

Muller, Christophe

Working Paper

The spatial association of price indices and living standards

CREDIT Research Paper, No. 99/8

Provided in Cooperation with:

The University of Nottingham, Centre for Research in Economic Development and International Trade (CREDIT)

Suggested Citation: Muller, Christophe (1999) : The spatial association of price indices and living standards, CREDIT Research Paper, No. 99/8, The University of Nottingham, Centre for Research in Economic Development and International Trade (CREDIT), Nottingham

This Version is available at:

<https://hdl.handle.net/10419/81772>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

THE INDEPENDENCE BETWEEN PRICE INDICES AND LIVING STANDARDS IN RWANDA

Christophe MULLER

Centre for the Study of African Economies
Institute of Economics and Statistics
University of Oxford

September 1998

(Preliminary version 1.1)

Codes JEL: I32 (Measurement and Analysis of Poverty), O15 (Income Distribution), D31 (Personal Income Distribution)

I acknowledge a TMR grant from the European Union. I am grateful to the Ministry of Planning of Rwanda that provided me with the data, and in which I worked from 1984 to 1988 as a technical adviser from the French Cooperation and Development Ministry.

Abstract

Using data from several seasons in Rwanda, we test the independence between Laspeyres local and seasonal price indices and nominal living standards in Rwanda. The results show that the hypothesis of independence cannot generally be rejected in Rwanda, although the choice of the adult-equivalence scale can be influential in some seasons.

This result has several consequences
insérer parag de l'intro

Résumé

1 Introduction

Geographical differences in prices that households face is a typical feature of LDCs, much explained by imperfect markets, high transport and commercialisation costs, information problems.

The independence between prices and real living standards is commonly taken for granted in applied microeconomics, often without mention, let alone statistical test. In welfare analysis, the non independence between prices and living standards may imply to use more sophisticated methods as usual (as in Muller (1998c)). In behavioural models such as consumption demands or output supply, the consideration of the sampling scheme generating decisions and price observations, and the non independence between prices and living standards may imply to revise the usual hypothesis of exogeneity of prices, similarly to what happens when using unit-values instead of prices (Deaton (1988, 1990)).

decrire a ...nd les raisons pour lesquelles les p i et les n l s peuvent etre lies. Idem poout les p i et les r l s

The theoretical literature about price indices is extensive¹. It has been applied to empirical welfare studies (Muellbauer (1974); Glewwe (1990), Grootaert and Kanbur (1996)). Theoretical price indices are ratios of cost functions representing the preferences of households. However in practice, applied price indices are generally Laspeyres or Paasche price indices, much ignoring the responses of households to price movements.

The aim of this article is to test the independence of living standards and Laspeyres price indices. We use data from Rwanda in which substantial seasonal and geographical variability of prices justifies to correct living standards using local price indices.

We present the data in section 2 and the results of the tests of independence in section 3. Finally, section 4 concludes.

2 The Data

Rwanda in 1983 is a small rural country in Central Africa. At this period, it is relatively preserved from extreme economical, political or climatic shocks.

¹ See among others: Fisher and Shell (1972); Pollak (1978); Diewert (1981); Foss, Manser, Young (1982), Baye (1985); Pollak (1989); Diewert (1990), Selvanathan and Rao (1995).

Its population is 5.7 million, nearly half under 15 years of age. Rwanda is one of the poorest country in the world, with per capita GNP of US \$ 270 per annum. More than 95 percent of the population live in rural areas (Bureau National du Recensement (1984)) and agriculture is the mainstay of the economy, accounting for 38 percent of GNP and most of the employment.

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))². 270 households were surveyed about their budget and their consumption. The consumption indicators are of very high quality. Indeed, every household was visited at least once a day, during two weeks for every quarter. Daily and retrospective interviews and food weighting were carried out, and every household had also to register much information in a diary between the quarterly survey rounds. This enabled a thorough cleaning of the data, by more than thirty ex-enumerators after the collection, under our supervision. Sophisticated verification algorithms have been designed using the many redundancies present in the data. Finally, the consumption indicators are based on algorithms reducing measurement errors, from the combination of several information sources.

