the case of non-deflation or imperfect deflation from the whole year and the whole country.

Finally, as show the poverty estimates in the next section, the occurrence of the severe poverty crisis in quarter D, does not mean that it would be sufficient to study only this particular season, e.g. before the December-January harvests, instead of running quarterly rounds of data collection. Poverty in Rwanda is high at every quarter and the whole year must be considered to get a relevant picture of poverty.

4.2. Poverty estimates

Six poverty lines are used. First, we define
z_1 is the first quintile of annual living standards;
z_2 is the sum of the first quintiles of quarterly living standards;
z_3 is four times the minimum of the first quintiles of quarterly living standards.

We denote the population whose per capita consumption is under these poverty lines, the "very poor". Three remaining poverty lines are also associated with the set of "poor" (very poor plus moderately poor). They are calculated as above, although from the second quintiles of the living standards distribution, and respectively denoted z_4 , z_5 , z_6. That is:
z_4 is the second quintile of annual living standards;
z_5 is the sum of the second quintiles of quarterly living standards;
z_6 is four times the minimum of the second quintiles of quarterly living standards.

Note that $z_4 > z_5 > z_6 > z_1 > z_2 > z_3$. The same types of poverty lines have been calculated using the nominal per capita consumption distribution (non-deflated). This implies that the utilised poverty lines are relative to the living standards distribution considered, as is frequently the case in poverty studies.

Here, poverty indices and poverty lines are based uniquely on per capita consumption levels (real or nominal), and the same poverty line is used for all seasons. Other elements could enter into the definition of living standards, such as health status, leisure (Riddel (1990)) or the arduousness of work. Accounting for the hours of work supplied would be especially interesting,

12 Results are available from request to the author.

since the amount of effort may imply different needs at different seasons due to the seasonality of agricultural tasks (Chambers, Longhurst and Pacey (1981)). Another cause of seasonal variation of needs is the climate itself, which implies different biological pressures, mostly due to heat, illness and dust, at different periods. A fundamental difficulty is that the actual nutritional needs of individuals corresponding to different tasks or climatic conditions are not very well known, even in laboratory biological experiments, and vary considerably across individuals. We shall not include these extensions as they would require very detailed indicators about the daily life of peasants.

Significance of the deflation:

Tables 4 and 5 show the estimates of FGT poverty indices using the six poverty lines, respectively without and with deflation. Table 6 shows the percentage of variation in these indices that is induced by the deflation. Similar statistics for the Ch and Watts' indices (denoted C&W) are available by request to the author[13]. One may want to consider that the difference between deflated and non-deflated measures is an indicator of the risk of the price variability for poor households. We shall not pursue this interpretation here which would necessitate a precise axiomatic approach. To assess the inaccuracy of our inferences, we estimate sampling errors that are shown in the tables.

There exists an order of magnitude between poverty estimates and their standard errors, which ensures that all poverty indicators are significant. The crucial importance of calculating sampling errors is illustrated by the fact that some deviations of poverty indicators caused by the price correction are significant and others are not significant. Tables 6 and 9 show the relative variations due to the price correction ($\Delta P/P$) and the sampling errors for the absolute variations (ΔP).

What is the order of magnitude of the loss occurred without price deflation, compared to the extent of usual measurement problems? This is difficult to say when one considers measurement errors in consumption and price indicators or mistakes in the choice of equivalence scales, for which little robust knowledge is available about the size of the error. By contrast, a useful benchmark is the size of the sampling error for poverty indicators. Accounting for these errors, systematic non-significant differences in poverty measurement, made by the deflation would imply that the price correction is of little interest.

The price correction brings significant changes in poverty measures: a ten percent change is not uncommon. For the most used indicator (CP), systematically significant results for changes are generally found using high poverty lines. For example with line 4, the chronic poverty measured with FGT(2) is 0.0272 without correction and 0.0302 with correction, which makes a significant relative variation of 11.2 percent.

At the opposite, changes in annual poverty (ΔAP) are often not significant for FGT and C&W indices using lines 2, 3, 5. As a matter of fact, averaging living standards or poverty indices across the year generally reduces the impact of price dispersion without eliminating it.

The deflation has a major impact for periods in which the aggregation level of prices is much lower or higher than the yearly average. The ΔP_t in quarters A and B, when the average price index is respectively at its highest and at its lowest, are significant for all indicators (except with line 6 in period A). For example with line 4, the relative variation of the FGT(2) index in period A is 39.4 percent, and as considerable with other lines. By contrast, in quarters C and D,

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[13] The poverty gap is both FGT(1) and CHU(1), and is repeated in tables so as to facilitate comparisons for different values of parameters in the same set of indicators.

when the average price index is closer to the annual national mean price, ΔP_t is sometimes significant and sometimes not (FGT and C&W for lines 2, 3 and 5). Thus, with line 3, the relative variation of the FGT(2) index in period C is an insignificant 2.9 percent, although it is a significant 13.2 percent with line 4. The variations in transient poverty caused by the seasonal fluctuations of living standards (ΔTP) are almost always statistically significant (except sometimes for the incidence of poverty). We can conclude that even when using a relatively small sample size, the effect of the local price correction is significant for most poverty lines, most poverty indicators and most quarters. It is remarkable that significant effects of prices on poverty measures occur in a case where the spatial and temporal dispersions of the price index are relatively moderate.

There exists a rough agreement between the results for the FGT indices and those of the C&W indices.

Sign of the correction

The sign of the correction is more related to the poverty lines than to the severity parameters of indicators. This implies that some patterns may occur for some categories of poor households, which are not systematically valid for other ones. The sign of the change is often negative in the case of the incidence of poverty. Changes in all CP indices, however defined, are negative for lines 2, 3, 5, 6 and positive for 1 and 4 . Changes in all AP indices, however defined, are negative for lines 5 and 6 , and positive for lines 1, 2 and 4.

Apart from periods of large aggregate price variations, the sign of poverty change caused by the price correction cannot be systematically inferred. This partly owes to the fact that the value of the poverty lines themselves changes with the price correction. The changes in seasonal poverty indices in quarter A (FGT and C&W) are always positive, and always negative for seasonal poverty indices in quarter B. This is consistent with a dominance of the effects of aggregate shifts of prices for these periods. It illustrates the importance of aggregate seasonal fluctuations in prices, which sometimes exceeds geographical dispersion effects. Changes in seasonal poverty indices in quarter C are positive for lines 1, 4 and negative for line 6. Changes in seasonal poverty indices in quarter D are positive for lines 1, 2 and 4. For the unmentioned lines, the signs of changes are contradictory among indicators.

Magnitude of the correction:

The absolute magnitude of changes is generally substantial, especially for seasonal poverty indices in quarters A and B (more than 30 percent for some lines). However, this is not systematic and depends on the poverty line considered. The magnitude of changes in CP FGT indices varies a lot (from -33 to 11 percent), although it is "always"[14] below 10 percent for line 1 and always above 10 percent for line 6 . The magnitude of changes in AP FGT indices (-12 to 14 percent) is always below 10 percent for lines 2, 3 and 5, and always above 10 percent for line 6. The magnitude of changes of P_A FGT indices (0.9 to 43 percent) is always above 10 percent for lines 1, 2, 3, 4 and may be substantial (above 30 percent for line 2 and in many other cases) while the magnitude of changes in P_B (-39 to -14 percent) is always above 14 percent in absolute value for all lines and often considerable (over 25 percent for 3, 5 and 6). The magnitude of changes in P_C FGT indices (-17 to 16 percent) is always below 10 percent for lines 2, 3, 5 and always above 10 percent for line 6. Finally, the magnitude of changes in P_D FGT indices (-7 to 18 percent) is always below 10 percent for lines 2, 3, 5, 6 and always above 10 percent for line 4. Such a variety in the absolute magnitude of price effects is also true for C&W indices[15]. The size of the impact

[14] always means here: " for all values of severity parameters of the considered indices"

[15] The magnitude of changes in CP C&W indices (-0.25 to 0.09) is always below 10 percent for lines1, 2, 4 and always above 23 percent for lines 3 and 6. The magnitude of changes in AP C&W indices (-0.12 to 0.11) is always below 10

of the price correction depends much on the chosen poverty line, and cannot be predicted a priori although it is often sizable. Again, the definition of the population of the poor is crucial and justifies to consider systematically several poverty lines.

Link with lines and parameters:

The link of changes in poverty with the poverty line is complex. There seems to exist two different regimes for the very poor (lines 1, 2 and 3), and the moderately poor (4, 5 and 6). In every regime, the poverty variation due to price correction decreases when the line diminishes, whatever the type of poverty indicator considered. However, it is no longer true when all poverty lines are considered altogether.

