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BY IGNORING INTRA-HOUSEHOLD INEQUALITY, DO WE UNDERESTIMATE THE EXTENT OF POVERTY?

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Abstract:
This paper uses a novel survey to re-examine inequality and poverty levels in Senegal. In order to account for intra-household inequalities, the paper uses consumption data collected at a relatively disaggregated level within households. This data reveal that first, mean consumption is higher than measured by standard consumption surveys; and second, that consumption inequality in this country is also much higher that what is commonly thought, with a Gini index reaching 48. These findings affect global poverty estimates in opposite directions and in this context, nearly compensate for each other. Intra-household consumption inequalities are shown to account for nearly 14% of total inequality in Senegal. These results are robust to the existence of plausible measurement errors. As a result of this intra-household inequality, "invisible poor" exist with 12.6% of the poor individuals living in non-poor households.

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Keywords: Inequality, Poverty, Household surveys, Intra-household allocation, Senegal.

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1. INTRODUCTION

Distribution of consumption in West-African economies is often considered to be rather less unequal than that of other parts of Africa and of Latin America; the Gini indices are around 40, while they reach the range 50 to 60 in many Austral African or Latin American countries (see fig 2.9, cha 2; World Bank 2005). This goes hand in hand with the view—spelled out by Pope John Paul II, for example—that "African cultures have a profound sense of solidarity and community life. In Africa it is unthinkable to celebrate a feast without there being the participation of the entire village" (1995, post-Synod Exhortation, *Ecclesia in Africa* (EA)). Still, not only is income inequality rather high (Beegle *at al.* 2016), but, as pointed out by Cogneau *et al* (2006), it is accompanied by rather low intergenerational social mobility, suggesting that inequality is weighing on individual trajectories.

The above inequality assessment is based on consumption surveys, which collect information at the level of the household as a whole, often by interviewing the household head. Individual consumption levels are derived from this aggregate measure.

Inter-personal inequality in living standards within households is a relatively uncharted territory. Standard measures of poverty and inequality are calculated assuming that resources are shared equally within the household (with some normalization for size and demographic composition). Thus, the individual poverty statuses calculated from most household surveys are homogenous at the household level. Viewing poverty as essentially an individual state imposes to go beyond this approach. It is indeed likely that individuals within the same household do not always have the same living standards: income and resources are not necessarily pooled, and members do not share in them equally. There is evidence that individuals within a household may not be equally vulnerable to shocks (Case, Paxson and Ableidinger 2004, Dercon and Krishnan 2000, Rose 1999). In countries where poverty is widespread, such intra-household inequalities might be particularly serious, as they might drop some individuals to very low levels of welfare.

Recent attempts at approaching this issue with non-monetary measures of poverty exist. Klasen and Lahoti (2016) study inter-individual inequality in India using individual multidimensional poverty indices (MPI) based on various individual outcomes and, comparing the estimate of inequality obtained on this basis with that obtained using a household-based MPI, they find that intra-household inequality accounts for 30% of total inequality. More relevant to our context, Brown, Ravallion and van de Walle (2017) use nutritional status as a proxy for individual poverty and observe that in Africa, around one half of undernourished women and children are not found in the (asset-) poorest 40% of households.

In this paper, we aim to quantify intra-household inequality and to assess whether, and to what extent, we underestimate global inequality and global poverty by ignoring intra-household inequality.

In Senegal, where households extend far beyond the parents-children nucleus, with both vertical and horizontal extensions of the household being very frequent, the chances for unequal distribution of resources among household members are particularly large. The household structure is rather complex, due to polygamy, the frequent presence of foster children (Beck et al 2015), and extended family members. Furthermore, the fertility level is relatively high (about five children per woman, see Lambert and Rossi 2016).

Some works, based on structural models of intra-household allocation of resources (collective household models, see Chiappori 1988), deliver estimates of consumption shares by type of household members for nuclear households (Dunbar et al. 2013). In general, these estimates cannot be confronted to the actual sharing of resources, as these data are not available. Moreover, there is not yet an available model to account for the more complex structure and budgetary organization of West-African households.

We conducted an unusual survey aimed at better understanding household structure and intra-household resource allocation in Senegal (De Vreyer *et al.* 2008). The consumption section of the survey has been designed to collect consumption expenditures at the level of small groups ("cells") within the household. Uniquely, the data can be used to construct a relatively individualized measure of consumption, which allows us to better assess individual economic welfare.

The PSF data allows for examining two errors that standard consumption surveys make by collecting consumption data at the household level, mostly from a single respondent. First, they do not capture household consumption exhaustively; and second, they ignore high intra-household inequality. We argue that the first aspect leads to an underestimation of household's consumption level, in particular, for households that contain more than one budgetary unit and are on the upper part of the income distribution. As a result, standard consumption surveys are likely to underestimate both mean consumption and consumption inequality. We indeed find that mean consumption in PSF is 15 to 20 % higher than that measured with a classical survey only a few months earlier, and that inequality is much higher than what is commonly thought, with a Gini index estimated to reach 48. Aggregate poverty measures are affected in opposite directions by these two errors; the first leads to overestimating poverty, while the second underestimates it. Remarkably, in the case of Senegal, the overall bias is quite small.

Furthermore, these data are very revealing on intra-household inequalities. The data demonstrate that not everyone has the same level of access to resources. In general, food expenditures are equitably distributed, as far as it is observable, since in most cases, meals are collectively taken within a single dish, and we cannot observe differences in individual food intake. Differences emerge with respect to non-food expenditures. It appears that intra-household inequalities account for 14% of total inequalities in Senegal.

Choices of equivalence scales to define individual consumption do not affect the results. Worries that these results could be in part driven by measurement errors are tackled by using correction of the inequality estimates as well as by using simulations techniques. We assess the sensibility of our results to the size of measurement error. Qualitatively, all results stand for plausible level of measurement errors.

We consider some consequences of these inequalities within households in terms of poverty analysis that may be of importance in a country like Senegal, where the poverty rate reaches about 48% at the time of our survey (World Development Indicators[1]). We find that more than 9% of non-poor households contain at least one poor cell. There are also non-poor cells in poor households. The estimations mentioned above are obviously highly dependent on the choice of a poverty line. In the paper, we explore sensitivity to this choice. Gaining a thorough understanding of these issues is all the more crucial that a number of new redistributive public policies are developed today, such as the

[1] World Development Indicators, http://data.worldbank.org/data-catalog/world-development-indicators

Programme National de Bourses de Sécurité Familiale, PNBSF, a large conditional cash transfer scheme meant as the stepping stone of a broader social safety net. We further discuss how ignoring this dimension of inter-personal inequality leads to flawed poverty diagnostics.

The paper is organized as follows. In Section 2, we present the data collected with all their specificities. In section 3, we describe intra-households inequality and its contribution to overall inter-individual inequality. Section 4 is dedicated to the revision of poverty assessments brought about by the prevalence of intra-household inequalities, and Section 5 concludes.

2. THE "POVERTY AND FAMILY STRUCTURE" SURVEY.

1. *CONTEXT*

Senegal has a Human Development Index that ranked it 154th in 2012 (UNDP, 2013). GDP grew at an average of 5% per year in the 10 years before our survey took place (1995-2005) (Agence Nationale de la Statistique et de la Démographie (ANSD), 2013). At that date, nearly half of the population was still living with an income below the national poverty line (World Development Indicators). More than half the population is rural (55%), and the challenges faced for poverty reduction are even more acute in rural areas (ANSD, 2013). According to World Development Indicators, Senegal presents relatively high levels of inequality, with a Gini index calculated by the World Bank reaching 40.3 in 2011.

2. *THE SURVEY*

The data come from an original survey entitled *Pauvreté et Structure Familiale* (Poverty and Family Structure, henceforth PSF) conducted in Senegal in 2006-2007. The PSF survey results from the cooperation between the National Statistical Office of Senegal and a team of French researchers.[2] It is a nationally representative survey covering 1,800 households spread over 150 clusters drawn randomly from the census districts so as to insure a nationally representative sample. About 1,780 records can be exploited. Nevertheless, for the purpose of this paper, we exclude households with missing consumption information and few (19) outliers. We are left with a sample of 1728 households.