Agricultural year 1982-83 is a fairly normal year in terms of climatic fluctuations (Bulletin Climatique du Rwanda (1982, 1983, 1984)). The agricultural year can be split up into four climatic seasons and two cultural seasons. The collection of the consumption data was organised in four rounds, corresponding to four quarters (A, B, C, D) of the agricultural year 1982-83, and roughly assimilated to seasons.

The average household size has 5.22 members, including 2.67 children or adolescents (less than 18 years old), and 2.55 adults (18 years old and more). The average land area is very small (1.24 ha). Table 1 shows that for the sample used in estimations, the average agricultural production is worth 57 158 Frw (Rwandan Francs), which is to compare with 51 176 Frw of average consumption (10613 Frw per capita).

Several studies of price surveys in Rwanda show that the geographical and seasonal price variabilities are considerable (Niyonteze and Nsengiyumva (1986), O.S.C.E. (1987), Ministère du Plan (1986b), Muller (1988b)).

²The main part of the collection has been designed with the help of INSEE (French national statistical institute).

We have calculated elementary price indicators of the main categories of goods, for every season and every cluster of the sample. The prices of each category of goods are represented by the price of the main product, which enables us to compare prices across seasons and clusters with little quality bias. Muller (1998a) discusses the type and the sample of prices used, the price index and the difficulty of the shadow prices approach. True price indices could be derived from the estimation of a complete demand system (as in Braithwait (1980) and Slesnick (1993)). Because of market imperfections and high own-consumption rates, production and consumption decisions of most agricultural households are likely to be non separable. In that situation, shadow prices (Pollak (1978), Singh, Squire and Strauss (1986)), would be required for the calculus of price indices. Since the high own-consumption ratios that are observed in the sample, these shadow prices are expected to be intermediate between observed consumption prices and observed production prices (de Janvry, Sadoulet, Fafchamps (1991)). 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 valorise the observed weighted food for consumption. The average market and consumption prices at the cluster level, are preferred herein for the calculation of price indices.

We approximate the theoretical price index with a Laspeyres price index (I_{it}) specific to each household and each period, in which the basis is the annual national average consumption.

$$I_{it} = \sum_j \lambda_j \frac{p_{gt}^j}{p_{it}^j} \text{ where } \lambda_j = \frac{S_i S_t p_{it}^j q_{it}^j}{\sum_j S_i S_t p_{it}^j q_{it}^j} \quad (1)$$

where p_{it}^j (resp. p_{gt}^j) is the price of good j for household j (resp. in cluster g where is observed household i) at date t , q_{it}^j is the consumed quantity of good j by household i at date t in cluster g .

The annual national prices are calculated as follows:

$$p_{it}^j = \frac{S_i S_t p_{it}^j q_{it}^j \text{POND}_{it}}{\sum_j S_i S_t q_{it}^j \text{POND}_{it}} \quad (2)$$

where POND_{it} is the sampling weight of household i at date t , corrected for missing values. We therefore consider simultaneously geographical and

seasonal price variability, although without modelling temporal and spatial autocorrelations of prices.

The living standard indicator for household i at period t is

$$y_{it} = \frac{c_{it}}{es_i I_{it}} = \frac{w_{it}}{I_{it}} \quad (3)$$

where c_{it} is the value of the consumption of household i at period t ; w_{it} is the standard of living of household i at date t ; es_i is the equivalence scale of household i and I_{it} is the price index (or "p.i.") associated with household i and period t . We denote $w_{it} = c_{it}/es_i$, the living standard indicator non corrected for price variability (nominal living standard, or "n.l.s.").

The equivalence scale is defined by:

where n_{mk} is the number of members in class k and a_k is the adult-equivalent coefficient for a member of class k . Four classes have been defined: male adults ($k=1$), female adults ($k=2$), children over 10 years old ($k=3$), children between 0 and 10 years old ($k=4$). es_0 corresponds to the per capita consumption ($a_k = 1$ for all members); es_1 is defined by: $a_1 = a_2 = 1$, $a_3 = 1/3$, $a_4 = 1/4$; es_2 is defined by: $a_1 = 1$, $a_2 = 0.7$, $a_3 = 0.2$, $a_4 = 0.15$. We do not consider the change of household composition across the seasons because of the lack of reliable data.