Although, the effects are generally less strong than with respect to the choice of the poverty line, the relative changes in poverty indicators caused by the price correction often increase with parameter a (resp. c) in FGT (resp. Ch) poverty indicators. A higher concern for severity of poverty is often associated with a relatively larger impact of prices. This phenomenon is observed for both FGT and Ch indices, AP and CP, and seasonal indicators, except in periods B and D. It implies greater sensitivity to price correction for indicators with high values of these parameters.

Share of transient poverty:

Transient poverty is generally underestimated. Changes in the share of transient poverty can sometimes be considerable (from -26 to 78 percent), although it is generally small (about 5 percent). It is always positive for C&W and FGT indices with lines 1, 4, 5 and 6, showing that non-corrected price dispersion generally hides part of the influence of the seasonal variability of living standards on annual poverty. This rejoins the single intuition that at seasons when the agricultural output is low in rural areas, the living standards are low and the food prices are high, and the opposite when output is high. The change in this share for FGT indices is always below 10 percent for lines 1 and 4, and always above 10 percent for line 6. For C&W indices, it is below 10 percent for lines 1, 2, 3, 4 and always above 10 percent for lines 5 and 6.

Bilan:

When is deflation needed from a policy perspective? The above results suggest that detailed price statistics for poverty analysis are the more useful in monitoring of:

- policies against seasonal and transient poverty;
- policies against poverty when there exist large seasonal price fluctuations;
- policies against poverty when there exist large geographical price differences;
- policies directed against severity of poverty by opposition to mere incidence of poverty;
- policies dealing with the poor near the threshold level rather than when looking at extreme poverty.

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percent for lines 1, 2, 3, 5 and always above 10 percent for lines 4 and 6. The magnitude of changes in P_A C&W indices (0.064 to 0.36) is always below 10 percent for line 6 and always above 10 percent for other lines (above 0.30 for lines 1 and 2), while the magnitude of changes in P_B C&W indices (-0.35 to -0.14) is always above 14 percent for all lines (above 0.30 for lines 3 and 6). The magnitude of changes in P_C C&W indices (-0.11 to 0.11) is always below 10 percent for lines 2, 3 and 5, and always above 11 percent for line 6. The magnitude of changes in P_D C&W indices (-0.06 to 0.17) is always below 10 percent for lines 2, 3, 5 and 6, and always above 10 percent for lines 1 and 4.

However, on the whole, it is generally difficult to predict safely the direction and the size of the bias due to price dispersion. This implies that the price correction is important whatever the poverty indicator used, and that constructing local and seasonal price indicators must be encouraged for all types of poverty analysis. Furthermore, even in situations where aggregate poverty indicators are little sensitive to the price correction, this correction may still matter for more disaggregate poverty analysis as shows the next section.

4.3. Variations of the population of the poor

The deflation may change the composition of the population of the poor even when the aggregate poverty measure is not significantly modified. In table 10, column ‘Type I error’ (for `false poor’) show the percentages of households that are poor before the deflation but not after. Columns ‘Type II error’ (for `omitted poor’) show the percentages of households that are poor after the deflation but not before. For policy targeting, type II is sometimes considered more important since some needy households cannot be reached at all.

The size of changes in the population of the poor caused by the deflation is very varied. On average, type I errors dominate. At most 2.3 percent of the poor would be omitted according to poverty line z4, while 4.9 percent and 7 percent of the false poor would appear actually above poverty lines z5 and z6. Over the year, the type I errors vary from 0.58 to 7.12 percent of the whole population depending on the poverty line, and less than 3 percent in most cases. Still for the year, the proportion of the type II errors vary from 0.29 through 2.29 percent.

No strong systematic tendencies appear when comparing the two columns for periods C and D. By contrast, in quarter A when the aggregate price index is high before January harvest, the number of the Type II errors is always greater than the number of the Type I errors, while it is the opposite in quarter B when the aggregate price index is low.

At the quarterly level, the changes in the composition of the poor can be important both by incorporation and elimination of households. In quarter A, the proportion of the Type II errors varies from 3.19 to 7.46 percent, following the poverty line, while during the last quarter it reaches 1.70 to 8.04 percent. At the opposite it is almost null in quarter B where the proportion of Type I errors varies from 4.52 through 11.8 percent following the poverty line.

Higher percentage of households misclassified (up to 11.8 percent) are observed with poverty lines computed with the second quintile (consistent with table 6).

5. Comparisons with the Correction Based on Regional Prices

Using regional price deflators is one of the most accurate correction used in the literature. Regional prices get rid of the ‘quality puzzle’ inherent with local prices computed on household budget data. The regional index is calculated from mean prices at the regional level rather than at the cluster level[16].

[16] A price index, similar but different, was used in Muller (1997), and was associated with a rather conservative picture of the transient poverty in order to guarantee that the results of the paper were not overly determined by the price correction. Minor adjustments have been done since during the correction of defaults in the data. They entail slight changes in weights of indices and in prices for the comparison basis. We use here new Laspeyres local

Table 7 shows the descriptive statistics of local prices by region and by quarter. T-tests of comparison of price means for different regions show that in quarter A and B most means of the price index are significantly different in different regions.

However, mean price indices are not significantly different at quarter A in regions North-West and South-West; or at quarter B in regions North-West and Centre-North, or in regions South-West and Centre-South. At quarter C, mean price indices in North-West, Centre-North and Centre-South, and mean price indices in Centre-South and East, are not significantly different. At quarter D, the mean price index in Centre-South only is significantly different from the others.

On the whole, in most cases regional prices are distinct in different regions. T-tests of comparisons of mean prices for specific goods lead still more often to the rejection of the equality of price means for different regions. This outcome happens for all quarters and all representative products, although coincidences of prices of two regions may sometimes arise.

The regional means of prices are sometimes far apart. For example, at quarter C for beans (47.04 Frw in North-West and 23.14 Frw in East), or quarter B for plantain (18.22 Frw in Centre-South, 9.23 in East), or even at period D for sweet potatoes (7.04 Frw in North-West, where soils are relatively well adapted to this crop, and 14.29 Frw in South-West). The differences between regions are less marked for banana beer, palm oil and soap that are widely commercialised throughout the country.

Substantial standard deviations can be observed for the price of many products, in most quarters and regions. They indicate that inside a region at the same quarter the geographical variability of prices is not negligible[17].

Price indices in each region are more concentrated than the prices of specific products, while their means still vary with regions and quarters, from 0.889 at quarter B in the East through 1.139 at quarter A in Centre-North. The standard deviations show that there exists a moderate geographical variability of quarterly price indices in the same region.

The poverty estimators using the regional price indices for the deflation, along with the percentage of variation in poverty estimates caused by the regional price deflation and associated sampling errors are available by request to the author. Tables 8 and 9 shows the means and standard deviations of the relative variation in poverty induced by deflating, calculated by considering the different poverty lines altogether.

Regional prices only partially correct for the global price variability. The comparison shows that poverty estimates using regional price indices are often intermediate between, in the one hand poverty estimates with local prices deflation, and in the other hand poverty estimates without deflation. In particular, this occurs for all values of parameters of FGT indicators in quarter C, and at three occasions out of four in quarter D, or for indicators CP and F. This happens also for all values of parameters of C&W indices at quarters A and D, and for indicators CP and F.

However, that is not the whole story since in other cases the correction caused by regional prices may be larger in absolute value than the correction associated with local prices. Moreover,

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and regional price indices, so as to be able to interpret differences as arising only from differences in aggregation levels of prices and not from differences in the weights or price basis in the formula of the Laspeyres indices. The share of transient-seasonal poverty in annual poverty is very substantial in Rwanda, which confirms one of the main results of Muller (1997).

17 In rare cases (sweet cassava in region North-West), the samples of local prices at the cluster level were judged too small to be used and have been replaced by a regional mean price. Then, the shown standard deviation is equal to zero, but does not reflect the actual local dispersion of prices in the considered region.

these latter situations cannot be attributed to insignificant deviations since they occur in particular at period B for all FGT and C&W indices, when deviations are always substantial and significant. In all cases, the differences in the two types of corrections are frequently considerable, which invite the analysts to attach a crucial importance to the price deflation in poverty analysis.