This survey collects the usual information on individual characteristics, as well as a detailed description of household structure, consumption, and budgetary arrangements.

[2] Momar B. Sylla and Matar Gueye of the Agence Nationale de la Statistique et de la Démographie of Sénégal (ANSD), as well as Philippe De Vreyer (University of Paris-Dauphine and IRD-DIAL), Sylvie Lambert (Paris School of Economics-INRA), and Abla Safir (World Bank), all designed the survey. The data collection was conducted by the ANSD, thanks to the funding of the IDRC (International Development Research Center), INRA Paris, and CEPREMAP. The survey is described in detail in De Vreyer *et al.*, 2008.

a. CONSUMPTION

Contrary to traditional consumption surveys that only aim at estimating the level of household consumption, PSF is designed to allow a relatively precise measurement of individual access to resources. Field interviews conducted at the early stages of the PSF project showed that within Senegalese households, it is possible to distinguish sub-groups of household members that are at least partly autonomous in their budget management. Consumptions common to various groups in the household appeared clearly defined, as well as the responsibilities for paying for those consumptions, and groups' own resources turned out to be not entirely pooled. We designed the survey so as to capture this detailed information.

To best capture intra-household structure and resource allocation, each household was divided into "cells" whereby the head forms a cell with unaccompanied dependent members; each wife of the head, her children, and any other dependents then form separate cells, as do any other adults with dependent (such as a married brother or a married son, for example). Polygamous men other than the household head are treated in the same way as the head, with the husband and each wife in separate cells. This cell structure reflects households' internal organization in Senegal (and other parts of West Africa). A similar approach had already been used to structure households in the Senegalese census in 1988, but was abandoned for the more recent censuses (van de Walle and Gaye, 2006) and seemed very intuitive to enumerators who had to implement the survey. In the PSF sample, more than a third of households contain at least three cells (see Table 1 below).[3]

Consumption data are collected in four distinct parts: food taken at home; household common consumption expenditures, including self-consumption of household products; cell specific expenditures (such as clothing, mobile phone, transportation, and food outside the home expenditures); and finally, expenses shared between several cells (but not common to the whole household). From this data, per capita consumption is computed at the cell level. Common consumption expenditures are attributed to cells on the basis of the number of members they include, assuming these expenditures are shared equally among all household members. Food expenditures are compiled based on a detailed account of who shares which meal and how much money is specifically used to prepare the meal.[4] Each cell is ascribed its share in the food expenditures according to the per capita expenditures for the meals it joined in. Food expenditures for meals at home are often shared by the whole household. Nevertheless, in 17% of households, subgroups emerge that take some or all of their meals separately, making room for unequal food consumption among household members. In addition, some members take parts of their meals outside. In any event, non-food expenditures naturally offer wider possibilities of divergence within households.

All the analyses presented in this paper exclude housing expenses. In this survey, only a very small share of the sample declares paying a rent for their dwelling. In some regions, and in many clusters, not a single household pays a rent. In fact, when everyone lives in their own-built adobe house, as is the case in many parts of the country, the market price for the rental of such a dwelling simply doesn't exist. In such a situation, it is hardly possible to use the data to impute rents to home owners. Hence,

[3] Half of the households with 3 cells or more are headed by a polygamous household head.

[4] The DQ, « Dépense quotidienne », the name Senegalese give to the amount of money a woman has at her disposal to buy the fresh ingredients for the meals of the day. One of the husband's duties is to provide the DQ.

the term "total consumption" used in this paper refers, in fact, to total consumption except housing (rent) expenses.[5]

It is important to note that the survey is designed so that information collected at the cell level is not the expenditures made by the cell's members, but actually the expenditures made by anyone, whether a member of the cell or the household or not, to the benefit of cell's members. For example, any expenditures made by the head of household for the clothing of his children are recorded in the cell where the children are listed, more often than not that of their mother, distinct from the one of their father. In addition to the level of consumption benefiting cells, the contributors to these expenditures are also registered, separately for each category of goods.

A measure of total cell's consumption is then constructed — by adding expenditures specific to the cell and not shared with any other cell plus the cell's imputed share of the expenditures shared with other cells and of the household's joint expenditures—allowing an identification of unequal consumption levels within households. Our most individualized measure of consumption is then the per capita cell's consumption. Obviously, the same can be done using equivalence scales to obtain per adult equivalent consumption measures.

In what follows, we therefore talk of *per capita (or per adult equivalent) cell's consumption* when we measure consumption per capita at the cell level, while the term *per capita (or per adult equivalent) household's consumption* designates the measure obtained with the more "traditional" way of measuring individual consumption, when individuals' access to resources is estimated from the aggregate household measure of consumption. The comparison between the inequality and poverty diagnostics reached when using one or the other measure of consumption is central for the analysis presented in this paper.

A first remark to be made is that with data being collected at the cell level, several members of the household are contributing information to the consumption survey. Since the household head doesn't directly observe all individual expenditures, in particular in a context where individual resources are not public knowledge within the household (see Boltz, Marazyan and Villar, 2015, Ziparo, 2014, Baland, Guirkinger and Mali, 2011), interviewing other household's members allows to record expenditures that might have otherwise gone unnoticed. Proxy reporting as a potential source of underestimation was mentioned by Deaton (2005). Furthermore, the sheer fact that consumption is recorded in a more disaggregated manner allows for a better recall (see Deaton 1997; Beegle *et al*. 2012). As a result, the total amount of expenditures we record is significantly higher than the one reported by ANSD (2007) or by Ndoye *et al*. (2009) based on the standard consumption survey conducted in Senegal the previous year (ESPS).[6] [7] We estimate the PSF estimate of 300920 FCFA to

[5] According to ANSD (2007), in 2005-2006, more than 80% of households in Senegal were owners of their housing. Less than 16% were renting it, and only 2.6% in rural areas. This leaves a very small number of observations to compute meaningful imputed rents, unless a very large sample is available. Even in the ESPS sample, which includes 13600 households, the imputed rent for owner households in rural areas is based on the observation of rents paid by 129 households (on a total of 4960 rural households).

[6] Enquête Suivi de la Pauvreté au Sénégal (ESPS), conducted in Senegal between December 2005 and April 2006.

[7] These two sources, despite being based on the same data, provide very different numbers for mean household per capita consumption, with the Ndoye et al (2009) estimate being nearly 20% higher than the number provided by ANSD (2007) in the final ESPS report.

be roughly 15 to 20% above the corresponding number for ESPS. Appendix A1 details the comparison. Clearly, collecting data at a more disaggregated level also induces a risk of additional measurement error. We will therefore assess the sensitivity of the results to measurement errors.

This difference in consumption estimates is in itself an important result: traditional surveys in countries where individuals within the household do not fully share the information on their resources and on their expenditures are likely to seriously underestimate consumption. Such underestimation is likely to be more important for households in the upper part of the consumption distribution. In fact, poor households have less often several income earners or transfer recipients, so that opportunities for individual, unnoticed, expenditures are plausibly less frequent. As will be shown in Section 4, poverty estimates obtained with the two sets of data are indeed very comparable, confirming that the differences are more important at levels of consumption above poverty line. The fact that the underestimation of consumption is not distribution neutral pleads against anchoring poverty measure to National Accounts estimates of consumption, as it is likely to result in an overestimation of poor household's consumption levels, following an argument made by Ravallion (2000).

b. HOUSEHOLD STRUCTURE

In the PSF survey, a household is defined as the set of co-residing individuals who recognize the authority of a given household head. Table 1 describes the main characteristics of Senegalese households. These households are large, with about eight members on average in the PSF sample and a dependency ratio nearly equal to 50%. They are typically multigenerational and extended both horizontally and vertically, with 28.7% of household members that are neither the head, nor one of his wives or children. Two thirds of households include such "extended" family members.

Polygamous unions are common, with 23% of married men and 35% of married women engaged in such unions. Most of these comprise a husband and two wives (only 20% of polygamous unions have more than two wives). We find that 31% of polygamous men have non-cohabiting wives. In half of these cases, the husband is either considered the head of both households, or of one, while one of the wives is considered head of the other household. In the other half, a married polygamous woman lives in a separate household headed by a relative (mainly her father, brother, or son). In this work, we ignore the consumption of non-co-residing members of the conjugal family unit of the household head.