To account for geographical and seasonal price variations, we correct the individual welfare indicators by the individual price indices (see for instance Muellbauer (1973)). We calculate elementary price indices of the main categories of product for every season and every cluster. The prices of each category of product are represented by the price of the main product, which ensures the comparability of prices across seasons and regions with little quality bias. Again, the estimation of a cost function for every household may introduce some variability coming from the inaccuracy of the estimates, which is probably not wise when studying the transient component of poverty. We therefore prefer to approximate the structural individual price index by a price index (I_{it}) specific to each household and each period.

Because of market imperfections and high autoconsumption rates, production and consumption decisions of most agricultural households are likely to be non separable. For this reason, shadow prices corresponding to the separating budget constraint would be more appropriate in the calculus of price indices. However, these shadow prices are unobserved and their estimation from a complete agricultural household model may lead to very noisy estimates, in contradiction with our robustness approach.

3 Tests of independence

Table 1 provides the mean and standard deviation of real and nominal per capita consumption, real production and consumption, price index, for every quarter and at the yearly level. While the mean price index and the mean nominal per capita consumption do not seem to move parallelly across the quarters, their standard deviations are large enough to indicate that most of their variability comes from differences across quarters. This suggests to examine the link between p.i. and n.l.s. at the household level.

Table 2 shows the correlation coefficients between price indices and nominal living standards (i.e. value of household consumption divided by adult-equivalent scale), and the correlation coefficients between the same variables in logarithms, at several periods and for several equivalence scales. Most of the correlation coefficients are not significant. However, it may be that the relation between p.i. and n.l.s is not linear, which implies to test directly their independence and not only their linear correlation.

Table 3 shows the results of tests of independence between nominal living standards and price indices, based on deciles of these variables. Of course, deciles of variables in levels and in logarithms are identical.

\hat{A}^2 , ϕ (difference between conditional probabilities of like and unlike order) and Kendall's λ_b test statistics have been calculated, as well as the Cramer's V association measure. Goodman and Kruskal (1954, 1959, 1963, 1972) discuss measures of association for cross classification.

Definition 1 Let be P, the number of concordances of the two classification variables, and Q, the number of discordances, then

$$\phi = (P-Q)/(P+Q);$$

$$\lambda_b = (P-Q)/((n^2 - n_{i.})(n^2 - n_{.j}))^{1/2}$$

$$\text{and Cramer's } V = (\hat{A}^2/(n \cdot \text{Min}(I-1, J-1)))^{1/2}.$$

The results of the \hat{A}^2 test show that there is almost always independence between price indices and nominal living standards (except once in period C). The ϕ and the λ_b tests indicate that the only period when independence is rejected is quarter A (and not with the equivalence scale es0).

A few differences occur between the results on the one side of the correlation coefficients and \hat{A}^2 tests, and on the other side of the ϕ and the λ_b tests. Such upshot is due to the different proximity measures associated with the

various tests. Moreover, the measure of association V is between 0.17 and 0.23, implying that the non rejection of the independence hypothesis may well be attributed to the small sample size.

However, on the whole, price and nominal living standards are close to a situation of independence, even if quarters A and B are sometimes associated with a significant dependence between price indices and nominal living standards with scales es1, es2, es3).

Scales es1 and es2 are more often related to significant dependence (in quarter A or C for some tests), which invite analysts to try several different scales when the dependence matters for the problem under study.

ajouter tests d independence avec real living standards to show that dividing by the peice index can create a pb

4 Conclusion

Using data from several seasons in rural Rwanda in 1983, we test and cannot reject the hypothesis of independence of Laspeyres local and seasonal price indices and nominal living standards.

This implies firstly that prices can be safely considered as exogenous in living standards models and in consumption demand equations since our notion of living standard is based on observations of quarterly consumption **AV** Secondly, that theorems of welfare analysis based on this assumption of independence can be applied (see Muller (1998d)); thirdly this justifies the separated study of distributional functional forms for price indices or nominal living standards distributions.