The differences between the two series of results might also come from the fact that the samples of prices used for regional price indices are larger than the samples of prices used for local price indices. Then, the random variability of local price indicators is larger than the random variability of regional price indicators. While possible, we believe that it is unlikely because the prices used in local price indices are themselves means of local price samples for which a requirement of a minimal sample size was imposed to ensure their representability (Muller (1998a)). This requirement should eliminate most of the non systematic `noise' in the price data. Of course, that is not the case for locally systematic measurement error such as those related to the selection of markets of transaction sites or sellers in these sites, who would practice prices different from the mean on the surveyed area. For this last problem, using regional averages may help, although we doubt that it is a strong argument in favour of aggregate indices. In a sense, the same type of arguments when analysing consumption behaviour would lead to trust systematically more aggregate time series estimates than microeconomic panel data estimates, on the grounds that random errors cancel out in aggregate data. Finally, the fact that the difference in the deviation caused by the two types of corrections has not a systematic sign, suggests that a simple stochastic explanation is to exclude.

In which cases would the deflation with regional prices be sufficient? Clearly, it will be sufficient when there is little geographical price dispersion in each region. That is not the case here but could occur with other data sets. This situation is easy to check using local price surveys, or perhaps sometimes unit-values of surveys.

Tables 11 and 12 show the difference between estimates of poverty indices deflated using local and regional price indices (denoted D_{LR}, for local – regional). In spite of the non-negligible magnitude of the differences in the relative variation caused by the two types of deflation (see table 10), D_{LR} is not always significant.

At the annual level (i.e. for CP), D_{LR} is never significant. Then, for the most used poverty indicators, corresponding to the usually avai;lable living standard indicators, using regional price indices seems sufficient.

By contrast, at the seasonal level, the choice of local deflation instead of regional deflation can be crucial in some quarters. While D_{LR} is almost never significant in quarters B and D, it is often significant in quarter A when prices are high) and C. Both the choice of the poverty line and of the formula of the poverty indicator are important for the significance of D_{LR}.

In almost all cases, when D_{LR} is significant, it corresponds to an underestimation of poverty when using regional prices.

On the whole, the current practice of developing price deflators only for a small number of regions is not reliable when studying seasonal poverty, although the bias may sometimes be neglected when measuring chronic annual poverty.

6. Conclusion

Static and dynamic poverty indicators are in general imperfectly corrected for the dispersion of prices across households and seasons. To some extent the poverty deduced from variations in nominal living standards could as well follow from variations in prices across households and periods. To our knowledge, the importance of such price effects at local and seasonal level for poverty measurement has not been empirically studied in the literature.

Using seasonal panel data from Rwanda, we show the substantial consequences of an accurate price deflation based on local and seasonal prices. In many instances the price correction changes significantly the levels of average living standards and poverty indicators, whether seasonal, chronic or transient. However, if changes in aggregate living standards are moderate in every quarter, this is not always the case for poverty, for which the magnitude of changes may be very high in the first two seasons.

In terms of the impact of price deflation on the assessment of poverty, the choice of the poverty line or the quarter considered are generally more influential than the formula of the poverty indicator, especially when attention is restricted to axiomatically valid poverty indicators. In the first two quarters the effects of aggregate seasonal fluctuations of prices dominate the effect of geographical price dispersion and imply substantial and unambiguously positive or negative variations of poverty in these periods when deflation is implemented. Poverty indicators giving a high importance to the severity of poverty are more likely to lead to strong price effects. Moreover, large changes in the composition of the population of the poor may occur, caused by the deflation.

Finally, the comparison with poverty indicators deflated using regional price indices, one of the most accurate method used in the literature, instead of local price indices shows that when studying seasonal poverty, regional price indices provide an imperfect correction only, and may sometimes be misleading. Nonetheless, the bias due to using regional prices is negligible for the measurement of chronic annual poverty.

Table 1: Mean and standard deviation of deflated yearly consumption and production, and shares of goods in consumption

Total Consumption	51176 (24985)
Total Production	57158 (38207)
Per Capita Total Consumption	10613 (5428)
share of beans in consumption	0.203
share of fruits and vegetables	0.127
share of sweet potatoes	0.091
share of other tubers	0.121
share of traditional beers	0.139
share of other foods	0.150
share of fire wood	0.028
share of other non foods	0.143

The share of goods in production are the ratios of the values of the aggregated consumption for these goods over the value of total consumption.
For total consumption and total production, the first number is the mean and the number in parentheses is the standard deviation

Table 2: Local seasonal prices (Frw)

Products	Quarter A	Quarter B	Quarter C	Quarter D	CV for quarterly price means	σ for quarterly price means	average for quarterly price means
beans (kg)	38.70 (9.07) [0.23]	24.79 (6.43) [0.26]	31.81 (11.45) [0.36]	36.41 (6.34) [0.17]	0.161	5.31	32.93
plantain (kg)	12.51 (3.27) [0.26]	12.21 (4.94) [0.40]	13.61 (5.70) [0.42]	14.77 (5.13) [0.35]	0.077	1.017	13.29
sweet potatoes (kg)	10.11 (4.21) [0.42]	8.13 (2.77) [0.34]	7.90 (3.54) [0.45]	9.98 (5.12) [0.51]	0.113	1.019	9.04
sweet cassava (kg)	17.00 (4.92) [0.29]	14.35 (3.51) [0.24]	16.10 (4.33) [0.26]	15.57 (3.97) [0.25]	0.061	0.956	15.76
banana beer (l)	39.16 (10.34) [0.26]	38.41 (9.71) [0.25]	43.01 (11.21) [0.26]	36.85 (9.51) [0.26]	0.058	2.265	39.36
palma oil (kg)	181.23 (27.77) [0.15]	165.16 (20.49) [0.12]	178.31 (21.81) [0.12]	179.91 (40.02) [0.22]	0.034	6.431	176.16
soap (kg)	22.55 (6.27) [0.28]	22.67 (6.52) [0.29]	21.57 (4.58) [0.21]	20.86 (4.28) [0.21]	0.034	0.741	21.92
price index	1.108 (0.129) [0.12]	0.953 (0.101) [0.11]	1.047 (0.13) [0.12]	1.084 (0.097) [0.09]	0.057	0.0594	1.049

Standard deviations in parentheses. Coefficient of variation in brackets.

Table 3 : Mean and standard deviation of deflated and non-deflated consumption

Variable	period A	period B	period C	period D
Deflated per capita consumption	2750 (1701)	2702 (1620)	2850 (1968)	2310 (1511)
Non-deflated per capita consumption	2995 (1826)	2539 (1475)	2902 (1834)	2468 (1524)
Deflated total consumption	13521 (9527)	13232 (8192)	13452 (8249)	10969 (6092)
Non-deflated total consumption	14681 (10396)	12431 (7451)	13755 (7995)	11764 (6274)

By quintiles:

Deflated Variable	period A	period B	period C	period D
per capita consumption (Q=1)	1331 (487)	1547 (525)	1328 (506.	1255 (417)
per capita consumption (Q=2)	2088 (766)	1984 (499)	1776 (577	1619 (558)
per capita consumption (Q=3)	2500 (1003)	2356 (792)	2529 (844)	1959 (559)
per capita consumption (Q=4)	3221 (1365)	2736 (828)	3345 (1108)	2593 (1075)
per capita consumption (Q=5)	4587.92 (2154.43)	4855 (2149)	5233 (2695)	4095 (2110)

Deflated Variable	period A	period B	period C	period D
total consumption (Q=1)	8420 (4722)	9553 (4804)	8382 (4466)	7775 (3644)
total consumption (Q=2)	1242 (6129)	11723 (5278)	10513 (5214.)	9473 (4614)
total consumption (Q=3)	15415 (9520)	14784 (8058)	15609 (7966)	11980 (5781)
total consumption (Q=4)	14092 (9452)	12299 (7380)	14623 (8352)	11594 (7033)
total consumption (Q=5)	17256 (13158)	17753 (11336)	18086 (10050)	13997 (6871)

By quintiles:

Variable	period A	period B	period C	period D
Non-deflated per capita consumption (Q=1)	1492 (512)	1475 (502)	1408 (558)	1377 (469)
Non-deflated per capita consumption (Q=2)	2225 (691)	1946 (504)	1865 (554)	1758 (607)
Non-deflated per capita consumption (Q=3)	2748 (1166)	2227 (712)	2663 (960)	2119 (571)
Non-deflated per capita consumption (Q=4)	3473 (1408)	2586 (780)	3510 (1168)	2729 (1011)
Non-deflated per capita consumption (Q=5)	5011 (2313)	4433 (2010)	502 (2367)	4328 (2074)

Variable	period A	period B	period C	period D
Non-deflated total consumption (Q=1)	9440 (4978)	9110 (4641)	8901 (4987)	8574 (4191)
Non-deflated total consumption (Q=2)	13215 (6095)	11480 (5230)	11079 (5724)	10256 (5056)
Non-deflated total consumption (Q=3)	17034 (11230)	13954 (7642)	16103 (7872)	12864 (5937)
Non-deflated total consumption (Q=4)	15145 (10063)	11572 (6904)	15137 (7809)	12200 (6888)
Non-deflated total consumption (Q=5)	18568 (14342)	16014 (9875)	17525 (9472)	14896 (7043)

Standard deviations are in parentheses. Q denotes the quintile of per capita consumption, respectively deflated and non deflated.