More than half of the households live in rural areas, while 28% are in Dakar. About one fifth of those households are headed by a woman and 40% by an uneducated person. Cells other than the household head's are in vast majority (80%) headed by a woman, who on average is younger and less often educated. Less than 2% of those cells are that of polygamous men who are not household heads.

Table 1a: Household characteristics

	N	Mean	min	Max
Household size	1,781	8.26	1	44
Number of cells per household	1,781	2.50	1	12
3 cells or more (%)	1,781	37.85		
Nb of children 0-5 y.o.	1,781	1.52	0	11
Nb of children 5-15 y.o	1,781	2.11	0	13
Nb of elderly 66+ y.o	1,781	0.31	0	4
Share of extended family members in hh (%)[a]	1,781	28.69	0	97
Hhold contains extended family members (%)	1,781	66.94		
Dakar (%)	1,781	28.32		
Other urban areas (%)	1,781	19.71		
Rural areas (%)	1,781	51.97		
Female household head (%)	1,781	20.56		
Polygamous male hh.head (%)	1,781	22.10	0	100
Polygamous female hh. head (%)	1,781	5.47	0	100
Uneducated hh. head (%)	1,781	42.18	0	100
Age of the household head.	1,777	49.82	18	93

Source: PSF2006/2007 survey, authors' calculations using sampling weights, a: extended family members are all household members that are neither the head, nor one of its coresiding spouse or children (biological or adopted).

Table 1b: Cell characteristics

	N	Mean	min	Max
Cell size	4,372	3.30	1	15
Nb of children 0-5 y.o.	4,370	0.61	0	5
Nb of children 5-15 y.o	4,370	0.84	0	7
Nb of elderly 66+ y.o	4,370	0.12	0	3
Female cell head (%)	4,372	56.79		
-excl household head	2,591	80.91		
Polygamous male cell head (%)	4,372	9.97		
-excl. household head	2,591	1.88		
Polygamous female cell head (%)	4,372	19.64		
-excl household head	2,591	29.08		
Uneducated cell head (%)	4,372	52.76		
-excl household head	2,591	59.81		
Age of the cell head.	4,367	42.19	0	98
-excl household head	2,588	37.14	6	98

Source: PSF2006/2007 survey, authors' calculations using sampling weights.

3. INEQUALITY AND INTRA-HOUSEHOLD INEQUALITIES LEVELS

a. GLOBAL INEQUALITY.

Our main results on inequality are presented in Table 2. Using per capita household's expenditures, the Gini index is 47.5 %, quite a bit higher than the one reported in the WDI (40.3% for 2011)[8]. This difference should be related to the fact that collecting consumption data at the cell, rather than at the household level, leads to an upward revaluation of total consumption that is higher for households with several income earners or transfer recipients and/or several budgetary units (see Section 2.a.). As this is often not the case at the bottom of the distribution, our data reveal that the consumption distribution is more spread out in its upper part than what appears in standard consumption data. This is likely to explain in part why the high level of inequality is not visible when using usual consumption surveys.

As expected, the Gini index of inequality in the distribution of per capita cell's food expenditures is much lower than that of non-food spending, reaching 39.8% vs. 63.9% (see Table 2).

Table 2: Inequality measures

	Gini	90/10	75/25	Mean log dev	Theil-T
Per capita Household consumption:					
Per capita household's total consumption	47.54 (1.28)	7.58 (0.40)	2.97 (0.12)	0.38 (0.02)	0.45 (0.04)
Per capita household's non-food consumption	63.92 (1.54)	18.09 (1.50)	4.96 (0.27)	0.78 (0.04)	0.88 (0.07)
Per capita household's food consumption	39.83 (0.75)	5.95 (0.36)	2.48 (0.09)	0.27 (0.01)	0.29 (0.01)
Per capita cell's consumption:					
Per capita cell's total consumption	49.99*** (1.21)	8.19*** (0.39)	3.01 (0.10)	0.43*** (0.02)	0.52*** (0.04)
Per capita cell's non-food consumption	68.36*** (1.34)	24.39*** (1.57)	5.80*** (0.27)	0.95*** (0.04)	1.08*** (0.08)
Per capita cell's food consumption	41.04*** (0.73)	6.45*** (0.36)	2.55* (0.10)	0.28*** (0.01)	0.30*** (0.01)

Source: PSF2006/2007, N=1728, authors' calculations, using sampling weights. Bootstrap standard errors (250 replications) between parentheses. . *,**,***: difference with per adult eq. household's consumption inequality measure is significant at the 10%, 5% or 1% level (see Note 9 and Appendix B for details).

All measures of inequality display the same result: when using the per capita cell's consumption measure, rather than the per capita household's consumption, inequality levels are revised upward.[9] Most of the difference comes from the inequality of non-food consumption, while inequality in food

[8] It is slightly lower when using per adult equivalent measure of consumption. See Table A1 in the Appendix.

[9] Standard errors in Table 2 cannot be used to assess the significance of the differences between inequality indices, since household and cell level indices are computed on the same sample. In order to account for the resulting correlation between indices, standard errors of differences have been computed using 250 bootstrap replications. Results are presented in Appendix B, Table B1. Since all inequality indices used in this paper can be shown to be asymptotically normally distributed (see references in Appendix B), the usual t tests can be used to assess significance.

consumption is only mildly affected. The Gini of total consumption increases to nearly 50% when each individual is attributed their cell's per capita consumption level (and that of non-food consumption to 68.4%).

It is well known that measurement errors are likely to drive up many measures of inequality. Following Chesher and Schluter (2002), we assess the robustness of the above estimates to various amounts of measurement errors. Assuming a measurement error to signal (measured consumption per capita) variances ratio of 10% (resp. 20%) would decrease the estimated Gini from 47.5 to 45.8% (resp. 44.2%) and the Theil-T from 0.45 to 0.42 (resp. 0.39). The assumed variance of measurement error needs to reach 40% of that of the signal for the Gini to go down to a level comparable to the uncorrected published statistics (40.8 instead of a published 40.3). Such level of measurement error is highly unlikely (Bound et al, 2001, give much lower orders of magnitude, closer to 20%). Hence, it is unlikely that measurement error explains the high observed inequality in the PSF survey. In addition, given ESPS data is as likely to be error-ridden as PSF, measurement errors certainly cannot account for the difference in the inequality estimates.

b. INTRA-HOUSEHOLD INEQUALITY.

The difference between results based on per capita household's expenditures and per capita cell's expenditures might seem small, but it would be wrong to interpret this as the sign of negligible intra-household inequalities. In fact, a Theil decomposition indicates that nearly 18% of total inequalities in non-food expenditures occur within households (Table 3). This is obviously much less in the case of food expenditures, reaching only about 6% of total inequalities.

Assuming equal sharing of food between household members eating together possibly underestimates actual intra-household inequality in food consumption. In fact, as household members who partake in the meal share a unique dish, it is hardly possible to measure individual intakes. There are some indications in the literature that in African contexts there exist intra-households inequalities in the access to nutritional inputs, as testified by the findings of Dercon and Krishnan (2000), for example.

Table 3: Inequality decomposition

	Theil within	Theil between	share within
Per capita cell's consumption	0.07	0.45	13.60
	(0.01)	(0.03)	(2.35)
Per capita cell's non-food consumption	0.19	0.89	17.70
	(0.03)	(0.07)	(2.46)
Per capita cell's food consumption	0.02	0.29	5.93
	(0.00)	(0.01)	(0.87)

Source: PSF2006/2007, N=1728, authors' calculations, using sampling weights. Bootstrap standard errors (250 replications) between parentheses.