1 parag sur resultats avec real livingf atnadrds

Table 1: Mean and standard deviation of the main variables

	Annual	A	B	C	D
Real Consumption	$\frac{51176:15}{(24985:80)}$	$\frac{13521:52}{(9527:40)}$	$\frac{13232:20}{(8192:52)}$	$\frac{13452:85}{(8249:68)}$	$\frac{10969:57}{(6092:44)}$
Real Production	$\frac{57158:02}{(24985:80)}$	$\frac{13240:50}{(12178:27)}$	$\frac{15548:30}{(16610:28)}$	$\frac{15416:63}{(18171:03)}$	$\frac{12952:59}{(10662:06)}$
Real Per Capita Consumption	$\frac{10613:27}{(5428:08)}$	$\frac{2750:173}{(1701:169)}$	$\frac{2702:944}{(1620:898)}$	$\frac{2850:082}{(1968:637)}$	$\frac{2310:075}{(1511:553)}$
Price Index	$\frac{1:0487}{(0:0634)}$	$\frac{1:1087}{(0:1294)}$	$\frac{0:9534}{(0:1015)}$	$\frac{1:0476}{(0:1316)}$	$\frac{1:0847}{(0:0978)}$
Nominal Per Capita Consumption	$\frac{10905:18}{(5355:731)}$	$\frac{2995:399}{(1826:006)}$	$\frac{2539:347}{(1475:742)}$	$\frac{2902:023}{(1834:125)}$	$\frac{2468:417}{(1524:948)}$

Standard deviations in parentheses.

Table 2: Correlation coefficients between nominal living standards and price indices

Quarter	es0	es1	es2	es3
A	0.0448 (0.48)	0.0606 (0.33)	0.0506 (0.42)	0.0478 (0.45)
B	0.0442 (0.48)	0.0774 (0.22)	0.0903 (0.15)	0.1051 (0.0933)
C	0.1103 (0.0782)	0.1448 (0.0205) [*]	0.1566 (0.0121)	0.1568 (0.012) [*]
D	0.1124 (0.0726)	0.1123 (0.0729)	0.118 (0.0591)	0.1157 (0.0645)

Correlation coefficients between logarithms of nominal living standards and logarithm of price indices

Quarter	es0	es1	es2	es3
A	0.1170 (0.0617)	0.1349 [*] (0.0310)	0.1289 [*] (0.0393)	0.1176 (0.0602)
B	0.0371 (0.5547)	0.0569 (0.3648)	0.0740 (0.2380)	0.0939 (0.1339)
C	0.0945 (0.1315)	0.1179 (0.0596)	0.1279 [*] (0.0408)	0.1305 [*] (0.0369)
D	0.0471 (0.4529)	0.0256 (0.6836)	0.0304 (0.6279)	0.0441 (0.4822)

*: significant at 5 percent levels. P-value in parentheses.

Table 3: Independence tests

Quarternscale	es0	es1	es2	es3
A	0:340	0:131	0:415	0:265
	0:1928	0:2035	0:1899	0:1961
	A	R	R	R
	A	R	R	R
B	0:701	0:626	0:852	0:669
	0:1784	0:1817	0:1706	0:1798
	A	A	A	A
	A	A	A	A
C	0:304	0:005	0:217	0:144
	0:1943	0:2261	0:1984	0:2026
	A	A	A	A
	A	A	A	A
D	0:287	0:666	0:066	0:275
	0:1951	0:1804	0:2099	0:1956
	A	A	A	A
	A	A	A	A

In each cell, are shown successively: P-value of \hat{A}^2 test; Cramer's V association measure; Result of χ^2 test at 5 percent level (A = not rejected, R= rejected); Result of χ_b^2 test at 5 percent level (A = not rejected, R= rejected).

BIBLIOGRAPHY

BAYE, M.R., "Price Dispersion and Functional Price Indices", *Econometrica*, Vol. 53, No. 1, January 1985.

BULLETIN CLIMATIQUE DU RWANDA, "Climatologie et Précipitations", Kigali, 1982, 1983, 1984.

BUREAU NATIONAL DU RECENSEMENT, "Recensement de la Population du Rwanda, 1978. Tome 1: Analyse.", Kigali, Rwanda, 1984.