Table 4 : FGT's Poverty indices (Non-deflated)

	poverty lines based on first quintile											
	z_1	>			z_2	>			z_3			
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.22724 (0.032372)	0.056450 (.0085433)	0.022917 (.0045108)	0.011500 (.0028381)	0.14289 (0.018457)	0.038136 (.0067978)	0.015247 (.0036458)	.0076064 (.0022485)	0.13108 (0.017001)	0.031783 (.0064083)	0.012588 (.0032845)	.0062881 (.0020110)
B	0.29033 (0.047001)	0.074961 (0.010376)	0.02768 (.0049961)	0.012475 (.0029501)	0.21468 (0.029169)	0.049022 (.0079844)	0.016791 (.0038721)	.0074576 (.0021871)	0.19148 (0.020691)	0.038836 (.0071677)	0.013126 (.0033963)	.0058939 (.0018945)
C	0.24022 (0.026413)	0.07058 (.0090653)	0.028323 (.0041660)	0.013556 (.0022386)	0.20399 (0.025220)	0.049092 (.0069807)	0.018231 (.0029885)	.0085290 (.0015983)	0.17188 (0.015691)	0.039633 (.0060750)	0.014707 (.0025337)	.0068729 (.0013912)
D	0.36998 (0.047373)	0.10197 (0.015113)	0.04517 (.0097907)	0.026636 (.0077450)	0.27800 (0.037547)	0.069851 (0.011783)	0.032198 (.0087118)	0.020456 (.0070165)	0.22606 (0.028832)	0.057922 (0.011177)	0.027927 (.0083579)	0.018454 (.0067160)
AP	0.28194 (0.027264)	0.075991 (.0058738)	0.031027 (.0025860)	0.016042 (.0016952)	0.20989 (0.017109)	0.051525 (0.043290)	0.020617 (.0018790)	0.011012 (.0014845)	0.18013 (0.013796)	0.042043 (.0033971)	0.017087 (.0016690)	.0093772 (.0014480)
CP	0.20021 (0.016454)	0.037374 (.0043412)	0.011192 (.0019041)	.0041173 (.00081049)	0.09944 (0.011849)	0.08184 (.0038821)	0.092405 (.0012062)	0.12307 (.00045115)	0.084648 (0.012021)	0.015858 (.0033597)	.0041071 (.00090929)	.0012937 (.00034497)
F	0.28989 (0.017495)	0.50817 (.0063319)	0.6392 (.0029933)	0.74334 (.0020730)	0.5261 (0.021774)	-0.58834 (.0043939)	-3.48207 (.0022769)	-10.1753 (.0017976)	0.53006 (0.015950)	0.62282 (.0033511)	0.75963 (.0020865)	0.86204 (.0017198)

	poverty lines based on second quintile											
	z_4	>			z_5	>					z_6	
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.36668 (0.035531)	0.099308 (0.012818)	0.040904 (.0064911)	0.020728 (.0040157)	0.35845 (0.042983)	0.094143 (0.01231)	0.038675 (.0062558)	0.019575 (.0038773)	0.29763 (0.032514)	0.077667 (0.010613)	0.031683 (.0055180)	0.015981 (.0034310)
B	0.48185 (0.038625)	0.12870 (0.013654)	0.052094 (.0069722)	0.024941 (.0042782)	0.43361 (0.031864)	0.12215 (0.013201)	0.049168 (.0067569)	0.023387 (.0041356)	0.36878 (0.02820)	0.10231 (0.012427)	0.039825 (.0060434)	0.018519 (.0036554)
C	0.38567 (0.033330)	0.11798 (0.011634)	0.050013 (.0062033)	0.025184 (.0035772)	0.38125 (0.036816)	0.11274 (0.011430)	0.047402 (.0060022)	0.023761 (.0034272)	0.3497 (0.037521)	0.094562 (0.010645)	0.039051 (.0052793)	0.019273 (.0029275)
D	0.52273 (0.040554)	0.16301 (0.019096)	0.074119 (0.011956)	0.041691 (.0091169)	0.49905 (0.041372)	0.15609 (0.018742)	0.070708 (0.011713)	0.039832 (.0089635)	0.43212 (0.041442)	0.13352 (0.017250)	0.059728 (0.010914)	0.033976 (.0084571)
AP	0.43923 (0.029367)	0.12725 (.0086872)	0.054283 (.0039786)	0.028136 (.0023664)	0.41809 (0.028774)	0.12128 (.0083188)	0.051488 (.0038194)	0.026638 (.0022824)	0.36207 (0.023873)	0.10201 (.0073173)	0.042572 (.0033043)	0.021937 (.0020179)
CP	0.40021 (0.027372)	0.084134 (.0047054)	0.027167 (.0024822)	0.010799 (.0014396)	0.37183 (0.028127)	0.078213 (.0044218)	0.025011 (.0024373)	.0098743 (.0013817)	0.30756 (0.024802)	0.059477 (.0039451)	0.018536 (.0022830)	.0071423 (.0011672)
F	0.088836 (0.013333)	0.33882 (.0056222)	0.49952 (.0039393)	0.61618 (.0027077)	0.11064 (0.017356)	0.35511 (.0057317)	0.51424 (.0038818)	0.62932 (.0026404)	0.15057 (.0062085)	0.41698 (.0064543)	0.56459 (.0035949)	0.67442 (.0024045)

Sampling errors in parentheses. The number in parentheses in the F line is the sampling error for TP, not for F.

Table 5 : FGT's Poverty indices (Indicator per capita deflated for local and seasonal price variability)

	poverty lines based on the first quintile											
		z_1		>			z_2	>			z_3	
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.27189 (0.030734)	0.075877 (.0099346)	0.031568 (.0052653)	0.016138 (.0034780)	0.19746 (0.030005)	0.048906 (.0074624)	0.019924 (.0040855)	0.010223 (.0027987)	0.15348 (0.022306)	0.039262 (.0063292)	0.016126 (.0036951)	.0083063 (.0025537)
B	0.23740 (0.051143)	0.060845 (0.010223)	0.022156 (.0048516)	0.010036 (.0028479)	0.16945 (0.023375)	0.035544 (.0071378)	0.012353 (.0036807)	.0056358 (.0019884)	0.13475 (0.013544)	0.026476 (.0066739)	.0094194 (.0032016)	.0043511 (.0016486)
C	0.27967 (0.016900)	0.077589 (.0085844)	0.031239 (.0044593)	0.015304 (.0025955)	0.19695 (0.030958)	0.049681 (.0068602)	0.019153 (.0031984)	.0092182 (.0018683)	0.16626 (0.028095)	0.039814 (.0055685)	0.015127 (.0027770)	.0072705 (.0016188)
D	0.39871 (0.069129)	0.11607 (0.019727)	0.051120 (0.012408)	0.029425 (.0092638)	0.29491 (0.040729)	0.075526 (0.015837)	0.034325 (0.010597)	0.021273 (.0078982)	0.22351 (0.032612)	0.061999 (0.014641)	0.028930 (.0098712)	0.018728 (.0073296)
AP	0.29692 (0.032948)	0.082595 (.0073364)	0.034021 (.0033337)	0.017726 (.0021177)	0.21469 (0.022837)	0.052414 (.0047676)	0.021439 (.0023776)	0.011587 (.0017009)	0.16950 (0.016074)	0.041888 (.0039802)	0.017401 (.0020882)	.0096639 (.0015855)
CP	0.20748 (0.023314)	0.039374 (.0044385)	0.01 136 (.0017709)	.0040092 (.00073657)	0.099200 (.0096705)	0.075386 (.0034102)	0.079204 (.0010625)	0.099105 (.00035211)	0.080841 (.0093056)	0.013300 (.0030093)	.0032002 (.00076423)	.00093121 (.00023376)
F	0.30122 (0.015865)	0.52329 (.0059729)	0.66590 (.0032576)	0.77382 (.0022977)	0.53794 (0.019062)	-0.43827 (.0044953)	-2.69449 (.0026387)	-7.55279 (.0019059)	0.52307 (0.012722)	0.68248 (.0039738)	0.81609 (.0024122)	0.90364 (.0017542)