For total consumption, the share of within-households inequality is about 14% of total inequality. Whether this is a large share or not is difficult to assess without a comparison point. We can think of one external comparison, that given by Klasen and Lahori (2016), who estimate intra-household inequality as about 30% of total inequality in India. This comparison is interesting, but not conclusive, for two reasons. First, these authors base their analysis not on consumption levels but on

multidimensional poverty indices, so that the comparison cannot be done directly. It is well known that inequality estimates depend vastly on the variable used for measuring well-being, income inequality being in general much higher than consumption inequality, for example. According to the way intra-household allocation of consumption relates to the distribution of endowments, consumption inequality might underestimate more or less seriously inequality in non-monetary outcomes. Second, Klasen and Lahori estimates refer to India, a country that has an income per capita much greater than Senegal (1750US$ vs. 1042US$, in 2010 constant dollars, according to the World Bank Indicators), leaving a larger margin for non-subsistence consumption expenditures that are likely to be more unequally shared than those expenditures dedicated to subsistence needs.

Starting from this latter intuition, it is possible to construct a counterfactual situation from our data that maximizes intra-household inequality. In order to do this, we simulated a distribution where everyone gets his observed share of food consumption and of consumption common to the household (such as electricity, water, furniture…). Note that this shared consumption amounts to 68% of total consumption on average. We then imagine an amazingly unfair household head capturing any extra resource and attribute all the remaining consumption to his/her cell, thereby maximizing intra-household inequality. When doing this, the Theil index of this distribution reaches 0.66, and the within-household Theil index amounts to 0.21. The corresponding share of within–household inequality is therefore 32% of total consumption inequality. Gauging our result by this counterfactual situation, it seems that the observed within-household inequality is very significant, reaching 44% of this maximum.

Next, we need to assess the robustness of our results to different ways to account for household composition. Individual consumption can be measured *per capita* or per adult equivalent. The use of *per capita* consumption to assess the extent of inequality is likely to yield a higher level of inequality than the use of per adult equivalent consumption if there is a positive correlation between the risk of poverty and the number of children in a household. This is true between households, and also within households and between cells, if poor cells have more children than non-poor ones. Hence, using an equivalence scale may provide a different picture on inequality. In Appendix Table C1, we compute the same inequality measures as those presented in Table 3, this time based on consumption per adult equivalent, where a weight of 1 is given to adults, and children between 0 and 14 are weighted 0.5. As can be seen from this table, the difference with *per capita* estimates is in line with what was expected: inequality based on per adult equivalent consumption is indeed found lower. But the difference is not very high, and the gap between household's and cell's consumption estimates remains of the same order of magnitude as that of Table 3. As for intra household inequality, Appendix Table C2 shows the inequality decomposition obtained when using per adult equivalent consumption with two different equivalence scales: Scale A is the same as that employed in Table C1, while Scale B puts a reduced weight on very young children (0.2 for children less than age 4). As can be seen, results are hardly impacted by the reduced weight given to children: intra-household inequality still accounts for about 13% of the total.

So as to ensure that the results are not driven by education expenditures, an important child specific spending unevenly distributed in the population, we replicate the exercise on consumption aggregates net of education expenditures (school fees, furniture, and transportation). Results are shown in the bottom part of Appendix Table C2. They are not significantly changed.

We already mentioned the fact that inequality measures are particularly sensitive to possible measurement errors. In this particular case, because consumption data is collected at the cell level, measurement error will take place at the cell level. In such a case, working at the household level

would contribute to average out some of this noise, while it would be maximal when working at the cell level. That would suffice to induce some intra-household inequality even if the true distribution is egalitarian. In order to evaluate the sensitivity of our estimates of intra-household inequality to such measurement error at the cell level, we will here again resort to simulations. Assuming measurement error takes the form of a white noise, the idea is to assess how large it should be to explain the whole of the observed share of intra-household inequality.

The exercise is the following. Assume that the true distribution of consumption is such that there is no intra-household inequality. Everyone in household h gets Y_h. Nevertheless, because of (classical) measurement errors at the cell level, we observe $Y_{ch,}$ which differs from Y_h by a multiplicative white noise term. Assuming that consumption is log-normally distributed and taking logs, we get:

$$\ln Y_{ch} = \ln Y_h + u_c$$

We simulate the observed distributions of Y_{ch}, varying the magnitude of the error term u_c. This error term is drawn from a normal distribution with a variance fixed at a certain percentage of the variance of the original distribution of log-consumption. This percentage will vary from 10 to 95%. From this new cell consumption data, we compute the equivalent of our two measures of individual consumption: on the one hand, we aggregate at the household level to obtain the per capita household consumption; on the other, we construct the per capita cell consumption. We then compute the Gini and Theil indices of the 2 distributions and assess the variance of the white noise that would be enough to explain a level of intra-household inequality equal to 13.6% of total inequality. We replicate the simulation 100 times to compute the standard errors of the indices. We will not focus on total level of inequality, as the addition of such white noise will mechanically increase it.

Table 4 below gives the result of these simulations. It appears that it requires an error term with a variance fixed at 70% of the variance of the original distribution of log-consumption for the decomposition of the Theil index to indicate a within-household share of total inequality of 14%. At 40%, the Gini index for the distribution of per capita cell consumption is 5.4% higher than the one for the per capita household consumption, as we actually observe in our data (5.1%). In both cases, such levels of measurement error are unrealistically large (Bound et al. 2001), so that we are confident measurement error is not the only force driving our results.

The analysis below will confirm that this within-household inequality is not pure noise, as it correlates with a number of observable characteristics of the households.

Table 4: Simulated inequality measures in the presence of measurement error

$\sigma^2(u_c)$ $/\sigma^2(\ln Y_h)$	Per capita household consumption	Per capita cell consumption			
	Gini	Gini	Theil	Theil within	Share of within inequality
10%	48.38(0.35)	49.19(0.34)	0.48(0.01)	0.01(0.00)	0.03
20%	49.33(0.46)	50.86(0.44)	0.52(0.02)	0.03(0.00)	0.06
30%	50.01(0.66)	52.22(0.63)	0.55(0.03)	0.04(0.00)	0.08
40%	50.89(0.75)	53.66(0.72)	0.58(0.03)	0.06(0.00)	0.10
50%	51.73(0.79)	55.04(0.73)	0.61(0.03)	0.07(0.00)	0.11
60%	52.46(0.83)	56.28(0.76)	0.65(0.04)	0.08(0.00)	0.13
70%	53.20(0.86)	57.47(0.76)	0.67(0.03)	0.10(0.01)	0.14
80%	54.20 (0.98)	58.85(0.87)	0.72 (0.04)	0.10(0.01)	0.15

Source: authors' simulated distributions, 100 replications, standard errors between brackets.

c. THE CORRELATES OF INTRA-HOUSEHOLD INEQUALITY

One might want to characterize the level of inequality a given household is experiencing. This can be done in various ways. Table 3 gives the measures of within household Theil indices and points to a rather high inequality level in terms of non-food consumption. We can also use the ratio of expenditures of the richest cell to that of the poorest. Inequalities within the household are also evident by this measure: the ratio between the expenditures of the richest and poorest cells within a household can be as high as 5.3 after trimming off 5% of the most unequal households. On average, the richest cell has a consumption more than twice as much as that of the poorest (Table 5).

Using this ratio, we see that it is lower than 1.25 for a good third of the households with 2 cells of more, but greater than 2 for more than a quarter of those households. We will categorize the first group of households as "low inequality" households, the latter as "very high inequality" households, and the remaining middle group as "high inequality" households.

Table 5: Intra-household Inequality

	N	Mean	p25	p50	p75
Max/min	1,399	2.10	1.16	1.43	2.04
Low inequality: Max/min<=1.25	1,399	0.35			
Very high inequality: Max/min>=2	1,399	0.26			

Source: PSF2006/2007, sample of households with 2 cells or more, authors' calculations.

It is worth noting that in the large households (those with 3 cells or more), the cell of the household head is often the richest cell. One could worry that this is in part spurious if the household head declared as his expenditures some that in fact benefit to the whole household. Although intra-household inequality is indeed higher if we take the head into account (the max to min ratio reaches 3 on average), the levels of inequality among the other cells of the household are nevertheless quite high, as well. Excluding the cell of the household head, the average ratio of max consumption to min consumption still reaches 2.2. We examine the correlates of being an unequal household (Table 6). Column (1) presents the coefficients of an ordered probit estimation for an ordered variable taking value 1 if the household presents a low inequality level, 2 a high inequality level, and 3 for a very high inequality level, as defined above. Column (2) gives the OLS estimation where the dependent variable is the log of the within household Theil index. Both approaches give rather similar results.