DEATON, A., "Quality, Quantity, and Spatial Variation of Price", *The American Economic Review*, pp 418-430, 1988.

DEATON, A., "Price Elasticities from Survey Data. Extensions and Indonesian Results", *Journal of Econometrics*, 44, 281-309, 1990.

DE JANVRY, A., M., FAFCHAMPS and E. SADOULET, "Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained", *The Economic Journal*, 101, 1400-1417, November 1991.

DEWERT, W.E., "The economic theory of index numbers: a survey", in A. Deaton, "Essays in the theory and measurement of consumer behaviour in honour of Sir Richard Stone", Cambridge University Press, 1981.

DEWERT, W.E., "Price Level Measurement", North Holland, 1990.

FISHER, F.M. and K. SHELL, "The Economic Theory of Price Indices", Academic Press, 1972.

FOSS, M.F., M. E. MANSER and A. H. YOUNG, "Price Measurement and Their Uses", NBER Conference on Research on Income and Wealth, Studies in Income and Wealth, volume 57, 1982.

GLEWWE, P., "The Measurement of Income Inequality under Inflation", *Journal of Development Economics*, 32, 43-67, 1990.

GOODMAN, L.A. and W.H. KRUSKAL, "Measures of Association for Cross Classifications: I", *American Statistical Association Journal*, December 1954.

GOODMAN, L.A. and W.H. KRUSKAL, "Measures of Association for Cross Classifications: II", *American Statistical Association Journal*, March 1959.

GOODMAN, L.A. and W.H. KRUSKAL, "Measures of Association for Cross Classifications: III", *American Statistical Association Journal*, June 1969.

GOODMAN, L.A. and W.H. KRUSKAL, "Measures of Association for Cross Classifications: IV", *American Statistical Association Journal*, 1972.

GROTAERT, C. and R. KANBUR, "Regional Price Differences and Poverty Measurement" in C. GROTAERT, "Analysing Policy and Policy Reforms", Avebury, 1996.

MINISTERE DU PLAN, "Méthodologie de la Collecte et de l'échantillonnage

de l'Enquête Nationale sur le Budget et la Consommation 1982-83 en Milieu Rural", Kigali, 1986a.

MINISTERE DU PLAN, "Enquête des Prix PCI au Rwanda", Kigali, 1986b.

MUELLBAUER, J., "Inequality Measures, Prices and Household Composition", *Review of Economic Studies*, 493-502, 1974.

MULLER, C., "E.N.B.C.: Relevés de prix en milieu rural", Ministère du Plan, Kigali, Rwanda, 1988.

MULLER, C., "The Measurement of Dynamic Poverty with Geographical and Temporal Price Variability", Working Paper CSAE, February 1998a.

MULLER, C., "The Watts' Poverty Index with Explicit Price variability", mimeo CSAE, July 1998.

MULLER, C., "A Valuation Algorithm for Non Monetary Consumption in a Household Survey", mimeo CSAE, August 1998.

MULLER, C., "A Decomposition of Price Distribution Effects on Poverty Measures", Discussion Paper CSAE, July 1998.

NIYONTEZE, F. And A. NSENGIYUMVA, "Dépouillement et présentation des résultats de l'enquête sur marchés Projet Kigali-Est", Projet Kigali-Est, Juin 1986.

O.S.C.E., "Note statistique rapide sur la comparaison des niveaux des prix du Rwanda", Bruxelles, 1987.

POLLAK, R.A., "Welfare Evaluation and the Cost-of-Living Index in the Household Production Model", *American Economic Review*, Vol. 68, No.3, June 1978.

POLLAK, R.A., "The Theory of the Cost-of-Living Index", Oxford University Press, 1989.

SELVANATHAN, E. A., and D. S. PRASADA RAO, "Index Numbers: A Stochastic Approach", Macmillan, 1995.

SINGH, I., L. SQUIRE and J. STRAUSS, "Agricultural Household Models", The World Bank, 1986.

SLESNICK, D.T., "Gaining Ground: Poverty in the Postwar United States", *Journal of Political Economy*, vol. 101, No 1, 1993.