					poverty lines based on					the second quintile		
		z_4	>			z_5	>			z_6		
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.43764 (0.049020)	0.13182 (0.014818)	0.057000 (.0076640)	0.029727 (.0048762)	0.39108 (0.035283)	0.11038 (0.012988)	0.046880 (.0067157)	0.02425 (.0043267)	0.30032 (0.024550)	0.082611 (0.010378)	0.034563 (.0055528)	0.017709 (.0036483)
B	0.41365 (0.052073)	0.10961 (0.016335)	0.044291 (.0075299)	0.021253 (.0043868)	0.31763 (0.040284)	0.090437 (0.014440)	0.035551 (.0064653)	0.016660 (.0037985)	0.25984 (0.054530)	0.066808 (0.011252)	0.024774 (.0051549)	0.011283 (0.0030443)
C	0.41846 (0.042373)	0.12940 (0.012040)	0.056625 (.0062941)	0.029208 (.0039252)	0.35536 (0.037370)	0.10883 (.0099240)	0.046770 (.0055811)	0.023673 (.0034401)	0.29025 (0.017897)	0.084144 (.0087407)	0.034360 (.0047169)	0.016928 (.0027743)
D	0.60316 (0.056989)	0.19155 (0.025805)	0.087302 (0.015705)	0.048714 (0.011503)	0.54383 (0.055796)	0.16261 (0.023978)	0.073130 (0.014470)	0.040957 (0.010686)	0.41977 (0.065537)	0.12556 (0.020709)	0.055501 (0.012836)	0.031642 (.0095678)
AP	0.46823 (0.038324)	0.14060 (0.011728)	0.061305 (.0053892)	0.032225 (.0031634)	0.40198 (0.031797)	0.11807 (0.010249)	0.050583 (.0045829)	0.026387 (.0027419)	0.31755 (0.031250)	0.089780 (.0079631)	0.037300 (0.037300)	0.019390 (.0022372)
CP	0.39403 (0.028823)	0.091759 (.0062360)	0.030223 (.0027097)	0.011939 (.0014183)	0.33501 (0.016019)	0.070677 (0.005298)	0.022161 (.0023650)	.0084418 (.0011772)	0.23925 (0.023817)	0.045216 (.0045317)	0.013308 (.0019074)	.0047814 (.00083111)
F	0.15846 (0.017412)	0.34735 (.0070198)	0.50701 (.0043154)	0.62951 (.0029991)	0.16658 (0.025985)	0.40138 (.0069776)	0.56188 (.0039706)	0.68008 (.0027407)	0.24657 (0.015171)	0.49637 (.0062677)	0.64322 (.0034104)	0.75341 (.0023886)

Sampling errors in parentheses. The number in parentheses in the F line is the sampling error for TP, not for F.

Table 6: <u>Proportion of changes in FGT poverty indices due to the local and seasonal price deflation</u>

poverty lines based on the first quintile

			z_1	>			z_2	>			z_3	
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.19649** (0.023858)	0.34415* (.0046442)	0.37749* (.0019527)	0.40330* (.0010873)	0.38190* (0.025451)	0.28241* (.0031295)	0.30675* (.0012457)	0.34400* (.0008014)	0.17089 (0.020485)	0.23531* (.0024399)	0.28058* (.0010489)	0.32098* (.00073014)
B	-0.18231* (0.025483)	-0.18831* (.0016063)	-0.19983* (.0003868)	-0.19551* (.00014697)	-0.21069* (0.011822)	-0.27494* (.0016692)	-0.26431* (.00029671)	-0.24429* (.0002133)	-0.29653 (0.011549)	-0.31826* (.0013447)	-0.28239* (.00026636)	-0.2618* (.00027169)
C	0.16422* (0.011661)	0.099259* (.0017733)	0.10296* (.0010298)	0.12895* (.00070888)	-0.03451 (.0060296)	0.011998 (.0019987)	0.050409 (.00071220)	0.080807 (.00056326)	-0.0327 (0.019413)	0.00457 (.0019967)	0.0286 (.00057141)	0.057850 (.00052997)
D	0.077653* (0.023707)	0.13828* (.0051992)	0.13150** (.0030082)	0.10471** (.0016792)	0.060827 (0.014360)	0.081244 (.0049327)	0.066060 (.0022128)	0.039939 (.0010082)	-0.01132 (.0096882)	0.070388 (.0048803)	0.035915 (.0017854)	0.014848 (.00074811)
AP	0.053132 (0.013300)	0.086905* (.0023388)	0.096497* (.0009962)	0.10497* (.00047937)	0.022869 (.0083444)	0.017254 (.0015222)	0.039870 (.00063842)	0.052216* (.00025861)	-0.05901 (.0045181)	-.003686 (.0014440)	0.018318 (.00050899)	0.030574 (.00018728)
CP	0.036312 (0.010227)	0.053406 (.0026896)	0.015011 (.0007148)	-0.026255 (.00026352)	-.002473* (.0081068)	-0.07886* (.0011051)	-0.14286* (.00028498)	-0.19477* (.00015577)	-0.04498 (.0068518)	-0.16131* (.0006901)	-0.22086 (.00022265)	-0.28020 (.00014493)
F	0.039084 (0.015253)	0.029754* (.0010057)	0.041641* (.0003486)	0.041004* (.00024772)	0.022330* (.0057855)	-0.25507* (.0006904)	-0.22618* (.00041716)	-0.25773* (.00013640)	-0.01318 (.0045066)	0.095790* (.0008583)	0.074326* (.00036152)	0.048258* (.000083998)

poverty lines based on the second quintile

			z_4	>			z_5	>			z_6	
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.19352* (0.013838)	0.32739* (.0054379)	0.39351* (.0029346)	0.4341 (.0017476)	0.091031 (0.017698)	0.17162* (.0045340)	0.21215* (.0025028)	0.23928* (.0014859)	.0091398 (0.011377)	0.063656 (.0040950)	0.090900 (.0021133)	0.10813 (.0012305)
B	-0.14154* (0.020583)	-0.14833* (.0051404)	-0.14979* (.0013416)	-0.14787* (.00035497)	-0.26748* (0.016944)	-0.25962* (.0046522)	-0.27695* (.0011972)	-0.28764* (.00052006)	-0.29541* (0.034528)	-0.34700* (.0039181)	-0.37793* (.0015214)	-0.39044* (.00071117)
C	0.085021 (0.037852)	0.096796* (.0035301)	0.13221* (.0012685)	0.15978* (.00088391)	-0.06790 (0.036075)	-0.03468 (.0031442)	-0.013333 (.0012623)	-.0037035 (.00069958)	-0.17015* (0.020343)	-0.11017* (.0030949)	-0.12012* (.0011552)	-0.12167* (.00055386)
D	0.15387* (0.017243)	0.17508* (.0079112)	0.17786* (.0043152)	0.16845* (.0026658)	0.089730* (0.020486)	0.041771 (.0060684)	0.034254* (.0032413)	0.028244* (.0020153)	-0.02858 (0.030013)	-0.05961** (.0039857)	- 0.070771** (.0025743)	- 0.068696** (.0014624)
AP	0.066025* (0.013996)	0.10491* (.0039257)	0.12936* (.0018363)	0.14533* (.00095095)	-0.03853 (0.012343)	-0.02646 (.0033498)	-0.017577 (.0013989)	-.0094226 (.00069028)	-0.12296* (0.013080)	-0.11989* (.0027424)	-0.12384* (.0010506)	-0.11611* (.00048370)
CP	-0.01544 (0.016140)	0.090629* (.0034957)	0.11249* (.0015513)	0.10557* (.00069238)	-0.09902* (0.024106)	-0.09635* (.0027577)	-0.11395** (.0011509)	-0.14507* (.00051911)	-0.22210* (0.015362)	-0.23977* (.0022373)	-0.28205* (.00081065)	-0.33055* (.00041112)
F	0.78374* (0.020539)	0.025176* (.0018006)	0.014994* (.0005333)	0.021633* (.00035170)	0.50560* (0.028051)	0.13030* (.0015000)	0.092642* (.00055199)	0.080658* (.00029433)	0.63758* (0.019936)	0.19039* (.0016612)	0.13927* (.00064138)	0.11712* (.00029162)

The first line of each cell is:(estimates corrected by local price indices)/(non corrected estimates)-1. Sampling errors for the differences in parentheses.