Household structure clearly plays a role in explaining intra-household inequality. In a nearly mechanical way, larger households are more likely to be unequal. Polygamous households and households with young children appear to also allow for more heterogeneity of consumption levels. In a less expected manner, households containing extended family members display lower levels of inequality. It appears that intra-household inequality increases with household consumption, and in a related way is lower when the household head is uneducated and higher if the household lives in Dakar.

The evidence of strong intra-household inequality raises the suspicion that some poor individuals might go unnoticed because they live in households where not everyone is poor and that may not be

identified as poor by poverty measures based on standard assessments of consumption levels. This issue is explored in the next section.

Table 6: Correlates of intra-household inequality.

VARIABLES	(1) Type of household	(2) Log of within household Theil
Household structure:		
Hhold contains extended family members	-0.0246*	-0.0550*
	(0.0148)	(0.0293)
Hhold size	0.0514***	0.0972***
	(0.0157)	(0.0319)
Nb of children 0-4 y.o.	0.120***	0.257***
	(0.0265)	(0.0531)
Nb of children 5-14 y.o	0.0260	0.00955
	(0.0274)	(0.0520)
Nb of elderly 66+ y.o	0.0494	0.00261
	(0.0617)	(0.138)
Household lives in (Ref. is Dakar) :		
Other urban areas	-0.256***	-0.662***
	(0.0829)	(0.209)
Rural	-0.202**	-0.410*
	(0.0923)	(0.19)
Polygamous hhold head	0.191**	0.286*
	(0.0742)	(0.147)
Uneducated hhold head	-0.175**	-0.343**
	(0.0752)	(0.137)
Log per capita household expenditures.	0.211***	0.464***
	(0.0487)	(0.113)
Constant cut1	2.730***	
	(0.669)	
Constant cut2	3.804***	
	(0.673)	
Constant		-11.28***
		(1.549)
R-squared		0.114
Observations	1,399	1,391

Source: PSF 2006/2007, authors' calculations. (1) Ordered probit estimates: The type of household varies from 1 to 3, 1 being the most equal and 3 the most unequal. (2): OLS estimates. Additional controls: ethnic group of the household head and religion. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

4. MEASURES OF POVERTY IN SENEGAL

a. POVERTY LINES

In this section, we examine the poverty rates obtained from consumption observed at the cell and household levels in the PSF. In order to compare with the results of previous surveys, we choose to use the same poverty lines as that of Ndoye et al. (2009), which presents a poverty profile established with data from the Enquête Suivi de la Pauvreté au Sénégal (ESPS), conducted in Senegal between December 2005 and April 2006. Two lines are retained, established following the basic needs approach. First, a food poverty line is defined as the cost of the food basket that provides at least 2400 kcal per day. The second line is the national poverty line in Senegal. It is obtained by augmenting the food poverty threshold with the amount of resources that is necessary to cover individual basic needs other than nutrition. This amount is obtained through the observation of the average non-food consumption of households for which food consumption per adult equivalent belongs to a interval of more or less than 5% around the food poverty threshold.

Table 7 shows the values of the two poverty lines for Dakar, other towns and rural areas separately. The food poverty line is very close to the $1.25 (PPP 2005) international line (that would be equal to 366 CFA francs at the time of our survey). The $2 line corresponds to 586 CFA francs.

Table 7: Value of the poverty thresholds

	Food poverty line	National poverty line
Dakar	397	968
Other Towns	370	693
Rural Areas	357	588

Note: ESPS poverty lines adjusted to take one-year inflation into account. Numbers correspond to daily expenditures per adult equivalent. Equivalent scale: 0.5: children 0 to 14 years old; 1: adults Measurement unit is the CFA franc.

b. GLOBAL POVERTY

As explained in section 2a, incorporating intra-household resources allocation concerns in the survey by collecting data from several respondents in the household had as a consequence to reveal that the standard consumption survey seriously underevaluates consumption. The underestimation is particularly stark in the upper part of the consumption distribution, where households are likely to have several income earners and therefore more widespread responsibility for spending. Both mean consumption and consumption inequality are therefore higher in PSF than in ESPS. Using the Datt and Ravallion decomposition framework (Datt and Ravallion 1992) to think about the implications of such differences in terms of poverty estimates, we can decompose the difference in the poverty measures from the 2 surveys into its “growth” (difference in mean consumption) and “redistribution” (difference in inequality) components, and a residual. The fact mean consumption is higher in the PSF data should lead to a decrease in poverty relative to ESPS, but the higher inequality plays in the opposite direction.

Which of these components plays most is not a priori obvious. It happens that in this context, these two opposite biases happen to nearly exactly compensate each other. Consequently, if we use the same poverty line, ignoring intrahousehold inequality, poverty headcount computed on the PSF per adult equivalent *household* consumption yields only a slightly lower poverty level than that computed by Ndoye et al (2009) using ESPS data, and the poverty gap is hardly different (see Table 8).[10, 11] Headcount is most overestimated in Dakar, which is not surprising, as Dakar offers many more personal spending opportunities that may be unnoticed by the household head than rural areas.

Table 8: "Poverty estimates – comparison between ESPS and PSF"

	ESPS	PSF	ESPS	PSF
	Headcount index	Headcount index	Poverty gap index	Poverty gap index
National	50.8	49.62	16.4	17.80
		(1.63)		(0.72)
Dakar	32.5	31.08	8.3	8.90
		(2.43)		(0.86)
Other urban areas	38.8	39.13	10.8	12.12
		(3.04)		(1.37)
All urban areas		34.66		10.33
		(1.95)		(0.78)
Rural areas	61.9	60.99	21.5	23.47
		(2.19)		(1.10)

Source: ESPS results reproduced from Ndoye et al (2009); PSF2006/2007, N=1728 observations, authors' calculations. Poverty estimates based on per adult equivalent consumption. Equivalent scale: 0.5: children 0 to 14 years old; 1: adults. Bootstrap standard errors (250 replications) between parentheses.

c. POVERTY OF HOUSEHOLDS, POVERTY OF CELLS

Computing poverty estimates using per adult *cell* consumption rather than per adult *household* consumption allows to factor in intra-household inequality. In Table 9, we present the various poverty estimates obtained for the two poverty lines. The upper part shows poverty estimates based on per adult equivalent household consumption, while the bottom part presents results based on per adult equivalent cell consumption.

[10] Since our consumption aggregate does not include rents nor imputed rents, it would make sense to adjust the value of the poverty line when comparing poverty rates with those of the Ndoye et al. (2009) study. But the data at hand only allows to evaluate the average rent level, not that of households close to the poverty line (see Appendix A for details). However, Ndoye et al. (2009) consider 15000FCFA per year as the minimum acceptable value for rents declared by households in the ESPS survey and use this threshold to impute rents for households whose declared value appears unreasonably low. Since poor households are likely to live in poor housing, the value of their rent (real or imputed) is likely to be close to this minimum. Adding this amount (adjusted for inflation) to all households in the survey does not significantly change our results.

[11] For comparison purposes, the equivalence scale used is the same as Ndoye et al. (2009): adults aged 15 or over receive weight 1; children between 0 and 14 have weight 0.5.

Table 9: Poverty estimates PSF 2006/2007 - different poverty lines

	Food poverty line		National poverty line	
	Headcount index	Poverty gap index	Headcount index	Poverty gap index
Per adult eq. household's consumption:				
National	19.57	4.99	49.62	17.80
	(1.34)	(0.44)	(1.59)	(0.75)
Dakar	1.58	0.33	31.08	8.90
	(0.67)	(0.16)	(2.31)	(0.79)
Other urban areas	10.74	2.19	39.13	12.12
	(2.34)	(0.60)	(3.15)	(1.38)
Rural areas	30.14	7.90	60.99	23.47
	(2.29)	(0.78)	(2.30)	(1.24)
Per adult eq. cell's consumption:				
National	21.34***	5.99***	53.52***	19.78***
	(1.25)	(0.48)	(1.53)	(0.80)
Dakar	1.96	0.46**	36.81***	10.97***
	(0.59)	(0.18)	(1.93)	(0.78)
Other urban areas	11.66*	3.02***	42.79**	13.66***
	(2.28)	(0.75)	(2.93)	(1.38)
Rural areas	32.78***	9.33***	64.19***	25.56***
	(2.05)	(0.73)	(2.22)	(1.25)

Source: PSF2006/2007, authors' calculations, using sampling weights. Sample sizes are 1728 households and 4206 cells. Bootstrap standard errors (250 replications) between parentheses. Equivalent scale: 0.5: children 0 to 14 years old; 1: adults. *,**,***: difference with per adult eq. household's consumption poverty measure is significant at the 10%, 5%, or 1% level (see Note 9 and Appendix B for details).