* = difference significant at 5 % level. ** = difference significant at 10 % level.

Table 7: Means and standard deviations of quarterly regional prices

Products	Quarter Region	A	B	C	D
beans (kg)	1	36.22	28.82	47.04	35.18
	[37]	(5.51)	(5.18)	(19.05)	(7.41)
	2	39.37	26.17	32.24	38.71
	[41]	(7.51)	(5.20)	(6.51)	(2.07)
	3	36.56	27.93	28.47	38.14
	[51]	(4.63)	(8.84)	(4.15)	(7.22)
	4	40.94	24.37	33.91	39.57
	[64]	(9.82)	(2.92)	(4.56)	(3.20)
	5	39.16	19.43	23.14	31.03
	[63]	(12.48)	(4.12)	(6.15)	(5.64)
plantain (kg)	1	10.58	12.78	8.16	19.82
		(0.08)	(1.74)	(0.83)	(6.85)
	2	9.80	9.48	10.31	17.00
		(0)	(2.02)	(1.90)	(0)
	3	14.08	10.13	18.31	10.76
		(3.20)	(2.03)	(6.33)	(2.63)
	4	12.47	18.22	17.56	17.30
		(0.85)	(4.67)	(2.59)	(2.69)
	5	14.18	9.23	11.39	11.04
		(4.80)	(3.97)	(5.25)	(3.95)
sweet potatoes (kg)	1	13.93	9.03	8.90	7.04
		(3.94)	(2.66)	(4.37)	(3.64)
	2	12.10	9.70	9.18	14.29
		(4.24)	(2.30)	(3.82)	(6.48)
	3	11.19	8.91	7.38	8.90
		(4.29)	(2.98)	(4.15)	(2.81)
	4	8.05	7.54	7.27	8.16
		(3.00)	(2.31)	(3.01)	(4.75)
	5	7.78	6.54	7.56	11.66
		(2.46)	(2.44)	(2.37)	(4.36)
sweet cassava (kg)	1	15.20	13.60	14.00	14.24
		(0)	(0)	(0)	(0.22)
	2	16.26	19.82	11.16	11.40
		(3.86)	(3.95)	(0.84)	(0)
	3	21.51	15.39	22.65	20.17
		(4.22)	(2.38)	(2.62)	(4.04)
	4	11.93	11.88	17.02	15.59
		(2.21)	(1.62)	(2.28)	(4.05)
	5	20.03	12.90	14.33	15.33
		(4.00)	(1.99)	(2.82)	(2.20)

Standard deviations in parentheses. Number of observations in each region in brackets.
Regions: 1 = North-West; 2 = South-West; 3 = Centre-North; 4 = Centre-South; 5 = East

banana beer (l)	1	35.71 (7.53)	32.45 (4.34)	37.03 (6.83)	36.62 (6.48)
	2	38.86 (16.21)	36.26 (6.44)	37.56 (8.87)	30.07 (9.85)
	3	35.60 (6.88)	34.51 (8.25)	37.87 (5.78)	33.42 (3.67)
	4	42.41 (7.43)	48.27 (9.27)	52.34 (8.92)	43.44 (8.67)
	5	40.95 (10.55)	36.44 (8.20)	44.73 (13.24)	37.49 (10.60)
palm oil (kg)	1	191.98 (18.48)	148.03 (10.46)	179.12 (8.44)	155.99 (11.00)
	2	166.77 (28.91)	143.66 (13.09)	183.21 (37.76)	151.33 (29.47)
	3	169.26 (18.39)	171.80 (19.87)	184.79 (24.03)	169.56 (7.47)
	4	169.20 (12.99)	169.95 (21.77)	174.14 (11.11)	176.62 (29.65)
	5	206.23 (29.69)	178.98 (4.28)	173.65 (17.71)	224.30 (45.11)
soap (kg)	1	23.51 (4.83)	22.36 (5.21)	24.21 (6.35)	22.83 (2.51)
	2	20.85 (1.20)	24.80 (4.80)	19.75 (0.87)	19.81 (2.26)
	3	22.74 (5.68)	20.10 (1.68)	19.64 (1.19)	19.51 (1.97)
	4	19.16 (18.70)	19.34 (1.64)	18.89 (2.42)	20.68 (6.66)
	5	26.39 (9.44)	26.92 (10.05)	25.49 (4.77)	21.68 (3.86)
price index	1	1.106 (0.065)	0.951 (0.064)	1.077 (0.145)	1.077 (0.105)
	2	1.075 (0.139)	0.983 (0.082)	0.960 (0.095)	1.084 (0.085)
	3	1.139 (0.123)	0.942 (0.094)	1.098 (0.122)	1.044 (0.084)
	4	1.034 (0.076)	1.006 (0.092)	1.115 (0.064)	1.131 (0.080)
	5	1.132 (0.151)	0.889 (0.109)	0.976 (0.140)	1.073 (0.111)

Standard deviations in parentheses.

Table 8: Descriptive statistics for the comparison of local and regional deflations (FGT indices)

a	0 L	0 R	1 L	1 R	2 L	2 R	3 L	3 R
A	0.1738	0.0776	0.2374	0.1176	0.2758	0.02687	0.3083	0.01534
	(0.114)	(0.0757)	(0.0966)	(0.0843)	(0.102)	(0.0125)	(0.108)	(0.00656)
B	-0.2323	-0.2425	-0.2560	-0.233	-0.2585	-0.259	-0.2545	-0.252
	(0.0585)	(0.109)	(0.0691)	(0.119)	(0.0712)	(0.0634)	(0.0759)	(0.0661)
C	-0.009336	-0.03	0.01129	-0.04833	0.030121	-0.115	0.05033	-0.0455
	(0.107)	(0.108)	(0.0729)	(0.0730)	(0.0822)	(0.175)	(0.0927)	(0.0800)
D	0.05703	0.04383	0.07452	0.056	0.06246	0.06033	0.04791	0.05966
	(0.0617)	(0.0331)	(0.0745)	(0.0667)	(0.0788)	(0.0672)	(0.0740)	(0.0647)
AP	-0.01307	-0.04916	0.009838	-0.032	0.02377	-0.02283	0.06786	-0.013
	(0.0667)	(0.0684)	(0.0745)	(0.0691)	(0.0818)	(0.0705)	(0.0359)	(0.0685)
CP	-0.05795	-0.0605	-0.07204	-0.06333	-0.1053	-0.06516	-0.1452	-0.06583
	(0.0842)	(0.0737)	(0.114)	(0.102)	(0.134)	(0.117)	(0.148)	(0.129)
F	0.3291	0.1361	0.03605	0.03016	0.02278	0.01933	0.00849	0.01183
	(0.323)	(0.196)	(0.142)	(0.0569)	(0.117)	(0.0364)	(0.122)	(0.0291)

a is the parameter of the FGT indices. The first number in each cell is the mean of the relative variation due to the local deflation, calculated over the six poverty lines. The number in parenthesis is the standard deviation of the relative variation due to the local deflation, calculated over the six poverty lines.

Columns (L) correspond to local deflations, while columns (R) correspond to regional deflations.

Table 9: Descriptive statistics for the comparison of local and regional deflations (C&W indices)

c	W	W	1	1	1/2	1/2	1/3	1/3
	L	R	L	R	L	R	L	R
A	0.2561	0.161	0.2375	0.1172	0.2451	0.1181	0.2484	0.1185
	(0.0993)	(0.0906)	(0.0965)	(0.0843)	(0.0976)	(0.0848)	(0.0980)	(0.0847)
B	-0.2573	0.08549	-0.2548	0.06525	-0.2564	-0.2475	-0.2566	-0.2588
	(0.0696)	(0.0386)	(0.0680)	(0.0293)	(0.0692)	(0.0607)	(0.0693)	(0.0759)
C	0.01815	-0.049	0.01129	-0.006966	0.01450	-0.04788	0.03707	-0.0484
	(0.0765)	(0.0737)	(0.0729)	(0.0776)	(0.0744)	(0.0730)	(0.0832)	(0.0734)
D	0.06186	-0.0205	0.07452	0.05590	0.0700	0.05553	0.06834	0.05516
	(0.0703)	(0.199)	(0.0745)	(0.0661)	(0.0736)	(0.0648)	(0.0729)	(0.0636)
AP	0.01530	-0.02703	0.009807	-0.03333	0.02916	0.0167	0.03261	-0.02985
	(0.0752)	(0.06794)	(0.0745)	(0.0705)	(0.0816)	(0.0871)	(0.0841)	(0.0696)
CP	-0.08009	0.0644	-0.07202	-0.06303	-0.075634	-0.0631	-0.07707	-0.0755
	(0.118)	(0.105)	(0.114)	(0.102)	(0.116)	(0.103)	(0.117)	(0.120)
F	0.07661	0.03358	0.083887	0.03961	0.08479	0.03685	0.08274	0.03578
	(0.0470)	(0.0373)	(0.0499)	(0.0464)	(0.0530)	(0.0423)	(0.0511)	(0.0407)

c is the parameter of the Ch indices. W denotes the Watts' index.

The first number in each cell is the mean of the relative variation due to the local deflation, calculated over the six poverty lines. The number in parenthesis is the standard deviation of the relative variation due to the local deflation, calculated over the six poverty lines.

Columns (L) correspond to local deflations, while columns (R) correspond to regional deflations.

Table 10: <u>Variation of the population of the poor caused by the deflation</u>

Poverty lines	1	1	2	2	3	3	4	4	5	5	6	6
Error Type	I	II	I	II	I	II	I	II	I	II	I	II
Year	1.45	2.18	0.63	0.61	0.58	0.20	2.90	2.29	4.94	1.26	7.12	0.29
Quarter A	0.67	5.13	0.00	5.46	0.93	3.17	0.36	7.46	0.93	4.20	3.66	3.93
Quarter B	5.59	0.30	4.52	0.00	5.67	0.00	8.60	1.78	11.8	0.29	10.8	0.00
Quarter C	2.57	6.52	2.23	1.53	2.35	1.78	2.36	5.64	4.43	1.84	6.38	0.43
Quarter D	1.57	4.44	1.85	3.55	3.52	3.27	0.00	8.04	0.89	5.37	2.94	1.70

The first column (Type I error) for each poverty line shows the percentage of households that are poor before the deflation and not after. The second column (Type II error) for each poverty line shows the the percentage households that are poor after the deflation and not before. The poverty lines are those calculated from deflated living standards distributions.

Table 11 : Differences in C&W's Poverty indices between regional and local deflation (local – regional)

	poverty lines based on the first quintile											
	z_1			>			z_2	>			z_3	
Poverty index	W	C(1)	C(1/2)	C(1/3)	W	C(1)	C(1/2)	C(1/3)	W	C(1)	C(1/2)	C(1/3)
A	0.00891	0.00689*	0.00374*	0.00224*	0.0296*	0.00553	0.00268*	0.00162*	0.0179	0.00416	0.00237*	0.00140*
	(0.0151)	(0.00321)	(0.00187)	(0.000998)	(0.0148)	(0.00349)	(0.00130)	(0.000627)	(0.0200)	(0.00293)	(0.00100)	(0.000509)
B	-0.0108	-0.000220	0.0000285	-0.0000396	-0.00937	0.000980	-0.0000200)	-0.0000872	0.0328*	0.000848	-0.000147	-0.0000873
	(0.0173)	(0.00356)	(0.00106)	(0.000413)	(0.0157)	(0.00183)	(0.000584)	(0.00222)	(0.0125)	(0.00166)	(0.000444)	(0.000151)
C	0.0231*	0.00535*	0.00202	0.00124	0.00191	0.00267	0.00148	0.000960	0.0263	0.00330*	0.00130	0.000852
	(0.00521)	(0.00164)	(0.00121)	(0.000780)	(0.0132)	(0.00222)	(0.000947)	(0.000624)	(0.0176)	(0.00166)	(0.000800)	(0.000591)
D	0.00786	0.00133	-0.0000786	-0.000395	-0.0000572	-0.000175	-0.000326	-0.000489	-0.00513	0.000511	-0.000377	-0.000526
	(0.0333)	(0.00363)	(0.00216)	(0.00122)	(0.0111)	(0.00380)	(0.00172)	(0.000788)	(0.0177)	(0.00359)	(0.00142)	(0.00614)
CP	0.00366	0.000252	-0.000451	-0.000386	0.00230	-0.000645	-0.000590*	-0.000300*	0.00489	-0.00123	-0.000524	-0.000235
	(0.00531)	(0.00246)	(0.0151)	(0.000256)	(0.00820)	(0.000946)	(0.000270)	(0.000147)	(0.00780)	(0.000674)	(0.000202)	(0.000131)

	poverty lines based on								the second quintile			
		z_4		>		z_5		>			z_6	
Poverty indices	W	C(1)	C(1/2)	C(1/3)	W	C(1)	C(1/2)	C(1/3)	W	C(1)	C(1/2)	C(1/3)
A	0.0379*	0.0101*	0.00533*	0.00335*	0.0304	0.00850*	0.00469*	0.00295*	0.0177*	0.00739*	0.00395*	0.00239*
	(0.0140)	(0.00359)	(0.00231)	(0.00152)	(0.0175)	(0.00321)	(0.00214)	(0.00134)	(0.00901)	(0.00304)	(0.00194)	(0.00108)
B	0.0261	-0.00209	-0.000389	-0.0000787	-0.0308	-0.00141	-0.000114	-0.0000367	-0.00447	-0.000425	0.00000511	-0.0000343
	(0.0271)	(0.00643)	(0.00232)	(0.00101)	(0.0310)	(0.00527)	(0.00184)	(0.000761)	(0.0260)	(0.00397)	(0.00122)	(0.000474)
C	-0.00613	0.00268	0.00279	0.00189	-0.0383	0.00367	0.00275	0.00168	-0.00643	0.00584	0.00224	0.00132
	(0.0153)	(0.00335)	(0.00145)	(0.000997)	(0.0241)	(0.00231)	(0.00127)	(0.000924)	(0.0138)	(0.00171)	(0.00123)	(0.000816)
D	0.0336	0.00422	0.000877	-0.0000253	0.0169	0.00320	0.000445	-0.000194	-0.00792	0.00177	0.0000230	-0.000361
	(0.0186)	(0.00631)	(0.00306)	(0.00183)	(0.0183)	(0.00591)	(0.00263)	(0.00160)	(0.0367)	(0.00385)	(0.00223)	(0.00131)
CP	-0.00325*	-0.000297	-0.000182	-0.000332	-0.0212	0.000436	-0.000230	-0.000365	-0.00589	0.000548	-0.000399	-0.000390
	(0.0150)	(0.00353)	(0.00145)	(0.000651)	(0.0236)	(0.00312)	(0.00117)	(0.000488)	(0.0202)	(0.00247)	(0.000761)	(0.000298)

Sampling errors in parentheses. * = significant at 5 % level.

Table 12 : Differences in FGT's Poverty indices between regional and local deflation (local – regional)

	poverty lines based on the first quintile											
	z_1		>			z_2		>			z_3	
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.00843*	0.00534	0.00329	0.00235	0.00732	0.00494	0.00295	0.00209	0.00967*	0.00660*	0.00394*	0.00277*
	(0.00466)	(0.00312)	(0.00188)	(0.00133)	(0.00457)	(0.00347)	(0.00196)	(0.00136)	(0.00359)	(0.00277)	(0.00155)	(0.00107)
B	-0.00229	-0.00171	-0.000973	-0.000676	0.00000765	0.000293	0.0000920	0.0000437	0.00308	0.00270	0.00144	0.000979
	(0.00388)	(0.00332)	(0.00180)	(0.00122)	(0.00204)	(0.00179)	(0.000962)	(0.000649)	(0.00202)	(0.00173)	(0.000936)	(0.000635)
C	0.00527	0.00388*	0.00222	0.00155	0.00319	0.00196	0.00123	0.000886	0.00790*	0.00581*	0.00335*	0.00233*
	(0.00270)	(0.00167)	(0.00104)	(0.000748)	(0.00299)	(0.00220)	(0.00126)	(0.000882)	(0.00254)	(0.00194)	(0.00108)	(0.000753)
D	-0.00257	-0.000862	-0.000720	-0.000573	-0.00244	-0.00121	-0.000814	-0.000608	0.00514	0.00457	0.00242	0.00163
	(0.00477)	(0.00353)	(0.00207)	(0.00143)	(0.00465)	(0.00372)	(0.00209)	(0.00143)	(0.00471)	(0.00375)	(0.00209)	(0.00143)
	-0.00185	-0.00105	-0.000699	-0.000508	-0.00156	-0.00101	-0.000630	-0.000448	0.000197	0.000254	0.000116	0.0000737
CP	(0.00280)	(0.00232)	(0.00126)	(0.000865)	(0.00116)	(0.000950)	(0.000521)	(0.000356)	(0.000835)	(0.000705)	(0.000381)	(0.000259)