Strikingly, using per adult equivalent cell consumption rather than per adult equivalent household consumption leads to revise poverty levels upwards, both for the headcount and the poverty gap.

The results show that the household level approach leads to an underestimation of poverty rates by 0.4 to 5.7 percentage points, depending on the poverty line and the residential area. This corresponds to an underestimation of the prevalence of poverty by 7.3% (national poverty line) and 8.3% (food poverty line) at the national level. The underestimation is particularly severe in Dakar (above 15%), as could have been expected, given the especially high intra-household inequality in that area.

As seen in Table 9, the difference in poverty measures based on per capita household consumption or per adult equivalent cell consumption depends on the chosen poverty line. The sensitivity of these results to this choice requires further assessment of the robustness of the above findings. Figures 1 to 3 below show the estimated difference between the poverty rates obtained with per capita household consumption and per capita cell consumption depending on the position of the poverty line.[12] As we can see, the difference between poverty rates is significant for a large range of poverty lines. For rural areas, the maximum gap is obtained for a poverty line between the food and national poverty

[12] Graphs have been drawn using Stata command cfgts2d from the DASP Package and available on line at http://dasp.ecn.ulaval.ca/ (Araar and Duclos, 2007).

thresholds. For Dakar and other towns, the graph shows that a larger gap would be obtained with higher poverty thresholds, and that below the food poverty lines, the difference is hardly statistically significant.

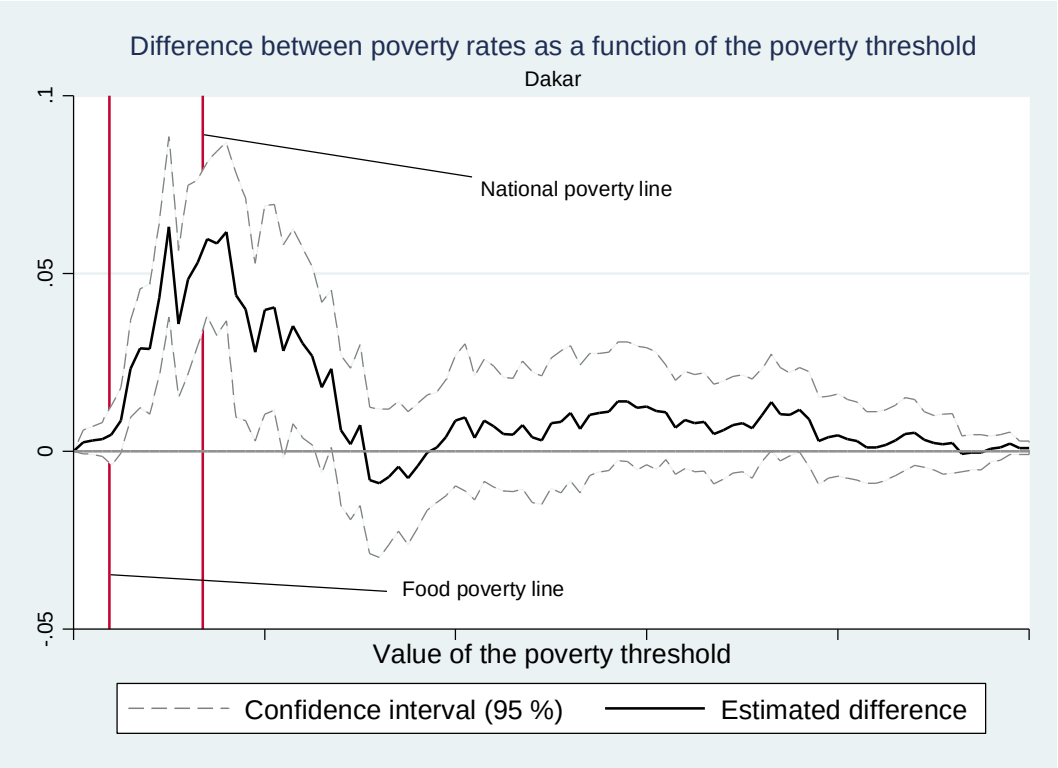

Figure 1

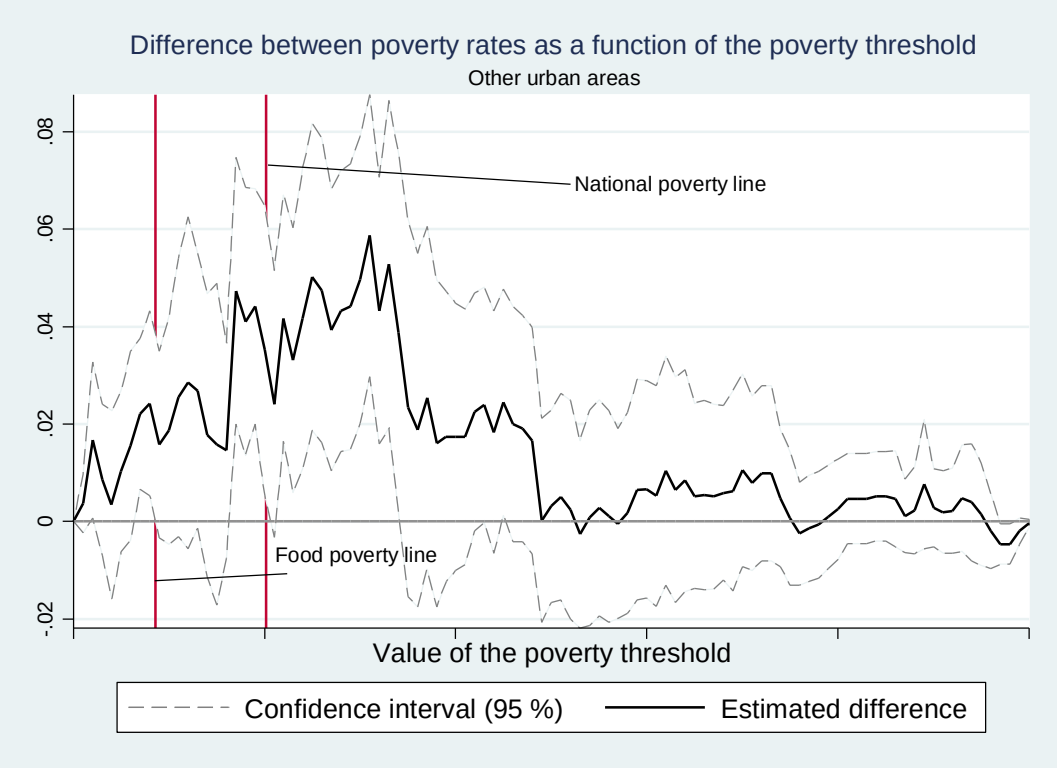

Figure 2

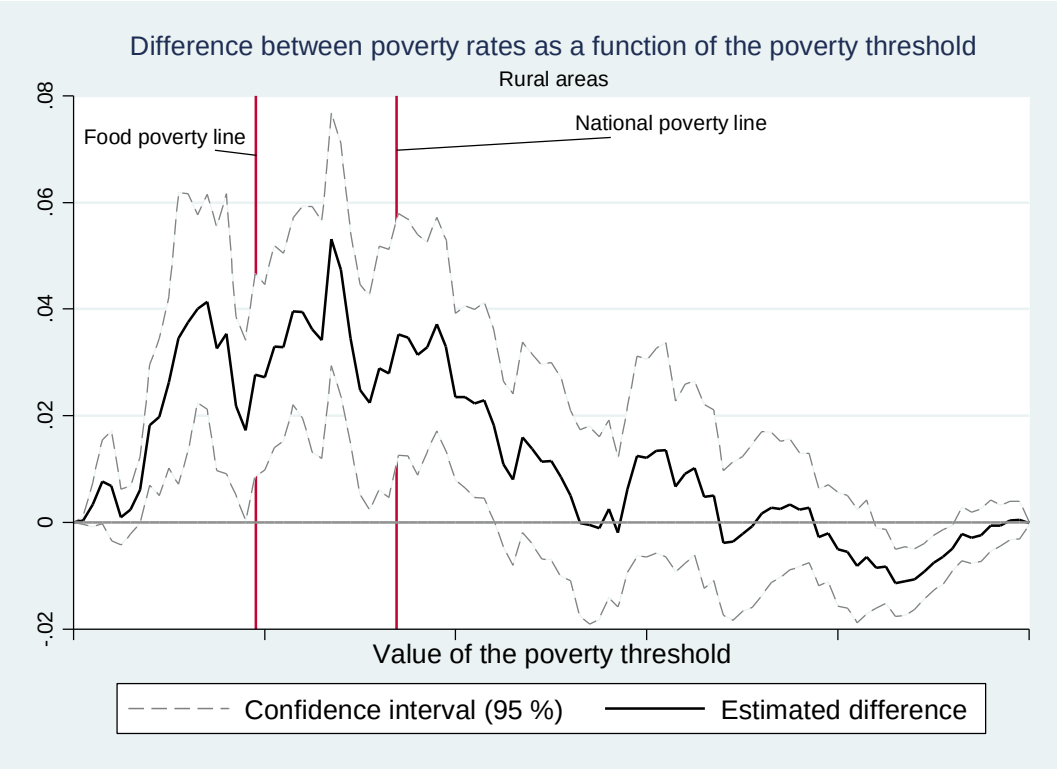

Figure 3

d. BEING POOR AMONG THE NON-POOR.

The inequalities documented above induce the existence of poor cells within non-poor households and, inversely, non-poor cells within poor households. This can be seen in Table 10, where one finds the distribution of cells according to their poverty status and that of their household. We observe that the proportion of poor cells belonging to a non-poor household varies between 2.6% and 5.3% of cells depending on the poverty threshold (4th column). Looking now at the population percentages (6th column), we observe that poor cells in non-poor households represent a higher proportion of the population than that of cells. The opposite is true for non-poor cells within poor households. In other words, poor cells in non-poor households seem to be large cells, which explains the higher poverty rate when using per adult equivalent cell, rather than household, consumption.

In total, following the national poverty threshold, 8.8%[13] of non-poor households include at least one poor cell, which means that 12.4% of the members of non-poor households are, in fact, poor, or that 12.6% of the poor live in non-poor households. This suggests that measuring poverty using a well-being measure computed at the household level can lead to a serious underestimation of the extent of poverty.

[13] 5.38/(55.96+5.38) from Column 2.

Table 10: Distribution of the poor by Poverty Status of their household

	Households		Cells		Individuals	
	N	%	N	%	N	%
National poverty line:						
Poor in non-poor households	93	5.38	232	5.52	893	6.52
Poor in poor households	633	36.63	1,664	39.61	6,174	45.09
Non-poor in poor households	35	2.03	172	4.09	320	2.34
Non-poor in non-poor hholds.	967	55.96	2,133	50.77	6,305	46.05
Food poverty line:						
Poor in non-poor households	36	2.08	111	2.64	409	2.99
Poor in poor households	210	12.15	557	13.26	2,130	15.56
Non-poor in poor households	10	0.58	103	2.45	222	1.62
Non-poor in non-poor hholds.	1,472	85.19	3,430	81.65	10,931	79.83

Source: PSF2006/2007, authors' calculations. Poverty status based on per adult equivalent consumption. Equivalent scale: 0.5: children 0 to 14 years old; 1: adults. Reading note: The line "poor in non-poor households" gives the number (and share) of non-poor households containing at least one poor cell; then, the number of poor cells found in non-poor households; and finally, the number of poor individuals found in non-poor households. Following lines are to be read in a similar way. The second line gives numbers for poor households where everyone is poor, the third line for poor households containing at least one non-poor cell, and the fourth line for non-poor households where all the cells are non-poor.

d. *ARE THE POOR IN NON-POOR HOUSEHOLDS AS POOR AS OTHER POOR?*

How poor are the poor that live in non-poor households? A natural question is that of whether the intensity of poverty is lower for them than for those who live in households where everyone is poor. Table 11 gives some elements to answer this question by presenting the poverty gap for the poor who live in non-poor households (Columns c1 and c2) and comparing it to that of the poor from homogeneously poor households (a1 and a2), and from poor households with non-poor members (b1 and b2).

Table 11: Poverty gaps for poor cells in poor and non-poor households

	Food poverty line			National poverty line		
	(a1)	(b1)	(c1)	(a2)	(b2)	(c2)
National	31.89	28.10	15.35	42.06	32.88	14.80
Dakar	32.83	30.28	9.50	35.38	28.42	16.18
Other urban areas	28.87	28.63	14.92	37.82	30.72	11.55
Rural areas	32.16	27.96	15.77	44.12	34.72	15.24

Source: PSF2007/2007, authors' calculations. Poverty status based on per adult equivalent consumption. Equivalent scale: 0.5: children 0 to 14 years old; 1: adults. Columns (a1) and (a2) show the value of the poverty gap for poor cells in poor households in which all cells are found poor; columns (b1) and (b2) show the value of the poverty gap for poor cells in poor households, in which some cells are found not poor; and columns (c1) and (c2) show the value of the poverty gap for poor cells in non-poor households.

Table 11 clearly shows that the poor in non-poor households are less poor than other poor. At the national level, the poverty gap for this group is only half that of the poor who live in poor households that contain non-poor members. At the national poverty line, it reaches only 37% of the poverty gap of the poor in poor households. This is understandable, as intra-household inequality is more likely to push part of the household members on the other side of the poverty line if the household as a whole is not too far from it. It suggests that the "invisible poor" are likely to be among the least poor of the poor.

5. CONCLUSION

This paper uses a novel survey designed to measure intra-household consumption inequalities. This new survey allows us not only to reveal the extent of both total inequalities and intra-household inequality, but also to analyze how this leads to a reassessment of the poverty diagnostic for the country.

The consumption survey we designed innovates by collecting information at the level of sub-groups within the household, using different respondents for different household's cells. A first consequence of this approach is that it allowed us to collect more complete consumption data. Total consumption is measured to be higher than what was obtained with a classical consumption survey at the same period, as well as more unequally distributed. The fact that we uncover both higher mean and higher variance of household consumption has an a priori ambiguous impact on global poverty assessment, since they should impact poverty estimates in opposite directions. In the context studied here, these two contrary effects seem to compensate each other so that the overall bias is rather small. Now, global inequality is shown to be much higher than what was previously thought, with a Gini coefficient reaching nearly 48, while international statistical yearbooks give a Gini of 40.

More central to this paper, this approach permitted to measure consumption at a relatively individualized level, and thereby to exhibit the intra-household unequal access to consumption. Within-household inequality accounts for nearly 14% of total inequality in Senegal (a level we evaluate as more than 44% of what would be the maximum intra-household inequality level, were the household head to capture the whole of consumption outside of food and utilities.) One of the consequences of such unequal repartition of resources within households is the potential existence of "invisible poor" in households classified as non-poor. Taking intra-household unequal access to resources into account, we assess that as many as 12.6% of the poor individuals live in non-poor households. They are therefore ignored when the poverty status of the household is supposed to apply uniformly to all household members. This could have important consequences for the effectiveness of anti-poverty policies.

When households are large and of a complex structure, as in Senegal and in many sub-Saharan African countries, where several relatively autonomous budgetary units cohabit, it is not the case that everyone has access to the same level of resources. In these contexts, coming as close as possible to the individual when measuring welfare is crucial in order to obtain adequate measures of poverty and help anti-poverty policies to efficiently target the poor.

Our results suggest that the more complex the household structure, the bigger the household size, and the more inequality is likely to be underestimated when computed using standard consumption surveys. This would imply that cross-country comparisons of inequality levels should take into

account that difference in family structure and organisation will translate into artificial differences in inequality levels.