	poverty lines based on								the second quintile			
	z_4		>			z_5		>			z_6	
a	0	1	2	3	0	1	2	3	0	1	2	3
A	0.0236*	0.0158*	0.00952*	0.00674*	0.00985	0.00609	0.00379	0.00272	0.00776	0.00483	0.00300	0.00215
	(0.00622)	(0.00383)	(0.00239)	(0.00172)	(0.00518)	(0.00318)	(0.00200)	(0.00143)	(0.00457)	(0.00298)	(0.00182)	(0.00129)
B	0.00538	0.00352	0.00217	0.00154	-0.00482	-0.00379	-0.00211	-0.00145	-0.00380	-0.00285	-0.00162	-0.00112
	(0.00829)	(0.00657)	(0.00368)	(0.00252)	(0.00624)	(0.00522)	(0.00285)	(0.00194)	(0.00429)	(0.00365)	(0.00198)	(0.00134)
C	0.0141	0.00875*	0.00549*	0.00394*	0.00273	0.000994	0.000837	0.000653	0.00435	0.00315	0.00181	0.00126
	(0.00488)	(0.00336)	(0.00197)	(0.00139)	(0.00351)	(0.00243)	(0.00142)	(0.00100)	(0.00279)	(0.00171)	(0.00107)	(0.00077)
D	0.0154	0.0120	0.00680	0.00468	-0.00221	-0.000208	-0.000435	-0.000401	-0.00425	-0.00196	-0.00138	-0.00104
	(0.00922)	(0.00668)	(0.00391)	(0.0273)	(0.00741)	(0.00581)	(0.00329)	(0.00226)	(0.00490)	(0.00375)	(0.00216)	(0.00149)
	0.00731	0.00592	0.00329	0.00225	-0.00329	-0.00221	-0.00133	-0.000944	-0.00295	-0.00191	-0.00118	-0.000839
CP	(0.00481)	(0.00369)	(0.00209)	(0.00144)	(0.00388)	(0.00302)	(0.00170)	(0.00117)	(0.00295)	(0.00240)	(0.00132)	(0.000905)

Sampling errors in parentheses. a is the parameter of the FGT index. * = significant at 5 % level.

Appendix 1: **Sampling standard-error estimators**

The poverty indicator of a sub-population is estimated by a ratio of the type

$$\overline{y_{x'}} = \frac{z'}{x'}$$

where ' denotes the Horwitz-Thompson estimator for a total (sum of values for the variable of interest weighted by the inverse of inclusion probability). z is the sum of the poverty in the sub-population and x is the size of the sub-population. The variance associated with the sampling error is then approximated by:

$$V(\overline{y_{x'}}) = [V(z') \; 2 \; \overline{y_{x'}} \, Cov(z',x') + (\overline{y_{x'}})^2 \; V(x')] \; / \; (x')^2$$

obtained from a Taylor expansion at the first order from function Y = f(Z/X) around (E y', Ex') and because E z' ≠ 0 and x' does not cancel, where the appropriate expectancies are estimated by x' and $\overline{y_{x'}}$.

We divide the sample of communes (first actual stage of the sampling since all the prefectures are drawn) in five super-strata (α = 1 to 5) so as to group together the communes sharing similar characteristics, and to reduce a priori the variance intra-strata. Several sectors are assumed to have been drawn in each strata. This allows the estimation of the variance intra-strata, while the calculation of the variance intra-commune was impossible, since in fact only one sector had been drawn in each commune. Then, the Horwitz-Thompson formula for superstrata α is:

$$z_{\alpha'} = \sum_h \frac{M_h}{m_{h\alpha}} \sum_{i=1}^{m_{h\alpha}} \frac{N_{hi}}{n_{hi}} \sum_{j=1}^{n_{hi}} \frac{Q_{hij}}{q_{hij}} \sum_{k=1}^{q_{hij}} z_{hijk}$$

and

$$x_{\alpha'} = \sum_h \frac{M_h}{m_{h\alpha}} \sum_{i=1}^{m_{h\alpha}} \frac{N_{hi}}{n_{hi}} \sum_{j=1}^{n_{hi}} \frac{Q_{hij}}{q_{hij}} \sum_{k=1}^{q_{hij}} x_{hijk}$$

where M_h is the number of communes in prefecture h; $m_{h\alpha}$ is the number of communes in prefecture h and drawn in superstrata α; N_{hi} is the number of sectors in commune i of prefecture h and superstrata α; n_{hi} is the number of sectors drawn in commune i of prefecture h and superstrata α; Q_{hij} is the number of households in sector j of commune i of prefecture h; q_{hij} is the number of households drawn in sector j of commune i of prefecture h and superstrata α. A similar formulae can also be used to account for the intermediary drawing of several districts in every sector.

Cov(z',x') is estimated by:

$$\hat{C}ov(z',x') = \frac{1}{20} \sum_{\alpha=1}^{5} (z_{\alpha'} \; z').(x_{\alpha'} \; x')$$

and similar formulae for V(x) and V(z) are obtained by making x=z.

More accurate formulae could be used (with resampling, post-stratification, optimal definition of strata), but the present one is believed to be enough to obtain useful assessments of the standard errors. Indeed, the existence of remaining measurement errors makes illusory the accuracy of inferences based only on sampling errors.

Appendix 2: Properties of the price samples

A preliminary analysis of the price data base has shown us for the main products that production prices are almost always below consumption prices and market prices, for the same product at the same period in the same district. This is expected because of transport, transaction and intermediate costs. Therefore, production prices are avoided when possible for the analysis of welfare based on consumption levels. By contrast, the preliminary analysis of the consumption price means and the market price means has shown that these indicators are very close and cannot be systematically ordered.

These two latter sources have different qualities. Market price surveys are believed to provide price information that is less dependent from household tastes and purchasing power by better controlling quality choices. However, since price observations are collected only in selected sites, they may provide inaccurate estimates of the prices to which are confronted some households. Moreover, the wording of the questions and the whole collection process of prices is always debatable in that it constitutes an artificial observation situation, different from what occurs during actual transactions. Finally, it is never possible to obtain price observations for all goods in all selected markets or transaction sites. This means that the treatment of missing values for prices is an important stage of using market price data. Furthermore, even when price observations are available, the analyst is not content to use them if they are isolated. A large sample of price observations is in fact necessary and what is called "market price" in the price file is a central tendency of this sample, the mean or the median of observed prices.

When budget data is used to calculate prices, the information about prices fit more closely the consumption patterns of the household. Indeed, goods that are usually consumed in an area generally appear in purchase or sale transactions, even when they are only consumed in kind (from their own production or received as gift) by some of the households of this area. Unfortunately, the prices extracted from a budget survey are in fact elementary "unit-values", i.e. ratios of values over quantity extracted from observations of the individual transactions. Elementary unit-values are believed to be affected by quality choices of consumers or sellers. In that situation, a higher level of prices for a specific household (for instance a rich one), might derive from a higher quality of its consumption[18]. Moreover, consumption data is known to incorporate large measurement errors, that can be amplified by the use of unit values instead of exogenous prices. Of course, when no price data are available, unit-values Paasche or Laspeyres indices might well be better than no correction at all.

This problem is here for elementary goods much less serious than for unit-values calculated from categories of consumption, as in Deaton (1988, 1990), where similar goods are aggregated in a common category, for example "fish". In the latter case the unit-value calculated from these aggregate values and quantities has little common with the observed prices in a market (the price of a specific fish). However, even if one expects it to be here relatively minor, the quality choice influence remains. Another difficulty is that elementary unit-values may be affected by the measurement errors occuring in value and quantity observations.

Because of these correlations, inferences issued in welfare analysis may be doubtful (Sen (1997)). The endogeneity of price indicators can be treated using a prediction model for prices, much relying on dummy variables of the clusters of the sample among other variables, or merely using average prices, at the cluster or at the region level. Indeed, aggregate means discard most of endogeneity problems associated with a specific household, which contributes only to a negligible fraction of the appropriate mean[19]. They do not eliminate endogeneity arising at a regional level, for example high prices reflecting a high quality due to the general wealth in this region or to regional tastes. However, this difficulty is also present with market prices.

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[18] "It is not possible to use unit values as direct substitutes for true market prices in the analysis of demand patterns. Consumers choose the quality of their purchases, and unit values reflect this choice" (Deaton (1988)).

[19] It is even possible to exclude the considered households in the calculus of the mean, although this does not change much the result in practice.

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