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Appendix A: ESPS/PSF comparison

Table A1 reports the (inflation adjusted) mean levels of household consumption per capita in 2006-2007 CFA francs, computed from ESPS and PSF data. [14] For ESPS, the final survey report (ANSD 2007), on the one hand, and Ndoye et al. (2009), on the other, provide rather different results, with a bit less than 20% difference in levels between ANSD and Ndoye et al. The origin of this discrepancy is unclear since the data source is the same, and since the consumption aggregates seem to have been built following the same methodology. At first sight, the PSF estimate appears 15% higher than that of ANSD and 3.7% lower than Ndoye et al. However, as already mentioned, our estimate does not include rents – either real of imputed – paid by the interviewed households, while both ANSD and Ndoye et al. do. According to ANSD, housing expenses (rents, imputed rents, water, and energy bills) amount to 20% of total household expenditures in Senegal. As PSF allows evaluating expenditures on water and energy, we are able to estimate the average value of the annual rent per capita that should be added to our estimate to match the 20% share of housing expenditures. Following this line, we find that mean household consumption per capita is about 13% higher than the highest estimate from ESPS (and hence, more than 30% higher than the low estimate).[15] The number given here for this difference is only indicative given the various approximations made to reach this result; nevertheless, the sign is unambiguous. We'll retain 15-20% as a rough order of magnitude for the difference.

Table A1: Mean value of household consumption per capita – EPSP and PSF surveys

	Mean household consumption per capita in CFA (standard deviation)
ESPS Survey (from Ndoye et al. 2009)	312056
ESPS Survey (from ANSD 2007)	260711
PSF Survey	300920 (401773)

Sources: Ndoye et al. 2009, ANSD 2007, PSF authors' calculations.

[14] In order to make meaningful comparisons, we have to hold account of the fact that between 2005-2006 and 2006-2007 when the PSF was on the field, the consumption price index increased. The PSF has been conducted between November 2006 and April 2007, almost exactly a year after the ESPS. In order to estimate the average evolution of the price index between these two periods, we computed the average of the annual inflation rates calculated over the 6 twelve-month periods going from November 2005 to November 2006, December 2005 to December 2006, January 2006 to January 2007, February 2006 to February 2007, March 2006 to March 2007, and April 2006 to April 2007. For total consumption, this leads to an average one year inflation rate of 4.7%. ESPS figures reported in Table 1 have been adjusted accordingly.

[15] Note also that ESPS consumption data have been corrected for outliers in a rather radical way. In fact, for each group of items (e.g. transport, lodging…), when budget shares were measured to be 2 standard errors above or below the mean budget share of the socioeconomic strata of the household, the amount corresponding to the median budget share was imputed. PSF data have also been corrected, but with a different methodology. Outliers have been treated one by one, and when possible, records have been corrected based on the observation of discrepancies between declared expenditures and the amount paid by contributors, income levels and, when available, data from the second wave of the survey. This should be kept in mind as a cautionary note when discussing comparisons between the 2 surveys.

Appendix B: Differences between poverty and inequality measures

The rationale for using bootstrap to evaluate the significance of differences between poverty and inequality indices is provided by Biewen (2002). Asymptotic normality of the interdecile, interquartile, mean logarithmic deviation, and Theil indices can be established using the delta-method (Green, 2000). Kakwani (1993) provides the same results for the headcount poverty and the poverty gap indices. For the Gini index, see Xu (2007). In this Appendix, we reproduce in Tables B1 and B2 the estimated differences between inequality indices, based on per capita consumption, and between poverty indices, based on per adult equivalent consumption. Similar results for inequality indices based on per adult equivalent consumption are available upon request but not shown.

Table B1: Differences between inequality indices from Table 2

Type of consumption	Gini	90/10	75/25	Mean log dev	Theil-T
All consumptions	2.45***	0.62***	0.04	0.04***	0.07***
	(0.22)	(0.23)	(0.07)	(0.00)	(0.01)
Non-food consumptions	4.44***	6.30***	0.84***	0.16***	0.19***
	(0.35)	(1.06)	(0.18)	(0.01)	(0.03)
Food consumption	1.21***	0.49***	0.07*	0.02***	0.02***
	(0.18)	(0.18)	(0.04)	(0.00)	(0.00)

PSF2006/2007, N=1728, authors' calculations, using sampling weights. Bootstrap standard errors (250 replications).*,**,***: significant at the 10%, 5%, 1% level.

Table B2: Differences between poverty indices from Table 9

	Food poverty line		National poverty line	
	Headcount index	Poverty gap index	Headcount index	Poverty gap index
National	1.77***	1.01***	3.90***	1.98***
	(0.63)	(0.19)	(0.65)	(0.18)
Dakar	0.37	0.13***	5.74***	2.07***
	(0.33)	(0.05)	(1.19)	(0.24)
Other urban areas	0.92	0.83***	3.65**	1.54***
	(1.29)	(0.29)	(1.51)	(0.24)
Rural areas	2.64***	1.43***	3.21***	2.09***
	(0.98)	(0.31)	(0.93)	(0.28)

PSF2006/2007, N=1728, authors' calculations, using sampling weights. Bootstrap standard errors (250 replications).
*,**,***: significant at the 10%, 5%, 1% level.

Appendix C: inequality measures, using per adult equivalent consumption.

Table C1: Inequality measures, on per adult equivalent consumption.

	Gini	90/10	75/25	Mean log dev	Theil
Per adult equivalent household's consumption					
Per adult equivalent household's total consumption	45.71 (1.36)	6.69 (0.31)	2.80 (0.11)	0.35 (0.02)	0.42 (0.04)
Per adult equivalent hhold's non-food consumption	62.79 (1.66)	16.35 (1.31)	4.68 (0.26)	0.75 (0.04)	0.86 (0.07)
Per adult equivalent food hhold's food consumption	37.99 (0.75)	5.51 (0.34)	2.33 (0.08)	0.24 (0.01)	0.26 (0.01)
Per adult equivalent cell's consumption					
Per adult equivalent cell's total consumption	47.70*** (1.29)	7.28*** (0.35)	2.86 (0.10)	0.39*** (0.02)	0.48*** (0.04)
Per adult equivalent cell's non-food consumption	66.71*** (1.47)	21.35*** (1.39)	5.28*** (0.24)	0.88*** (0.04)	1.03*** (0.08)
Per adult equivalent cell's food consumption	39.05*** (0.74)	5.98*** (0.35)	2.43** (0.08)	0.26*** (0.01)	0.27*** (0.01)

PSF2006/2007, N=1728, authors' calculations, using sampling weights. Bootstrap standard errors (250 replications) between parentheses. Equivalent scale: 0.5: children 0 to 14 years old; 1: adults. . *,**,***: difference with per adult equivalent household's consumption inequality measure is significant at the 10%, 5%, 1% level (see Note 9 and Appendix B for details).

Table C2: Inequality decomposition, per adult equivalent consumption

	Theil within	Theil between	Share within
Scale A			
per adult eq. cell's consumption	0.06 (0.01)	0.42 (0.04)	12.69 (2.71)
per adult eq. cell's non-food consumption	0.17 (0.03)	0.86 (0.07)	16.32 (2.79)
per adult eq. cell's food consumption	0.01 (0.00)	0.26 (0.01)	5.30 (0.78)
Scale B			
per adult eq. cell's consumption	0.06 (0.02)	0.41 (0.04)	12.74 (2.99)
per adult eq. cell's non-food consumption	0.16 (0.04)	0.84 (0.07)	16.26 (3.02)
per adult eq. cell's food consumption	0.02 (0.00)	0.26 (0.01)	5.93 (0.67)
Scale A – without educational expenditure			
per adult eq. cell's consumption	0.06 (0.01)	0.41 (0.04)	13.06 (2.67)
per adult eq. cell's non-food consumption	0.18 (0.03)	0.87 (0.08)	17.14 (2.82)

PSF2006/2007, N=1728, authors' calculations, using sampling weights. Bootstrap standard errors (250 replications) between parentheses. *Scale A:* 0.5: children 0 to 14; 1: adults; *Scale B:* 0.2: children 0 to 4 ; 0.5: children 5 to 14; 1: adults.